

The Oral Health of the Irish Army

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Doctor of Philosophy

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Declaration

I declare that this thesis has not been previously submitted as an exercise for a degree at this or another university. This submission comprises my own work towards the Ph.D. unless otherwise stated, and in which case, acknowledgments and references are given to the work of others.

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Summary

Background and rationale

Dental services are provided in the Army for operational reasons as a means of collecting dental forensic charting and reducing the likelihood of a dental emergency. The provision of services in a planned manner requires detailed data about the diseases and conditions prevalent in the Army population. Data reporting the oral health of soldiers was last collected in 1990 and was confined to a narrow range of age groups. In the interim the oral health of soldiers has been anecdotally reported to have improved markedly as a result of access to lifetime community water fluoridation and a change in dental treatment practices. Dental teams had reported that poorer oral health continued to be experienced by at least a proportion of the population but no data to support any of these observations existed. Collection of comprehensive data relating to normatively assessed need, the associated determinants of oral health and subjective measures of oral health would allow the Army to plan for the delivery of care and develop risk rating for the appropriate allocation of resources.

Aims

There were three aims that formed part of this survey. Firstly, to evaluate the oral health status of soldiers in the Irish Army, using standard clinical indicators. Secondly to evaluate the prevalence of such determinants of oral health that might affect the experience of disease in the Irish Army. Thirdly, to evaluate the subjective experience of oral health including oral health related quality of life.

Methods

Five trained and calibrated dentists examined patients using fixed dental surgeries in five Army barracks and using mobile dental chairs in two training locations. Standard clinical indicators were collected including number of teeth, Decayed, Missing and Filled (DMFT) scores, periodontal health using the Periodontal Screening Record (PSR) and tooth surface loss using the Basic Erosive Wear Index (Index). The consequences of advanced disease were recorded by reporting the presence of dentures, advanced prosthodontic therapies, unrestorable teeth and the presence of PUFA (pulpal, ulceration, fistula, abscess) signs. A comprehensive risk factor questionnaire was completed to identify the determinants of oral health. The questionnaire recorded subjective measures by asking questions about pain experience, self-reported oral health and oral health related quality of life (OHRQoL) using the Oral Health Impact Profile 14 (OHIP-14) questionnaire.

Results

The survey examined 777 soldiers, including 224 new entrants and 553 soldiers in the trained strength and was weighted by rank in the reporting. In the sample 99% retained 21 or more teeth, 75.6% had 18 or more sound untreated teeth and 1.6% had a denture. The prevalence of untreated caries in the Army was 16.1%, 27.1% had PSR codes 3 or 4 and 22.1% had BEWE $\geq$ 2. The sample included 7.1% with a DMFT score of zero. Soldiers in the poorest areas of deprivation were over-represented in the recruit pool and there were strong social gradients by rank and by education level. More officers lived in the most affluent areas and had higher university education whereas more private soldiers lived in the areas of greatest deprivation and had lower levels of education. There was a high prevalence of unhealthy behaviours, including 26.3% who smoked or vaped, 4% with high-risk alcohol intake, 14.5% who brushed less than twice a day and 51.3% with a cariogenic diet. In the subjective measures of oral health, 5.6% reported pain from teeth, 61.4% reported excellent to good oral health and 35.5% reported an OHIP-14 impact at least occasionally in the previous 12 months. An unexpected finding was the prevalence of pain associated with untreated periodontal disease. Regression analyses indicated that certain groups at higher risk of dental disease, unhealthy behaviours and impacts included new entrants, soldiers with some secondary education and less frequent attenders.

Discussion

The results showed remarkable improvements in oral health in soldiers in the thirty years since the last survey was undertaken. The results in soldiers from 50 to 64 years were better than age matched civilians reported in The Irish Longitudinal study on Aging and suggest an Army effect modulated by compulsion to attend and free access to most basic dental care. Overall, the system was successful in treating disease. The presence of 7.1% with a DMFT score of zero who could not be identified using traditional forensic markers showed the need for alternate methods, including digital scanning of oral anatomical characteristics. The high level of untreated disease in new entrants, coupled with very high levels of unhealthy behaviours indicated that the Army was recruiting from a subsection of the Irish population. The social gradients in both new entrants and in the wider Army confirmed anecdotal observation over many years and have important implications for policies in relation to diversity and inclusion. The new entrants reported a range of behaviours that adversely affect oral health but these were not addressed by the Army leading to on-going risk of disease development. High levels of attendance and the compulsion to be made dentally fit at certain timepoints masked the underlying risk. The treatment of disease led to a low prevalence of

pain and reported OHIP-14 impacts but the low prevalence of better self-reported oral health was an important indicator that soldiers were aware of the effect of negative health behaviours. The existence of high-risk groups marked the need to apply a risk rating to soldiers so that they could be streamed into more appropriate pathways of care.

Conclusion

There had been a marked improvement in the oral health of the Irish army in the last 30 years. The dental health system was effective in reducing the prevalence of diseases and conditions in the Army, particularly in advance of deployments overseas. The dental service should use the data collected to help inform a transition from a treatment-oriented system of care to one that prioritises preventative interventions in combination with behaviour change to improve soldier oral health. Additionally, efforts to improve oral health should be integrated with Army interventions to improve well-being and health of serving personnel.

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Glossary of commonly used terms and abbreviations

BEWE	Basic Erosive Wear Examination
CDC	Centre for Disease Control
CI	Confidence Interval
CPITN	Community Periodontal Index of Treatment Need
DMFT	Decayed, missing and filled teeth. An index of the severity of dental caries by measuring the total number of teeth with disease or treatment of disease.
DT	Decayed Teeth
FT	Filled Teeth
HSE	Health Services Executive
K-W	Kruskal-Wallis, statistical test
LDV	Last dental visit
MDAS	Modified Dental Anxiety Score
MT	Missing Teeth
NATO	North Atlantic Treaty Organization
NCO	Non-Commissioned Officer: A grade in the Army that is composed of soldiers promoted within the Enlisted ranks. They form the link between Private soldiers and the Commissioned Officer ranks.
New entrants	The term used in this thesis to describe recruits and cadets in the Army, who were characterized by recent civilian life and lack of access to the Army system of dental care.
NHANES	National Health and Nutrition Examination Survey
NHS	National Health Service, UK
OHIP	Oral Health Impact Profile
OHRQoL	Oral Health Related Quality of Life
PfP	Partnership for Peace: A programme developed after the collapse of the Warsaw Pact designed to increase trust and cooperation between NATO, neutral countries and former states of the Warsaw Pact.
PSR	Periodontal Screening Record.
PUFA	Pulpal involvement, Ulceration, Fistula, Abscess
STANAG	NATO Standardization Agreements
SUNT	Sound Untreated Natural Teeth
TILDA	The Irish Longitudinal study on Ageing

Trained strength	The officers and soldiers in the Army who had completed basic military training and were deployable in their role at home or overseas.
TSL	Tooth Surface Loss
UK	United Kingdom
UN	United Nations. A diplomatic and political organization whose purpose of maintaining world peace and security has been the foundation for deployment of Irish peacekeeping forces.
US	Unites States

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1 Introduction

1.1 Summary

The Irish Army is an all-volunteer professional force with roles in Ireland and on overseas deployments specified by government policy (Dept. of Defence, 2015). Medical services are required to support these roles and include the delivery of dental services. International publications reported that dental disease, particularly untreated caries, was an important cause of lost workdays in the military (Teweles and King, 1987, Gunepin et al., 2011, Simecek et al., 2014). Anecdotally, Dental Officers had observed that a subsection of new entrants presented with a high burden of oral disease and that some soldiers required considerable supports to maintain oral health. Data to support these observations that might aid in the planning of service delivery was unavailable. The Dental Service also collected forensic charting to aid *post mortem* identification, which was of high importance as no other biological markers were recorded by the Army. Dental Officers had reported an increasing number of recruits without caries experience who lacked markers that might be used in dental identification but the prevalence in the Army was unknown.

An oral health survey of the Irish Army was last conducted in 1990 and in addition to being dated was confined to narrow age groups of recruits and serving soldiers reducing the utility of the data. In the interim, the national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) suggested that oral health had improved, at least for sections of the population, but this data was also dated and difficult to use for inferences about the oral health of the Army in 2020. A sample of 12-year-old children in Ireland reported that 63% of those living in fluoridated and 47% of those living in non-fluoridated communities were caries free (Harding, 2016), which suggested that a large proportion of soldiers would have better oral health on entry but data to support these inferences was not available. A recent survey reported the oral health of older adults, but the examined age groups corresponded to a small part of the Army population and was of limited utility (Naseer, 2020). International military publications were, in the main, convenience samples, with limited reporting of epidemiological indices and a wide variability in reporting standards. Differences in the gender, ethnic, racial, age and other proportions in these studies further reduced the relevance to the Irish Army. These knowledge gaps suggested that an oral health survey would provide useful data that might be used in the planning for delivery of services.

Social gradients in oral health were reported in the national surveys by using *Medical Card* status as a proxy for deprivation (O'Mullane and Whelton, 1992, Whelton, 2007) and similar

findings were reported in high-income countries (Cooney, 2010, Ministry of Health, 2010, White et al., 2011). International military publications reported social gradients by rank (Horev et al., 2003), level of education (Sgan-Cohen and Eldad, 2000, Ceylan et al., 2004) and socio-economic position (Sgan-Cohen and Eldad, 1999, Bastos et al., 2007, Elmer et al., 2011) but the applicability to the Irish Army was unknown. A practice-based survey of Irish soldiers in 1992 reported that Officers had better oral health than other ranks (Hayden, 1995) but whether these findings were valid for soldiers in 2020 was unknown. In addition, little was known about the proximal behaviours associated with oral disease in the Army. These findings suggested that the collection and analysis of suitable intermediate and proximal determinants of oral health should be undertaken.

The Dental Service was aware that the Irish Army had never conducted a survey of the subjective assessment of oral health. The experience of dental pain was of relevant to presentation for dental emergency appointments but the prevalence of pain or other subjective measures of oral health was unknown. The collection of oral health related quality of life measures was recognized as a means of identifying groups at a higher risk of experiencing the impacts of oral health that would not be detected during normative assessment. These outcomes could be used to shape policy and enhance patient care by bridging the gap between clinically assessed normative need and subjective experience of oral health.

The overall aims of this research were to assess the oral health of the Irish Army, identify determinants associated with diseases and conditions and evaluate the subjective experience of oral health reported by soldiers. In order to achieve these aims, an oral health survey was undertaken that is reported in this thesis.

1.2 Structure of the thesis

The remainder of this chapter describes the milieu in which dental services were delivered in the Irish Army. The following chapters contain the literature review, materials and methods, the normatively assessed oral health of the Irish Army with relevant associated determinants of oral health, the proximal determinants of oral health, the subjective reports of oral health and a chapter of conclusions and recommendations.

1.3 Structure of the introductory chapter

This chapter describes the structure and organization of the Army along with the organizational culture to give context to the place of oral health and the role of the oral healthcare services in maintaining personnel as fit for duty and immediate deployment, including mitigation of urgent dental treatment need on deployment. Next, the organization of dental services in the Army are described with a review of dental policy in the Army. These sections provide the context for research into the oral health of soldiers which is described in the remainder of the thesis.

1.4 The structure of the Army

The Irish Army is the land component of the Irish Defence Forces, tasked with a variety of roles, as specified in the White Paper on Defence (Dept. of Defence, 2015). These include the contingent capacity to defend the State against armed aggression, participation in United Nations (UN) and European Union (EU) peacekeeping operations, aid to An Garda Síochána (the Irish police force) when requested, and assistance in the management of essential services during times of natural disasters. One of the implications for oral healthcare services is that soldiers may be deployed at short notice to austere environments where dental services are not available or difficult to access or present additional risk when being transported to the point of care.

By structure, the Army is organized on conventional military lines, with two self-supporting infantry brigades and a training centre in the Curragh Camp, Co Kildare. The functional unit of the Army is the infantry battalion and forms the nucleus of units that serve on overseas deployments. The seven battalions are located in Finner Camp, Co Donegal; Galway; Limerick; Kilkenny; Athlone; Dublin and Dundalk, as displayed in Figure 1-1. Other personnel in the Army serve in the joint Headquarters of the Defence Forces in Newbridge, Co Kildare and McKee Barracks, Dublin. A logistical difficulty associated with the distribution of soldiers across the State has been to provide appropriate dental services near to barrack locations. However, data reporting the distribution of diseases and conditions that would allow a greater degree of appropriate outsourcing was unavailable.



Figure 1-1: Main barrack locations of the Irish Army

1.5 The organizational culture of the Army

O'Donnell and Boyle (2008) described organizational culture as “patterns of behaviour and observable symbols and ceremonies, and more deep-seated and underlying values, assumptions and beliefs” (O'Donnell and Boyle, 2008). The role central to all military organizations is the capacity “to fight and succeed in combat” (Ministry of Defence, 2017) and organizational culture in the military internationally, as well as in the Army in Ireland, has developed to manage the fact that soldiers are trained and socialized that, when required, it is acceptable to transgress social norms by utilizing organized and systematic violence (Boëne, 1990). Implicit in military life is the understanding that personnel will use weapons and these may be in situations of grave personal danger when injury, disablement or death is possible (Joellenbeck, 1999).

The highest potential risk to personnel in the Irish Army occurs on deployment overseas on UN peacekeeping operations. Deployment has become a central pillar in the objective of Irish foreign policy to have a robust and effective UN (Murphy, 1998) and was one of the three stated core principles during Ireland's term on the Security Council during 2021-2022 (Government of Ireland, 2023). The operational tempo of overseas deployments has resulted in the training for, and deployment of, personnel on overseas missions becoming the principal

role of the Irish Army. The Commission for Defence (2022) reported that the Army had 8% of personnel on deployment at any one time and 20% committed over the course of a typical year, adding that this was an extraordinarily high “level of commitment by international standards” (Dept. of Defence, 2022b). Oral health policy and dental care delivery in the Irish Army has evolved in response to these requirements.

Selection, retention and control of personnel in the Army reflects the necessity to employ solely those personnel who fit the organizational culture. Personnel may serve as line soldiers, technical specialists or officers, each of which have specific entry requirements, including age limits. In this survey the term *new entrants* was used to describe cadets and recruits undertaking initial training and the term *trained strength* described soldiers who had completed initial training and could be selected for duty at home or deployment overseas. From the point of view of the epidemiological survey, an important distinction existed between these groups as the latter had access to the Army system of care for protracted periods.

Rigid discipline and high standards of health and physical fitness have been found to maximize combat effectiveness and are conditions of employment and shape the type of person that is permitted to join and stay in the Army (Brown, 2005). Socialization begins on entry when soldiers surrender many of their previously held legal rights including the right to strike, join a trade union or leave freely (Government of Ireland, 1954). Personnel are subject to military law at all times, including when off-duty, with standards of discipline and personal conduct that exceed those found in typical workplaces. Personnel can be prosecuted under military law for arriving late at work, failing to dress properly, failure to properly address or salute their seniors and a myriad of other regulations that shape the work environment (Government of Ireland, 1954). Consequently, while the Army may be considered a specific subgroup of Irish society any assumptions made about the oral health of soldiers on the basis of national findings may not be generalizable. For example, it is a requirement in the Army to have a minimum number of teeth on recruitment without reliance on dentures, thus in 1990 in the 25 to 34 years age group when the population prevalence of dentures was 14% in Ireland (O'Mullane and Whelton, 1992), the prevalence in recruits in the Irish Army was 3% (Hayden, 1995).

The organizational culture in the Army can be explained in terms of the Hofstede model as a general tendency of individuals to prioritize themselves in pursuit of promotion, accept

authority, be risk adverse, identify the military as a masculine occupation and favour tradition over innovation (Hofstede, 1980). The most distinctive aspect of organizational culture in the Army is the rigid hierarchy that leads to a strong power culture, where power radiates out from central figures (Handy, 1976, Harrison and Stokes, 1992). Clearly delegated authority is vested in roles, particularly commanding officers in units, who control budgets, facilitate access to services, extend employment contracts and carry out annual appraisals. At best this creates a form of paternalism, where the commander intuitively and reflexively does the best for those under their command. However, the Independent Review Group on the Defence Forces (2023) has reported serious negative aspects of organizational culture in the Army that impact on the autonomy of personnel and concluded that for some groups, at least, the Army was not a safe and respectful environment (Dept. of Defence, 2023a). An aspect of the paternalism relevant to healthcare delivery was the mandatory attendance for annual medical examinations and attendance at dental examinations on entry and prior to overseas service. A negative effect of this paternalism has been that service personnel may fail to develop independent skills that improve health or the autonomy to fully question and understand healthcare interventions (Pica-Branco and Hudak, 2008), relying instead on professional interventions. These skill development issues have not been confined to healthcare and have contributed to rising homelessness in veterans in Ireland (ONE, 2024) and other countries (Khan, 2010) (Ross, 2020)

It is within this context that the utility of the epidemiological survey must be viewed. Understanding the prevalence of oral disease, the associated risk factors and its impacts in the Army population will aid in the planning of dental service delivery in the Army. Presently the Army provides a range of health care services including dental care where attendance is mandatory and focuses predominantly on the collection of forensic records and the provision of dental treatments that reduce the risk of a dental emergency on deployment and suitable data is required to estimate the associated requirements. However, it is recognised within the dental service that a reorientation from a treatment service to one of prevention and health promotion is required to meet both the short-term objectives of the dental service of ensuring that personnel are fit for deployment and also the long-term objective of securing oral health. The collection of relevant oral health data and risk factor data will allow the identification of groups who would benefit from appropriate interventions.

1.6 The role of dentistry in the Army

Oral healthcare services had evolved in the Irish Army in response to the unique culture and organizational requirements therein described above. The three stated aims of the Army dental service, as established by the former Chief Dental Officer (Hayden, 2006) and agreed by the Joint Standing Committee for the delivery of healthcare on foot of a review of the delivery of dental services were:

- (1) Make personnel dentally fit for duty at home and overseas.
- (2) Return personnel with dental pain to duty as quickly as is possible.
- (3) The collection of timely and accurate forensic dental charting.

There are considerable information gaps presently which makes it difficult to plan and deliver these aims. It is proposed that an epidemiological oral health survey is needed to gather information relevant to these aims. Robust epidemiological data will inform and allow the Chief Dental Officer to formulate policy and strategic direction, set Key Performance Indicators (KPI)s, identify intermediate health and health service objectives and establish the type of workforce and *materiél* required to fulfil these aims.

1.7 The organization of dental services in the Army

The organization of oral healthcare services in the Army evolved in response to the policy requirements, outlined above. These services were provided using a blended system of in-house and external practitioners. An important part of the historical rationale for in-house services was the requirement to return personnel with dental problems to duty as quickly as was possible and for this reason the military dental barracks were situated in the centres with greatest troop concentration in Dublin, Athlone, Cork and the Curragh Camp, as displayed in Figure 1-2. The dental facilities were staffed by military and civilian dentists, hygienists and dental nurses. These personnel provided primary dental care and other services to personnel in defined geographic regions.

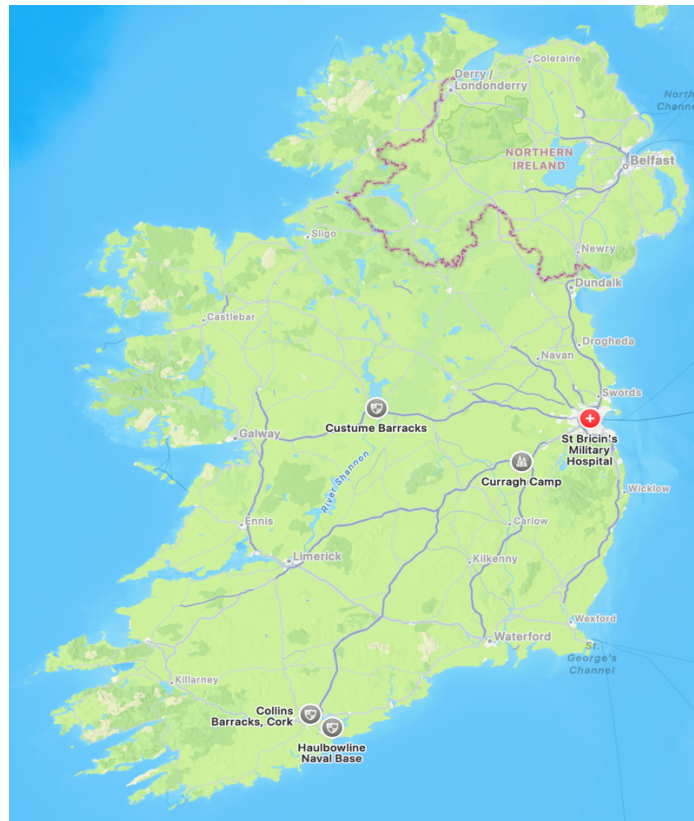


Figure 1-2: Location of military dental surgeries in the Defence Forces

Most personnel who served in the Army were not co-located with military dental facilities, including five of the seven infantry battalions who formed the majority of the troops who were deployed overseas. This structure necessitated the use of locally contracted community general dental practices that were subject to commissioning of services under a framework agreement of tendered prices. Personnel attended these general dental practices on demand at their own convenience without prior approval on production of an in-date Army ID card. Secondary care was provided using in-house and external consultants for other specialities, where required, using a system of prior approval and financial sanction. The main access issue relating to specialist endodontics for enlisted personnel is described below. An identified difficulty in the delivery of dental services in the Irish Army was the lack of dedicated in-house military dental Information and Communications Technology (ICT). Dental records were held in a distributed form using in-house paper records, standalone x-rays, medical and pharmacy ICT, records held by external dental practices, e-mails between external dentists and internal staff and invoices from external dentists with associated clinical information. Apart from the obvious deficit in management and oversight of the clinical and business processes, the lack of dedicated dental ICT meant that data captured during routine encounters could not be used to track clinical indicators, associated behaviours or the impacts of oral health.

1.8 The scope of dental treatments provided in the Irish Army

The scope of dental treatments provided by the Army broadly constituted those necessary from an occupational point of view. The in-house service provided primary care including routine examinations and assessments, restorations, endodontics and extractions. Under current regulations, in-house teams could provide dentures at no cost to the patient (Defence Forces, 1955) but regulations did not provide for the provision of advanced prosthodontic therapies including crowns, bridges or implants, except following incidents of trauma that occurred at work. Military dental centres had staff dental hygienists who provided subgingival debridement as required but who were recognised as being under-utilized in the provision of wider preventative therapies within their scope of practice such as diet advice, fluoride application or smoking cessation advice (Dept. of Defence, 2022a). Complementary therapies were provided by the external civilian dental practices under a framework agreement of tendered prices for examinations and assessments, radiographs, scale and polish, restorations, extractions and root treatments on incisor, canine and premolar teeth.

An important function of military dental clinics had traditionally been to provide an emergency service by operating a “sick parade” that allowed personnel attend with any dental problem of any level of complexity and to be seen immediately on presentation. This had significant implications for what constituted a “dental emergency” in the military as personnel could attend with any problem that might prevent daily work (Swan and Karpetz, 1995). The role of the dentist had been to satisfy the patient to the degree that they were able to return to duty as quickly as was possible regardless of the clinical urgency. As such, this process was duplicated in the outsourced model, with framework agreements guaranteeing access for soldiers with dental problems within 24 hours of initial contact.

Certain treatments were only available to soldiers following prior sanction/approval, for reasons of financial control. In general, these items of care referred to secondary care services such as molar endodontics but also included access to dental hygienist care. At the time of planning this research (2019), government policy since the foundation of the State had been that officers were eligible to be referred to civilian specialists in community practices but enlisted personnel could only be referred to public funded services, although this was reversed in 2023 (Dept. of Defence, 2023b). As there is little to no access to specialist care in the public dental services, the Army dental service responded to gaps by providing in-house specialist periodontal, oral surgery and oral medicine care to all ranks. Molar endodontics, however, was only available under sanction/approval to officers and delivered by specialists

in the community. The clinical impression amongst army dental personnel was that this had created a differential in the number of retained teeth between officers and enlisted personnel but there was little clinical data to support this observation or to take action to address this health inequality.

Prior to deployment overseas all personnel were required to attend a military dental clinic for recording of a forensic dental chart. Following the reorganization of the Army in 2012 the vast majority of personnel most heavily involved in deployment overseas, in the infantry battalions, were located in barracks without a co-located dental team. As a result, personnel who required a pre-deployment forensic chart or dental health assessment prior to deployment were required to physically travel to centralized dental service locations. A consideration in the formulation of this research was to determine the prevalence of personnel at a low risk of future disease development who might be more fully outsourced to community based general dental practices to avoid unnecessary travel to military dental centres. The time saved in military dental practices could then be allocated to provide additional supports for personnel assessed at a higher risk of future disease development.

In addition to the ancillary benefits of reducing the logistical challenge associated with moving groups and reducing the number of lost workdays associated with unnecessary appointments, it would also reduce the carbon footprint of the Army. Militaries worldwide are enormous consumers of energy both directly and indirectly (Belcher et al., 2020) and have been estimated to produce 5.5% of global greenhouse gases (Parkinson, 2022). It has been reported that the vast majority of carbon generated in the provision of dentistry is associated with staff and patient travel (Duane et al., 2019). Any reductions in carbon production made possible by alternatives to travel should be embraced as part of the overall carbon reduction strategy of the Defence Forces.

1.9 Conclusion

The focus of the dental service in the Irish Army had been the treatment of established dental need. However, it was understood amongst the Army oral healthcare services that the service should pivot to not only deliver the traditional army dental remit but should also include holistic risk assessment, targeted evidence-based prevention and oral health promotion. As the service transitioned to a reshaped military dental service there was a need for an epidemiological survey to underpin change and to enable assessment of oral health status and risk rating, prevention and treatment needs of serving personnel.

2 Review of the literature

2.1 Introduction

Specific operational, cultural, social and organizational aspects of military service have shaped the delivery of dental care in the Irish Army. This chapter presents the rationale for forensic dental charting in the military as well as the basis for the provision of oral healthcare services. These requirements underpin the stated roles of the dental service in the Irish Army.

This chapter also presents a review of the most recent and relevant literature relevant to the aims and objectives of this research. An important consideration in this regard is the lack of recently published Irish military or national data, which necessitated the examination of international military and civilian data for comparable trends in oral health. The literature reported in this review provides a framework for understanding the purpose of this research and the utility of the research findings within the context of the currently available data.

2.2 Aims of the literature review

The aims of the literature review chapter were:

- 1 To report the rationale for the provision of forensic and occupational services in the Irish Army.
- 2 To review contemporaneous trends in the oral health status of the Irish and similar high-income countries to provide context for the trends in oral health of Irish military personnel.
- 3 To review the literature on the oral health status of persons serving in the military to include trends in prevalence of caries, periodontal disease, tooth wear and the impact of oral health on the quality of life.
- 4 To review and explore risk factors associated with oral diseases in military populations and approaches used to risk assess, predict and mitigate the risk of urgent need for dental care during deployment.

2.3 Literature review methods

2.3.1 Search and retrieval of literature

The methodology used in this literature review was the narrative review, commonly utilized in medical research (Faggion et al., 2017) where broad questions need to be answered by less formal approaches than are found in a systematic review. Narrative reviews may be utilized where research seeks to answer more than one research question, as is the case in this research. Narrative reviews do not necessarily include formal methods, such as specific search strings and inclusion or exclusion criteria (Ferrari, 2015). The review was underpinned by a structured search strategy supported by an information specialist.

2.3.2 Literature search

The search strategy included an initial search of Pubmed in October 2018 using a dedicated search string, created by a subject specific librarian, as displayed in Figure 2-1. The results of the Pubmed database search were collated with documents retrieved from on-site searches of publications in the Dublin Dental University Hospital library as well as the grey literature including documents available in the library of the Irish Defence Forces and documents available in organizational websites including the Oireachtas, the Department of Health and LENUS.

```
"Military Dentistry"[Mesh]
OR
((military[tiab] OR army[tiab] OR armies[tiab] OR "armed forces"[tiab] OR
navy[tiab] OR naval[tiab] OR sailors[tiab] OR marines[tiab] OR submariners[tiab]
OR "Coast guard"[tiab] OR "air force"[tiab] OR soldiers[tiab] OR "Military
Personnel"[Mesh])
AND
(dentistry[tiab] OR caries[tiab] OR "tooth decay"[tiab] OR "gum disease"[tiab] OR
periodontitis[tiab] OR periodontal[tiab] OR dental[tiab] OR "oral health"[tiab] OR
"Dentistry"[Mesh] OR "Oral Health"[Mesh] OR "Stomatognathic
Diseases"[Mesh]))
```

Figure 2-1: Search terms used in Pubmed search

2.3.3 Search limits

Although narrative reviews do not require specific inclusion and exclusion criteria, it was necessary to use the following criteria to limit the search parameters:

- (1) The searches using this methodology were concluded by November 2018 and relevant publications were added until December 2022. An alert system for the publication of relevant documents was established after the conclusion of this process to capture documents of relevance which were published in the intervening period.
- (2) Documents were included if published or translated into the English language.
- (3) Studies were included if reporting the oral health status of military personnel.
- (4) Studies were included if reporting the oral health status of a population in high-income countries (Ireland, United Kingdom, United States, Canada, Australia, New Zealand) of an age relevant to the age groups commonly found in the military.

2.4 Forensic dental charting

2.4.1 Background

Military service is dangerous, and deaths occur both in combat and in robust military training (Dept.of Defense, 2023, Ministry of Defence, 2023). The military expends considerable resources in order to accurately identify personnel *post mortem* and transfer their remains to their family for burial (Dept. of Defense, 2019). Dog tags, pocket contents, rank marking and names on uniforms are all utilized as required (Komar, 2003). Many militaries also utilize DNA and fingerprint technology (Holland, 1993). However, the nature of military service is such that bodies of deceased personnel may not be recovered for some time after death (Steadman, 2009). Immersion in water and soil, spoilage by animals and the ever-present threat of fire on the battlefield may also limit identification by these methods (Zerrin, 2018).

In light of the limitations of the techniques described above, dental charting is used as an additional means of *post mortem* forensic identification (Friedman, 1989, Hiss, 2000, Guimares, 2017). Teeth and their most common restorative materials last indefinitely in soil and water and survive well in fires up 1000°C (Vandrangi et al., 2016) and dental charting is quick, easy, reliable and relatively cheap (Avon, 2004). The patterns of restored and missing teeth have an enormous number of permutations with even simple combinations running into billions of possible permutations (Senn, 2013). Adams (2003) has shown that ‘generic’ datasets that record only the teeth present, absent and filled identify 99.8% of individuals with an *ante mortem* record (Adams, 2003). He further noted that random matching occurred in

less than 2% of cases. It has long been known that increasing the complexity of charting does not show a proportional increase in the power of selection (Lorton and Langley, 1986). This is a significant and often overlooked factor in resource allocation.

Brown *et al.* (2017) carried out an audit of dental records and reported extensive errors in DMFT records that would impede forensic identification including: amalgam restorations that were present in the mouth that were absent from 13% of charts; tooth-coloured restorations missing from 18% of charts and 7.5% of records that charted amalgam restorations present that were not present in the mouth (Brown *et al.*, 2017). Following the Tsunami in south-east Asia in 2004, only 18% of Thai victims had a dental chart, of whom 7.4% had usable dental characteristics. Only 2% of Thai victims were identified by dental means (Petju *et al.*, 2007). By contrast, 80% of the non-Thai victims were identified by dental means (Schuller-Gotzburg and Suchanek, 2007) highlighting the importance of accurate *ante mortem* records in *post mortem* identification. It is for this reason that forensic dental records are collected by the Army.

2.4.2 Personnel without caries experience

In the Irish Army, dental forensic charting is the only biometric data collected to aid in the identification of personnel *post mortem*. Anecdotally, Dental Officers have remarked that an increasing proportion of new recruits have presented without restorations or teeth missing due to caries that might aid in *post mortem* identification but the prevalence was unknown. The Australian and New Zealand armies reported that between a quarter and a third of the youngest recruits had a DMFT score of zero, which decreased in prevalence with age (Hopcraft and Morgan, 2005, Hopcraft *et al.*, 2009, Naysmith *et al.*, 2023) but was not reported as a forensic charting concern. The proportion in the Irish adult population who are caries free was also unknown but it had been reported that 63% of children living in fluoridated communities and 47% of children living in non-fluoridated communities who were 12 years of age in 2016 were caries free, and it might be expected that these results would translate into improvements in oral health in recruits (Harding, 2016). Strategies to aid in the identification of personnel without restorations, such as scanning of the mouth to capture upper and lower study models and anatomical features, will be required to capture additional data. Epidemiological data are required to assess the number who might require this intervention.

2.4.3 Edentulousness

Personnel with complete loss of teeth cannot be identified by dental forensic markers. Anecdotally, Dental Officers have reported that it has been many years since they have treated personnel with complete dentures and this may partly be a result of Army discharge policies by age and rank. Nonetheless, it was important to determine what steps should be taken to provide an alternate biometric record for edentulous personnel.

2.4.4 Denture labelling

Denture labelling has been suggested as an ancillary means of forensic identification and is recommended by a number of forensic bodies, dental bodies, US states and a number of countries (Richmond and Pretty, 2006, Murray et al., 2007). However, this process is not in common practice in Ireland nor is it recommended by any Irish state agency. The prevalence of denture wearing in the Army had anecdotally been reported to have dramatically decreased over the previous 20 years but the prevalence was unknown. Epidemiological data was required to determine whether dentures should be considered as an alternate means of forensic identification. Data from an epidemiological survey would enable the Chief Dental Officer to set policy in this domain.

2.5 Provision of an occupational service

2.5.1 Historical basis for the provision of military dental services

Limitation of this review to the English language focusses by necessity on the largest Army of its era that used the English language, the British Army. In a review of the history of the British Army Dental Corps, Woods (1938) described the evolution of dental services over the course of three centuries (Woods, 1938). In the early 17th century teeth were regarded as a tool and soldiers were required to have incisors and canines to remove the pins of grenades and to remove the covers of powder charges used in rifles. At this time, the impacts of dental diseases were entirely viewed as an occupational issue and limited attempts were made to relieve pain by the extraction of teeth by Medical Officers.

Following the introduction of modern rifle cartridges in 1865, teeth were no longer required as a tool and the British Army's interest in dental health diminished. By the time of the Boer War, dental treatment was no longer provided to soldiers by the British Army. Following reports of great suffering by deployed troops in the Boer War caused by dental pain, a dentist in 1901 volunteered to treat soldiers for humanitarian reasons. This convinced the Army to retain a number of civilian dentists on a contract basis to relieve pain up until the outbreak of World War I, including dentists working in military barracks in Ireland.

At the start of World War I Woods (1938) reported that there were no dentists in uniform and no dental treatments provided to the expeditionary field Army in France (Woods, 1938). Commanders reported an on-going loss of manpower from the front line as soldiers sought relief of pain or replacement dentures and the British Army came to the realisation that the provision of dental treatment was necessary for both humanitarian reasons and to maintain unit effectiveness. In response, dentists were drafted into the Army and 850 were in service by the end of the war. Following the First World War, the British Army established an Army Dental Corps in recognition of the on-going need to maximize unit effectiveness by reducing the impacts of oral diseases and conditions.

A similar history was reported in the US, where civilian dentists were employed after the American Civil War, followed by the development of a commissioned service by 1911 and thereafter a large uniformed Dental Corps (King, 2008). In Ireland, a dental service was established following the establishment of the State as a uniformed service embedded within the Medical Corps (Hayden, 1995). On entry, soldiers were required to have a minimum number of teeth so that in recruit training, at least, the impacts of tooth loss would not affect

training. Subsequent therapies were *ad hoc* and on demand, when pain or loss of function created a need for dental treatment. The service subsequently evolved into the occupational service that exists today.

The history of dental provision in the military has shown an evolution from the need to preserve teeth as a tool, through the provision of dental services on humanitarian grounds to the utilization of dental services as an occupational scheme to maintain combat effectiveness by minimizing the numbers of personnel absent due to dental disorders. In wartime, an additional complexity is that dental casualties may add an additional burden to over-whelmed medical evacuation lines. Consequently, dental services are embedded in modern deployed forces as part of force protection. Home forces have dental service provision to ready troops for deployment, ensure forensic charting is present and up to date (as discussed in earlier discussions) and to minimize the number of lost workdays attributable to dental disease.

2.5.2 Dental emergencies in the military

Given that one of the purposes of a dental system in the military is to maximize the number of personnel fit for duty, it is unsurprising that the military literature is replete with publications detailing unscheduled visits for dental care that affects productivity. These are typically described as ‘dental emergencies’ and may be regarded as critical incidents during deployments when personnel may have to be removed from active service or an operation is delayed or cancelled. The term ‘dental emergency’ is a misnomer and has been used to describe any condition that induced personnel to seek a dental appointment, regardless of severity. The term ‘unscheduled visit’ more properly describes what is described in the US Army as ‘sick call’ and the British and Irish armies as ‘sick parade’. Swan and Karpetz (1985) highlighted the difficult task of classifying a dental problem as an emergency by further dividing the group into true emergencies needing immediate attention and urgent cases that might be seen within the next two days (Swan and Karpetz, 1995).

Mahoney (2000) reported the source of dental emergencies in the deployment of 6000 British Army soldiers in Kuwait in 1991 as 38% secondary to caries or defective restorations, 18% pericoronitis, 15% with endodontic emergencies and 15% with ANUG or other periodontal problems (Mahoney and Coombs, 2000). A similar mix and proportion of emergencies on deployment has been reported in the US Army (Teweles and King, 1987, Chaffin and Moss, 2008, Colthirst et al., 2012, Simecek et al., 2014); by the French Army (Gunepin et al., 2011); by the German Navy (von Wilmowsky et al., 2014); by the British Army (O'Shea and Scutt,

2009) and US Submarine Services (Deutsch, 2008) and by the British surface fleet (Alexander, 1996). Only one internal report exists for the range of dental emergencies experienced by Irish soldiers on deployment and that data was collected in The Lebanon in 2020-2021, as displayed in Table 2-1 (Dept. of Defence, 2022a). The types of emergencies were similar to those reported internationally, with about half of those presentations presented secondary to caries such as fractured restorations or periapical pathology, 6% with pericoronitis and 10% with periodontal inflammation.

Table 2-1: Types of dental emergencies experienced by soldiers in the Irish Army on deployment to The Lebanon, May to November 2021 (Department of Defence 2022a)

Problem	n	%
Fractured tooth with or without caries	20	38%
Periapical pathology	5	14%
Periodontal inflammation	5	10%
TMJ dysfunction/ muscle pain	5	10%
Retained root - infection	3	6%
Prosthodontic failure	2	6%
Pericoronitis	3	6%
Sinusitis	1	2%
Food trapping	1	2%
Secondary bleeding following extraction	1	2%
Dental trauma	1	2%

Reports of severe sepsis or life-threatening haemorrhage following dental treatment are rare (Wojcik et al., 2015). Wojcik *et al.* (2015) classified dental emergencies into three categories of severity, with the highest severity those conditions deemed to be a potentially life-threatening risk if untreated, and noted that less than 3% of presentations fell into this category (Wojcik et al., 2015). The pathological states added to each of the risk categories appeared arbitrary with, for example, the inclusion of necrotizing ulcerative gingivitis in the high-risk group difficult to rationalize on the basis of its life-threatening potential. Another criticism of the categorization is that normatively assessed need, such as fractured restorations, may have had widely different impacts, depending on the degree to which secondary impacts were observed such as pain or sharp edges cutting soft tissues. Overall, attendance at “sick parade” would seem to sharply delineate the subjective assessment of oral health from professionally assessed need as similar conditions warrant attention by some patients but not by others. However, there has never been an examination of the subjective assessment of patient oral health in the Irish Army using self-reported or quality of life measures.

The difficulty accessing urgent care is often complicated in austere environments where emergency care is not readily available. O'Shea and Scutt (2009) reported that one third of UK submarine operations were threatened with curtailing a three-month underwater deployment by the presence of dental emergencies and one in fifteen patrols had to surface and off-board a sailor for the management of a dental emergency (O'Shea and Scutt, 2009). Similarly, Deutsch (2008) reported that 6.9% to 9.3% of all medical evacuations from US submarines had a dental cause between 1991 and 1999 (Deutsch, 2008). In the Irish Army, at the time of writing, the only option available to personnel for the management of emergencies on deployment, other than medical intervention, was repatriation to Ireland for definitive care. However, the intermittent nature of repatriations suggested that some groups experienced the impacts of dental disease more than others, whether through past caries experience or subjective interpretation of pain and suggested that the Army needed to look beyond normative assessment of oral health and include subjective measures of oral health.

2.5.3 Prevalence of dental emergencies

The overall prevalence of dental emergencies has been reported as the number of visits per 1000 troops per annum and, as displayed in Table 2-2, ranged from tens to hundreds per 1000 personnel per annum depending on the oral health status of the deploying troops. In the deployment of the Irish Army to The Lebanon in 2021 the annualized rate was 377 per 1000 troops per year but this was in a group that could not be made dentally fit due to the restrictions of the Covid pandemic. These data indicate a large unmet treatment need in the Irish Army when professional interventions ceased for a short period and indicate the presence of risk behaviours that predispose to the development of dental disease. However, the prevalence of disease and associated risk behaviours was unknown in the Irish Army and needed elucidation.

Table 2-2: Dental emergency rates reported in the international military literature

Military	Location	Year	DE/ 1000/ year	Reference
US Army	Sinai	1983	160	(Teweles and King, 1987)
US Marines	Desert Storm	1990	149.3	(Mahoney and Coombs, 2000)
US Marines	Iraq	1990	100.5	(Deutsch and Simecek, 1996)
British Army	Iraq	1990	150	(Mahoney and Coombs, 2000)
British Navy	Sea	1990	52	(Alexander, 1996)
Croatian Army	Croatia	1991	392.3	(Jelaca-Bagic et al., 1997)
US Army	Bosnia	2000	170	(Chaffin et al., 2001)
US Air Force	Oman	2002	137	(Dunn, 2004)
British Army	Iraq	2003	160	(Richardson, 2005)
US Army	Saudi Arabia	2003	153	(Dunn et al., 2004)
US Army	Iraq	2003	145	(Dunn et al., 2004)
French Army	Afghanistan	2009-2010	293	(Gunepin et al., 2011)
German Navy	Sea	2010	147	(von Wilmowsky et al., 2014)
US Army	Iraq	2009-2011	116.3 to 144.1	(Simecek et al., 2014)
US Army	Afghanistan	2011/ 2012	81.4 to 85.8	(Simecek et al., 2014)

2.5.4 Preventable fraction of dental emergencies

Although subjective, estimates have been made as to the preventable fraction of emergencies in the reported rates. There appears to be no consensus in the literature as to how a dental emergency may be classified as preventable or non-preventable. This is surprising as it is a fundamental factor in determining the effectiveness of a military dental service and classification scheme. Teweles and King (1987) reported that only 33% of emergencies were not preventable in a group of 600 US troops deploying to the Sinai on a non-combat deployment but this group contained a large group of untreated personnel (Teweles and King, 1987). Similar rates were reported for US troops deployed between 1982 and 1984 (Keller, 1988). Gunepin (2011) reported that 78% of emergencies were preventable in an untreated group of French soldiers who had a rate of 293 emergencies per 1000 troops per year (Gunepin et al., 2011). By contrast, the British Army treated 1624 dental emergencies in Iraq between January and May 2003 and the reporting author identified 75% of cases as non-preventable in a case mix described as “very similar to those reported by other nations in previous conflicts” (Richardson, 2005). In the 2020-2021 deployment of Irish soldiers to The Lebanon, the preventable fraction was estimated as 20% due to the high proportion of emergencies that were not preventable including those secondary to tooth fracture, fractured restorations, broken dentures or crowns, pericoronitis and TMJ disorders.

In summary, although there appears to be an irreducible minimum of dental emergencies that cannot be prevented by treatment before deployment, the overall rate appeared to have been affected by the presence of disease. However, the prevalence of oral diseases and conditions and the impacts that they may have on soldiers in the Irish Army was unknown and the epidemiology collected within a survey would enable military management to plan for the delivery of appropriate services.

2.5.5 The development of dental fitness as a concept in the military

During the Vietnam War, battlefield commanders reported to the US Army Dental Corps commander that troops were absent from duty for the treatment of dental disease for up to seven days, and the Dental Corps recognized that troops were deploying dentally unfit as a result of the mass mobilization of personnel (Neel, 1991). After Vietnam there was a desire by Congress to develop meaningful metrics to measure readiness for deployment of the Army (King, 2008). As a precursor to the development of the current classification scheme, data in relation to emergencies was collected prospectively by King in the US in 1981 and in the Sinai on deployment in 1982 (King, 2008). The emergency rate increased from 67 per 1000 troops per year in personnel classified as free of disease to 145 per 1000 per year in those classified as having some disease and 530 per 1000 per year in those classified as having disease likely to cause a dental emergency. Data that reported dental emergencies experienced by an average of 47,000 US Marines deployed to the Middle East between August 1990 to April 1991 showed a very similar rate to that detected in Vietnam in Marines 20 years previously (Deutsch, 1996). This data convinced US military commanders to adopt a classification scheme and promote dental health.

A common framework for dental fitness has subsequently been developed and adopted by NATO that classifies patients by disease activity – a subtle but telling difference from the original demand by the US Congress. The latest classification system is known by its NATO title, STANAG 2466¹ (NATO, 2017). It defines the following dental fitness classes:

- Class I – free of disease and fit for 12 month's deployment
- Class II – fit for 12 month's deployment but with minor, specified dental complaints that will not likely cause a dental emergency in that time
- Class III - unfit with dental disease likely to cause an emergency on deployment
- Class IV – unknown

The 12-month time frame specified in the STANAG had no scientific basis and was an historical anomaly tied to the length of deployment for soldiers who served in Vietnam (King, 2008). It is interesting to note that the US Army aims to have 95% of personnel in dental classes I or II but in 2000 only 1.8% were dental class I and another 50.7% were dental class

¹ NATO has developed a suite of standardization agreements (STANAGs) to enable inter-operability across member states of the alliance by defining the required processes or technical requirements.

II (Dela Cruz, 2006). Moss *et al* (2004) reviewed the records of 1331 recruits at a 1994 intake and noted that only 61.2% were dental class I after four years of military service and 38.8% carried an oral health condition through the first four years of military service (Moss *et al.*, 2004). These data reflect the reality that competing pressures for time in initial periods of service can deprioritize oral health in the military. Ireland adopted the STANAG for dental fitness in 2008 to allow inter-operability on deployment with UN missions. The classification is currently only applied to personnel before deployment on UN service.

Successive publications have demonstrated the overall utility of making personnel dentally fit as per the classification scheme in reducing the dental emergency rate both at home and on deployment. York (2008) reported rates of dental emergencies based on fitness class in a retrospective analysis of records of 1331 recruits to the US Army in 1994 (York *et al.*, 2008). Class I, II and III had 85, 192 and 749 dental emergencies per 1000 personnel per annum respectively. In a retrospective analysis of 2449 soldiers deployed to Bosnia in 2000, all of whom were classified as Class I or II before deployment, the rates of dental emergencies per 1000 troops per year were 121 for Class I and 185 for Class II (Chaffin, 2001). Similar rates by fitness class have been reported in the British Navy (Alexander, 1996) and British Army (Richardson, 2005). Mahoney and Coombes (2000) estimated that the rate in an unprepared force could increase to 750 per 1000 per year (Mahoney and Coombs, 2000). The general results are that troops dentally fit before deployment had emergency rates around 150 personnel per 1000 troops per year or lower (Mahoney and Coombs, 2000) (Dunn, 2004, Simecek *et al.*, 2014) whereas groups that deployed with a high proportion of unfit personnel had rates of dental emergencies multiples of this rate (Jelaca-Bagic *et al.*, 1997, Gunepin *et al.*, 2011).

These results indicate that the collection of epidemiological data should aid in the identification of diseases and conditions in the Army that can be treated to make personnel fit for duty at home and overseas. In addition, the collection of appropriate risk factor data will allow the dental service to pivot to provide enhanced prevention, health promotion and other strategies that may prevent the development of future disease, thereby reducing the need for interventions.

2.6 Oral health status, determinants of oral health and impacts

2.6.1 Oral health data sources consulted in this review

The sections above have highlighted the approaches used by the Irish Army and other military organizations in high-income countries to assess, predict and mitigate against the risk of urgent need for dental care during deployment. In general, the management of this risk has included treatment of oral diseases and disorders to reduce the likelihood of dental emergencies on deployment. The review has highlighted the considerable gaps in knowledge that existed in the Irish Army in relation to the oral health status of the Irish Army and in the risk factors that might be associated with diseases and conditions. In addition, the Irish Army has never conducted a survey of the subjective assessment of oral health, which may help to identify groups at a higher risk of experiencing the impacts of oral health that elude normative assessment by Dental Officers prior to overseas deployment.

Data sources such as comparative national population surveys reporting status and trends are useful as they allow for the contextualization of the prevalence of oral diseases and conditions found in Irish Army data and provide a benchmark for sampling, protocol, choice of contemporary valid dental indices, and the conduct and planning of an epidemiological survey. A limited number of Irish national surveys are available for comparison (O'Mullane and Whelton, 1992, Whelton, 2007) (Naseer, 2020). These national surveys tended to report a restricted number of oral health outcomes and a number of international surveys in the UK (Steele and O' Sullivan, 2011), England (Public Health England., 2020, OHID, 2024), Canada (Cooney, 2010), Australia (Slade et al., 2004, Amarasena et al., 2021) and the US (Eke et al., 2015, Aldosari et al., 2021) were referenced, where necessary, in order to illustrate a more expansive suite of oral health outcomes and their trends.

Only one previous Irish Army survey has been conducted (Hayden, 1995) and this was confined to reporting of defined age groups, the majority of whom were recruits. Practice-based data collection exercises in the Army have been undertaken and reported upon for many years. However, only one of these has survived and will serve as an example of practice-based data reporting on an operational group deployed overseas (in The Lebanon in 1992). A limited set of international military data are available and will be reported where necessary but much of this data are difficult to use for comparison as they report by fitness class rather than using traditional epidemiological indices.

2.6.2 Determinants of oral health

2.6.2.1 Introduction

Diseases, including oral diseases, are not distributed evenly throughout populations, with greater disease experienced particularly by those with social disadvantage (Marmot, 2013, Tellez et al., 2014, Peres et al., 2019). Irish National oral health surveys have reported that clinical outcomes were affected by age, gender, water fluoridation and Medical Card status (as a proxy for deprivation) (Whelton, 2002; O'Mullane and Whelton, 1992). Although the Army had a relatively narrow demographic, being composed mainly of relatively fit and healthy young men, it was not homogenous and Dental Officers had anecdotally reported that rank and other factors appeared to influence the oral health of soldiers. Identification of susceptible subgroups would allow the dental service to target these groups for preventative interventions and appropriate health promotion. Reporting by age group or other factors would also allow comparison with the results of previous national oral health surveys, which did not report population values but reported solely by means of the selected determinants.

A complicating factor in the reported analyses was the use of terminology such as “risk factor”, “risk indicator”, “demographic risk factor”, “immutable characteristic” or “determinant” in the reported data. Porta *et al.* (2014) regarded the terms “risk factor” and “determinant” as synonymous (Porta et al., 2014), with a causal relationship between the factor and outcome, but this definition would seem to exclude inferences drawn from cross-sectional data. Beck (1998) saw risk factors as “part of the causal chain or... a factor that exposes the individual to the causal chain” (Beck, 1998), a distinction that would allow the reporting of an association between factors and outcomes in cross-sectional data without the requirement to specify them as causative agents. In this survey the reporting term used is “determinant”, as defined by Last as “any factor... that brings about change in a health condition...” (Last, 2001), as this definition allows for use in cross-sectional data, without the requirement for identification of causal factors and avoids the potential confusion that may arise when the term “risk factors” is used.

2.6.2.2 Demographic characteristics

Differences in the health outcomes associated with immutable characteristics of personal or biological determinants such as age, gender and race have widely been reported to affect the prevalence of oral diseases and conditions in Irish national (O'Mullane and Whelton, 1992, Whelton, 2007), Irish Army (Hayden, 1995) and international (Cooney, 2010, Steele and O'Sullivan, 2011, Jamieson et al., 2021) surveys. However, outcomes may not arise from

inherent differences in characteristics but rather from opportunities rendered by the distribution of other factors in these groups. For instance, the prevalence of periodontitis in Black and Hispanic populations in the US may reflect aspects of disadvantage such as cigarette smoking or service utilization rather than implicit risk (Eke et al., 2016).

2.6.2.3 Models of social determinants of oral health

Braveman *et al.* (2011) defined social determinants as “any nonmedical factors influencing health” (Braveman et al., 2011) and distinguished ‘downstream’ determinants “temporally and spatially close to health effects” from ‘upstream’ determinants, which were more remote from the health effect but created the necessary conditions that allowed the development of causal pathways. A conceptual model was developed by Solar and Irwin (2010) to allow research to improve understanding of the factors and processes involved while informing policy decisions for appropriate interventions (Solar and Irwin, 2010). Specific models have been produced for the categorization of social determinants in dental practice that allow for the collection and reporting of oral health data in a coherent manner (Newton and Bower, 2005, de Silva et al., 2016, Watt et al., 2019b). In this report the model developed by Watt *et al.* has been used as it categorized determinants in a manner relevant to the Army at the time of data collection (Watt et al., 2019b). Figure 2-2 displays the model with the proposed causal flow.

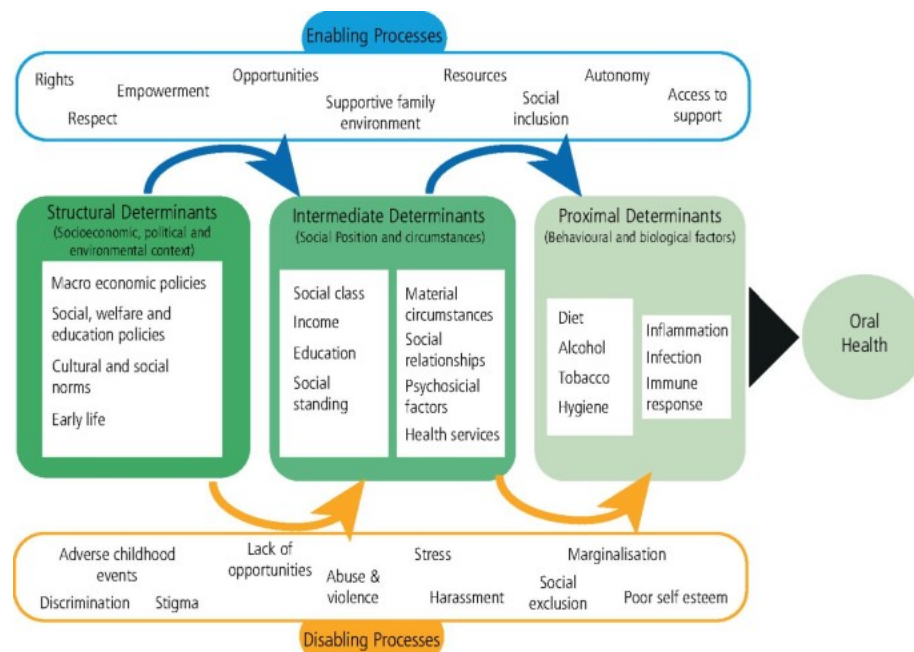


Figure 2-2: Determinants of oral health (Watt et al., 2019b)

The model includes upstream or ‘structural’ determinants formed by early life opportunity, government policy or other factors that are immutable in the Army setting. Cultural and social norms of military life may affect disease prevalence in soldiers that differs from civilian norms. For example, for many years soldiers in the US Army were given free or subsidised cigarettes, which were marketed as supporting morale, and this led to higher rates of smoking in soldiers than US civilians (Joseph et al., 2005) with the inevitable effect on cancer and mortality in veterans (Bedard and Deschênes, 2006). By contrast, policies in relation to dental fitness and mandatory attendance at free dental clinics may reduce disease prevalence in the military.

Intermediate determinants reflect social position and include rank in the military context. Andersen (1995) commented that markers of social structure have relatively low mutability, at least in civilian life, as alteration of opportunities in educational or occupation are not possible in the short term (Andersen, 1995). The military may provide access to educational opportunities not readily available in civilian life and may promote personnel more rapidly and as such these determinants may be more modifiable than in civilian life and have different effects on oral health than seen in civilian life. Dental phobia has been addressed as an intermediate determinant in this survey as it has psychosocial components and requires time, where possible, for interventions to have effect (Jöhren et al., 2000, Appukuttan, 2016). The implications of dental phobia may also be different in the military as a diagnosis of dental phobia may lead to medical downgrading and discharge from service (Edwards, 2023). Conversely, it is possible that mandatory dental appointments in the military may offset the poorer oral health reported in patients with avoidant behaviours (Kruger et al., 1998, Eitner et al., 2006). As such, the exploration of intermediate determinants may help identify trends in the military that differ from civilian life and help explain differences in the prevalence of diseases and conditions.

The proximal determinants in the model are health behaviours that are directly involved in disease initiation and progression and are typically the processes identified in the dental clinic and seen as targets for action. Soldiers undergo frequent and mandatory appointments for assessment of dental fitness and provide multiple opportunities for interventions, which affect the relative outcome of health behaviours. Enabling and disabling processes are modifiers of determinants and reflect the lived experience of individuals in the community but may be difficult to incorporate into an oral health survey given the sensitive nature of many of the processes specified in the model.

Many of these social determinants were reported in the national and international surveys but without a consistent approach in terms of reporting methodology. In general, there has been poor coverage of the potential structural determinants in the civilian and military literature. Limited intermediate and proximal determinants were reported in the Irish national surveys and it was necessary to assess the results in international surveys (summarized in Table 2-7) to expand the understanding of trends in high-income countries. In the Irish Army the reporting was limited to the demographic characteristics of age and some limited reporting by rank (Hayden, 1995). In the military literature there were a plethora of intermediate and proximal determinants reported. These were largely drawn from convenience samples and, although useful in demonstrating trends, it was difficult to determine how representative these might be of the population from which they were drawn. The results from these military and civilian publications are discussed below.

2.6.3 Subjective measures of oral health

Concepts of health have evolved from clinician-focussed normative assessments to patient-focussed subjective interpretations that include patient expectations, cultural modifications, social status and individual capacity (Wilson and Cleary, 1995). The model developed by Wilson and Cleary is displayed in Figure 2-3 and displays the pathway between normatively assessed need and overall quality of life. Important aspect in the model included the modifying effect of environmental and individual characteristics that will be considered in the Army.

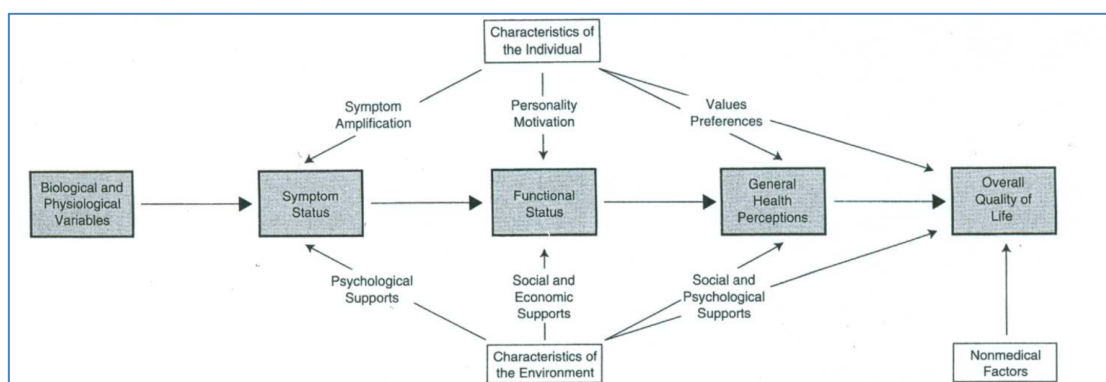


Figure 2-3: Wilson and Cleary model of relationships between measures of patient outcome in a health-related quality of life model (Wilson and Cleary, 1995)

An important aspect of military dental practice is to reduce the number of dental emergencies to maximize the number of fit troops available to commanders. As part of this process soldiers are examined and normatively assessed oral health needs are treated as a means of reducing the prevalence of dental emergencies, particularly on deployment (NATO, 2017). However, the correlation between normatively assessed need and reported pain that might create a need for a dental emergency is difficult to determine. In an Australian national survey 32.1% had untreated coronal caries (Peres et al., 2020) and 28.8% had a periodontal pocket of at least 4mm (Ha et al., 2020) but only 20.2% had reported pain in the previous 12 months (Brennan et al., 2020). Slade (2001) reported a moderate to strong correlation between untreated caries and toothache (Slade, 2001) but not all participants with disease reported pain. Conversely, up to 10% of dental emergency presentations on deployment have been reported to be of periodontal origin (Mahoney and Coombs, 2000) but typically periodontal disease is reported as a symptomless condition in civilian practice (Gaurilcikaite et al., 2017). Data on the prevalence of pain of dental origin in the Irish Army and the national population was unknown but has been widely reported in international civilian surveys (Cooney, 2010, Ministry of Health, 2010, Nuttall et al., 2011, Brennan et al., 2020, OHID, 2024) using a

variety of reporting mechanisms, complicating direct comparison. Nonetheless, these are useful as they provide a frame of reference for pain prevalence in high-income countries.

Self-reported oral health questions are short and easily incorporated into everyday clinical use, are simpler to interpret than quality of life measures and have demonstrated good association with clinical metrics such as number of teeth (Blizniuk et al., 2017, Nakahara et al., 2022, Atala-Acevedo et al., 2023). Global questions on self-reported health have been shown to be among the best predictors of all-cause mortality (Ganna and Ingelsson, 2015) and self-reported oral health status had as comparable a predictive power for tooth loss as clinical diagnoses (Meisel et al., 2018).

Self-reported health status is influenced by determinants including socio-economic status, access to healthcare, individual personality traits and broader cultural influences across countries and settings (Blizniuk et al., 2017, Thomson et al., 2019, Bado et al., 2020, Atala-Acevedo et al., 2023) which may indicate that the profile of self-reported oral health may be different in the Irish Army than in civilian communities. Sen observed that ill-health may be accepted as normal in communities with high morbidity and limited access to health services whereas in wealthier areas, where health approaching optimal is normal, minor issues may be reported as a sign of poor health (Sen, 2002). This may be relevant to military populations that are treated to completion and in optimal oral health and may help explain the prevalence of ‘dental emergencies’ in the military setting. In the Army, self-reported oral health may be a useful tool to identify groups who are at a higher risk of poor oral health and who would benefit from targeted interventions.

The fourteen item Oral Health Impact Profile (OHIP-14) is the most commonly used instrument for assessing oral health-related quality of life (OHRQoL) and has shown some correlations with clinical indices (Locker and Slade, 1994). Among these, tooth loss has emerged as the most significant factor, with associations being widely reported between oral health quality of life and the number of teeth or occluding units (Steele et al., 2004; Lawrence et al., 2008; Marino et al., 2008). Other conditions that have been shown to impact OHRQoL include untreated dental caries (Lawrence et al., 2008; Marino et al., 2008; Slade and Sanders, 2011; Masood et al., 2017), severe periodontitis (Ng and Leung, 2006; Lawrence et al., 2008; Slade and Sanders, 2011), and pain (Oghli et al., 2020; Cimilli et al., 2012; Magraw et al., 2015; Slade and Sanders, 2011; Masood et al., 2017).

The OHIP-14 instrument includes domains directly relevant to dental care in an occupational setting, such as physical pain and disability. Identifying high-risk groups with

greater prevalence or severity of impacts would enable the dental service to move beyond traditional measures and offer more patient-centred care.

Although normative oral health was assessed in the Irish Army several decades ago (Hayden, 1995b), no survey has specifically examined the oral health-related quality of life of soldiers. In the last national survey (Whelton, 2007), OHRQoL was reported using the Oral Health Quality of Life-UK instrument (OHQoL-UK) (McGrath and Bedi, 2001) but national information has not become available in Ireland in the interim, except for a defined subgroup of older patients over the age of 65 years undertaking prosthodontic therapy (da Mata et al., 2015, McKenna et al., 2015, McKenna et al., 2018, da Mata et al., 2019). However, OHIP-14 (or items derived from the instrument) has been extensively used in international surveys in and may be used to identify trends in high-income countries (Cooney, 2010, Ministry of Health, 2010, Nuttall et al., 2011, Public Health England., 2020, Brennan et al., 2020, OHID, 2024). These are reported below within the context of the oral health surveys.

2.6.4 Irish national surveys

2.6.4.1 Oral health of Irish adults 1989-1990

In 1990 a survey of the oral health of Irish adults was undertaken (O'Mullane and Whelton, 1992). The aims of the survey included measuring the oral health of adults over the age of 16 years in Ireland, carrying out a needs analysis and estimating the association of a number of determinants on the presence of diseases and conditions, with a particular emphasis on the role of fluoride in caries prevention. A comprehensive survey was undertaken reporting the number of teeth present; sound unfilled natural teeth (SUNT); DMFT status and its components; periodontal disease measured by the Community Periodontal Index of Treatment Need (CPITN) (Ainamo et al., 1982, Gjermo et al., 1983, Cutress et al., 1987); trauma to incisors; fluorosis; tooth wear; TMJ disorders; dento-facial anomalies and lesions of the oral mucosa. Prior to data collection, the examiners underwent training and calibration in the use of indices used to measure oral health. Although efforts were made to examine people in dental clinics, many were examined in their own homes using portable lights, which may have affected the quality of the examinations. Caries was recorded as present at the level of cavitation, following WHO recommended methodology at that time (World Health Organization, 2013). Apart from the fact that over 30 years have elapsed since the data were collected, direct comparison with caries prevalence rates using this threshold is problematic given contemporary views of caries and diagnostic thresholds (Banting et al., 2005) and the overall reduction in the severity of caries in populations.

Tooth wear was recorded using a modified index developed by Smith that recorded cervical notching and other wear as prevalence data by sextant (Smith BG, 1984). By contrast, more recent indices, including the BEWE index in clinical use in the Army dental service (Bartlett et al., 2008), can report both as prevalence data and by grading the degree of Tooth Surface Loss (TSL). In addition, the BEWE index does not separate the wear and non-wear components. Nevertheless, useful comparisons may be made using these data.

Periodontal disease was recorded using CPITN with additional measurements of gingival recession to capture attachment loss and is similar to the index in use in the Army. However, only six index teeth were examined, which is known to under-estimate the prevalence of disease (Albandar, 2011). The low prevalence of disease reported also highlights the on-going problems in disease diagnosis and classification. Inaccuracies in measurement arise from variations in probe shape, probe position, angulation, the presence of subgingival calculus and over and under-probing in disease and health (Listgarten et al., 1976, Magnusson and Listgarten, 1980, Hefti, 1997). Strategies to manage these problems include the use of defined thresholds and specifying the minimum number of sites affected (Tonetti et al., 2005, Page and Eke, 2007). However, Savage *et al.* commented that “inconsistencies in the use of disease indicators make large variations in the definition of periodontitis inevitable” (Savage et al., 2009). These factors need to be taken into consideration when considering the results of disease prevalence in national surveys.

In total 1927 participants were examined and the sample was judged to be self-weighting for age, gender and by geographic location. Data were reported using demographic characteristics of age group and gender and included respondents from 16 to 64 years that can be used to compare with soldiers. Clinical indicators were reported using a number of intermediate determinants including: the seven social classes defined for use in the 1981 national census (O'Hare et al., 1991); by fluoridation status, which acted to distinguish between urban and rural dwellers and by possession of a Medical Card, which was used as a proxy for deprivation, as in Ireland this card enables low-income groups eligibility to state funded free dental care. Data by attendance pattern and fear of the dentist was also presented. Of the proximal determinants, only toothbrushing frequency was reported. No impacts were recorded in this survey. Data from the 1990 national survey are presented in Table 2-4 and discussed below.

2.6.4.2 Oral health of Irish adults 2000-2002

A second national oral health survey was undertaken between 2000 and 2002 (Whelton, 2007). In total, 2888 subjects were examined by trained and calibrated examiners, some in their own homes using portable equipment, which again may have affected the results. The survey drew a stratified random sample by age, gender and *Medical Card* status of the national population. Only three age groups were examined, of which the 16 to 24 years and 35 to 44 years age groups were relevant to the Irish Army. However, the restriction of the survey to these three age groups meant that mean values for the national population could not be calculated.

In recognition of more contemporary views of incipient caries and caries diagnostic thresholds, the survey reported caries both at the level of cavitation and at visual caries detection and aligned with caries thresholds developed by the British Association for the Study of Community Dentistry (BASCD) (Pitts et al., 1997). A range of periodontal outcomes were reported using CPITN as a basis and included loss of attachment as well as periodontal pocketing. TSL was reported by examining three surfaces on the six maxillary incisor teeth and reporting the worst surface on the mandibular incisor teeth, making comparison with the later BEWE index (Bartlett et al., 2008) difficult.

Clinical indicators were reported using the demographic characteristics of gender and age in the selected groups. The outcomes were also reported on the basis of general health, as categorized using the American Society of Anesthesiologists (ASA) criteria² (Saklad, 1941, Horvath et al., 2021) to assess putative links between general and oral health. As was the case in the 1990 survey, reporting was by Medical Card and water fluoridation status and the effect of dental attendance and fear of the dentist on a number of clinical indicators. A wider range of proximal determinants were explored including smoking, alcohol use, diet and toothbrushing but with limited reporting. The relationship between general and oral health was reported and the impacts of oral health as measured by the oral health related quality of life measure OHQoL-UK (McGrath and Bedi, 2003) on quality of life. This instrument reports both positive and negative impacts of oral health but is not in wide use and is not directly comparable to OHIP-14. Data from the 2000-2002 national survey are presented in Table 2-4 and discussed below.

² The ASA classification categorizes patients based on their medical fitness to undergo general anaesthesia. The categories are: ASA I – healthy; ASA II – mild disease, little functional limitation; ASA III – moderate disease, substantial functional limitation; ASA IV – disease that is a constant threat to life; ASA V – death expected without operation; ASA VI – brain-dead patient awaiting organ donation.

2.6.4.3 The Irish Longitudinal Study on Ageing

The Irish Longitudinal Study on Ageing (TILDA) was an examination of the health of community dwelling adults over the age of 50 years, and featured a number of waves of data collection from this cohort since inception of the study. The investigation included an oral health module but the capacity to undertake an extensive oral health examination was reported to be limited by the time allocated (Sheehan et al., 2017). The survey included an age group between 50 and 64 years that reflected an age group employed in the Army.

The clinical outcome measures reported included standard oral health indicators such as number of teeth, SUNT, DMFT and its components. In relation to caries, the authors only reported caries at the level of cavitation because they found little difference between the two thresholds; for example, the mean DMFT in the 50 to 64 years age was 16.7 for cavitation and 16.8 for visual caries (confidence intervals not reported). In the 2000 adult oral health survey (Whelton, 2007), the mean DMFT scores were reported both at the level of cavitation and of visual diagnosis for selected age groups, as displayed in Table 2-3. The mean scores were higher by between 20% and 114% from the oldest to the youngest age group, when the diagnostic threshold was changed from cavitation to visual detection, as has been reported elsewhere (Pitts and Fyffe, 1988). The effect, although lower in older people, was present in all age groups. It seems unlikely that only cavitated lesions were present in adults examined in the TILDA study. It is possible that caries was under-reported or that calibration occurred at a higher threshold than is ordinarily reported. Caution must be exercised when comparing the caries prevalence in the TILDA sample with age matched soldiers in the Army.

Table 2-3: Reported increase in the mean number of decayed teeth detected by cavitation or visual caries in the 2000 adult oral health survey (Whelton, 2007)³

Age group	DMFT Mean (95% CI)		DT Mean (95% CI)		Increase	
	Cavitation	Visual and cavitation	Cavitation	Visual	N	%
16 to 24 years	4.9 (4.3, 5.5)	5.7 (5.1, 6.3)	0.7	1.5	0.8	114%
35 to 44 years	15 (14, 16)	15.4 (14.4, 16.4)	1.0	1.4	0.4	40%
≥65 years	25.9 (24.5, 27.3)	26 (24.6, 27.4)	0.5	0.6	0.1	20%

Periodontal health was reported using CPITN and tooth wear was measured using the Bardsley index, which graded the single worst affected tooth in a sextant using the criteria of

³ The data in this table were derived from Tables 4.1a, 4.1b, 4.5a and 4.5b in the Oral Health of Irish Adults, 2000 to 2002, pages 48 to 54 (Whelton et al., 2007)

health, wear affecting less than one third of the surface and wear affecting more than one third of a tooth surface (Bardsley et al., 2004). Data from the TILDA study are presented in Table 2-4 and discussed below.

The data were reported using the demographic characteristics of age group and gender and a number of intermediate determinants including education level, area of residence, income quantile and frequency of dental visits. In addition to oral health data the survey reported a number of impacts including self-reported oral health status and OHRQoL measures such as difficulty eating, speaking or smiling.

2.6.4.4 Healthy Ireland surveys

The government of Ireland has published a series of self-reported health surveys since 2015, conducted by interview until 2019 and by phone since 2021 in light of the Covid pandemic. The survey collected data on health service utilization and a range of proximal determinants including smoking, alcohol use, diet and nutrition (Dept. of Health, 2018, Dept. of Health, 2019). In 2018, specific questions about oral health were included in the survey, and asked about denture wearing, dental service utilization, self-reported oral health and reported problems with teeth or dentures. The data were reported by age group, gender, by smoking status for the self-reported oral health status and by deprivation quintile. As such, the report marked a departure from previous surveys by focussing on the proximal risk factors associated with the development of disease and the impacts of oral health rather than oral health status. However, the report published very little data, which was confined to a broad summary of the main conclusions.

2.6.4.5 Analysis of the main findings of the national data

A summary of the main findings of the clinical indicators in the national data is presented by age group in Table 2-4. In 2000, the reporting was restricted to three age groups, of which the 16 to 24 years and 35 to 44 years has relevance to the Army. The more recent data in the TILDA survey included respondents from 50 to 64 years that could be compared with a very small proportion of the Army, mainly of senior rank and higher education than typical soldiers. The utility of this age group is that they represent the terminal oral health status of soldiers at the end of many years of exposure to the military system. Overall, it is apparent from the table that there are large gaps in the data and most of the data that are available are several decades old and of limited use in the potential assessment of contemporaneous oral health in the Army.

In general, the dental health was better in 2000 than in 1990 in the comparable age groups, and better in 2015 in the 50 to 64 years age group than in either the 45 to 54 or 55 to 64 years age groups in 1990. The respondents in later surveys retained more teeth and had more Sound Untreated Number of Teeth (SUNT), had lower DMFT scores and a much lower proportion with dentures and edentulousness. The gap between the dental health of more recent and older surveys was wider in the older age groups as a consequences of accumulated tooth loss in earlier surveys. For example, in the 16 to 24 years age group, the difference in the percentage who retained more than 20 teeth between 1990 and 2000 was only 0.8%, but the difference in the 35 to 44 years age group was 27.2%. If improvements such as these have continued then the results suggest that the oral health of soldiers and civilians in 2020 may be substantially better than in 1990 and 2000 but data reporting these results are not available.

Table 2-4: Main findings from national surveys in 1990, 2000 and 2015 (O'Mullane and Whelton, 1992, Whelton, 2007, Naseer, 2020)⁴

Age group	Year	n	No teeth (n)	DMFT (n)	DT (n)	≥20 teeth (%)	≥18 sunt (%)	PSR Code (%)		Dentures (%)
								PSR 3	PSR 4	
16 to 24	1990	400	27.2	7.4	1.4	98.8	79.3	1	0	2
	2000	1196	28.1	5.7	1.6	99.6	90.0	11.5	0.4	1.4
25 to 34	1990	350	25.1	15.0	1.1	87.7	36.9	13	2	14
35 to 44	1990	419	21.0	19.0	1.1	62.5	16.2	12.0	1	32
	2000	978	25.2	15.4	1.4	89.7	36.8	33.9	6.3	16.4
45 to 54	1990	312	14.4	23.2	1.2	34.0	7.4	18	2	52.2
55 to 64	1990	204	9.1	26.0	0.8	18.1	4.4	9	3	66.2
50 to 64	2015	1218	21.3	16.8	0.4	72.1	17.4	54.9	6.6	31.2

An indicator of the reduction in tooth loss was in the proportion who had a denture in 1990 and later surveys. In 1990 about a third of adults between the age of 35 and 44 years had a denture whereas by 2000 the proportion had dropped to 16.4%. Further reductions were seen between 1990 and 2015 with over half of the 45 to 54 years age group and two thirds of the 55 to 64 years age group having a denture in 1990 whereas in 2015 the proportion had dropped to one third of the 50 to 64 years age group. In 2018, 18% of respondents over the age of 15 years in the Healthy Ireland survey reported complete tooth loss or full or part dentures (Dept. of Health, 2018). Although the results were not reported by age groups these

⁴ The data in this table were derived from the Oral Health of Irish Adults 1989 to 1990 (O'Mullane and Whelton 1992), the Oral Health of Irish Adults 2000 to 2002 (Whelton *et al.*, 2007) and The Irish Longitudinal Study on Aging (Naseer, 2020)

do at least provide a population prevalence with which Army results might be compared. Anecdotally dental teams in the Army report a low prevalence of dentures in soldiers, which would suggest better oral health than civilian peers but data supporting this view were unavailable.

Since 1990 implant therapy has become more widespread but the prevalence has not been reported in national surveys and could potentially account for a lower prevalence of dentures in later surveys. Anecdotal reports of “dental tourism” by soldiers for more complicated treatments, who are used to travelling and living in countries in the Middle East where such dental treatments are provided, may also account for the reduction in dentures reported anecdotally in the Army but no data that substantiates these impressions existed.

Concerns have been raised about the use of the CPITN index as a valid measure for reporting the prevalence of periodontitis, with reported under-estimation of disease prevalence in young populations (Baelum et al., 1995, Leroy et al., 2010, Ower, 2016). The national survey in 1990 would appear to have had a drastic under-reporting of periodontal disease prevalence. The prevalence of severe disease ranged from 0% in the 16 to 24 years age group to 3% in the 55 to 64 years age group. It is difficult to imagine any population without cases of severe disease as occurred in the 16 to 24 years age group in 1990 (Jenkins and Papapanou, 2001). In addition, about a third of men and women smoked daily in 1990 (Forey, 2013), which is a known risk factor for periodontitis (Bergström, 1989, Albandar et al., 2000) and therefore there might have been an expected increase in prevalence, especially in older age. In 1990 index teeth were used, which may have under-estimated the overall prevalence (Albandar, 2011). Ha *et al.* reported an increased prevalence in Australia between 2004 and 2018 that they ascribed to retention of a greater number of teeth (Ha et al., 2020). Although a propensity for extraction as a therapy in 1990 may have reduced the prevalence of periodontitis, it is impossible to reconcile the degree of tooth loss with the prevalence of disease reported and caution should be exercised when comparing these results with data collected at a later date.

The values reported for periodontitis in 2000 in the 35 to 44 years age group and in 2015 in the 50 to 64 years age group approximated that of the NHANES surveys in the US, which were “gold-standard” investigations using 6-point, full mouth probing (Eke et al., 2015) and suggests reported values closer to true values. Taking the 50 to 64 years of age group in the TILDA study in isolation would suggest that soldiers of a similar age may have a very high need for periodontal therapy, although the overall demand may be offset by the younger age of the Army population.

Substantial reporting using the demographic characteristics of age and gender was undertaken in the national surveys. In general, these showed a decrease in the number of teeth and SUNT, an increase in DMFT scores and an increased prevalence of TSL with age. As has been reported internationally (Peres et al., 2019), the mean number of decayed teeth was highest in the 16 to 24 years age group and decreased with age. If this pattern was followed in the Army, then it would have important implications for treatment delivery as it is mainly composed of younger people, with a high turnover of the youngest ranks (Dept. of Defence, 2018). The reported mean number of decayed teeth was higher in 2000 than in 1990 but reflected a change in the reporting criteria from 1990 at the level of cavitation to 2000 which reported at the level of visual detection, with a concomitant increase in caries detection.

Differences by gender were reported in most clinical indicators, but without exposition of underlying proximal determinants that might explain the differences. In 1990 and 2000 women had a higher proportion who were edentulous, fewer teeth, fewer SUNT and higher DMFT scores. In 1990 there were no differences in the proportion of decayed teeth by gender and both had similar attendance patterns, but there was a marked difference in the proportion with 'dental fear' and a higher mean number of teeth that needed to be extracted in women that might suggest that avoidant behaviour was underlying the differences. In 2015, however, attendance rates were higher in women and they had fewer decayed teeth and missing teeth and more filled teeth and had the characteristics of a treated group (Sheiham et al., 1985) but with a change from extraction to restoration as the primary therapy. Applying these differences to the Army might mean that a predominantly male force may have poorer oral health than civilian peers.

A number of intermediate determinants were reported in the national surveys, including the association between social disadvantage and poorer oral health. In 1990 respondents from lower social classes or holders of a Medical Card were reported to have higher rates of edentulousness, fewer teeth, higher DMFT, DT and MT scores, more teeth that needed extraction and a smaller proportion with periodontal health. Similar social gradients by Medical Card status were reported in 2000. In the TILDA study Medical Card status, education level and urban/ rural had reported associations with poorer oral health. These results show that despite the improvements in oral health since 1990 social gradients in clinical indicators continued to exist.

Limited data were available to report the attendance pattern of Irish civilians. The data from the national surveys is displayed in Table 2-5 and shows that in 1990 and 2000 only about half attended within two years. In 2015 65.9% of the 50 to 64 years age group attended within two years and in 2018 the Healthy Ireland survey reported that 47% had attended within 12 months, which might suggest greater attendance in more recent years. In 1990, older adults who attended for routine checkups had more teeth and lower DMFT scores but in the younger age groups the opposite was the case, presumably because of exposure to dental treatments and may have an implication in the Army setting where young soldiers are compelled to attend dental appointments. In the national survey in 2000 and the Healthy Ireland data in 2018, attendance was lower in those with social disadvantage. In 2000 although only 13% reported cost as a barrier, 60% stated that they would attend more frequently if services were free. On this basis free services in the Army might be expected to increase attendance rates, although this may be offset by the general finding of higher attendance in women than men. In 2000, 27.6% reported fear as a barrier to dental care (Whelton, 2007). Anecdotally, dentists in the Army have reported that severe dental anxiety appears to have a much lower prevalence and this may reflect the differences in the proportion of men in the Army and the reported differences in anxiety prevalence internationally by gender (Humphris et al., 2013).

Table 2-5: Percentage of respondents attending more frequently than every two years (O'Mullane and Whelton, 1992, Whelton, 2007, Naseer, 2020)

Age group (years)	Year		
	1990	2000	2015
16 to 24	47%	48.3%	N/A
35 to 44	48%	57.2%	N/A
50 to 64	N/A	N/A	65.9%

Water fluoridation played an important role in the reported reduction in tooth loss and decay experience between 1990 and 2015. In 2000, the adult survey reported that participants with over 35 years of exposure to fully fluoridated water had more teeth, lower DMFT scores, a lower prevalence of edentulousness and other markers of improved oral health. The benefits have continued to be displayed in Ireland with 63% of 12 year old children living in fluoridated communities caries free compared with 47% living in non-fluoridated communities (Harding, 2016) and might be assumed to result in improvements in soldiers' oral health.

In 1990 many respondents were adults when fluoridation was introduced in 1963 and the impacts of caries developed at a younger age were experienced throughout adult life. Between 1990 and 2015 a progressively greater proportion of adults have had access to

lifetime fluoridation, with population coverage estimated as between 71% (Forum on Fluoridation, 2002) and 84% (O’Sullivan, 2015). A shift in the proportion of Irish people living in rural environments from 43% in 1991 (CSO, 1993) to 37% in 2016 (CSO, 2016) may also have had an effect as almost all non-mains supplies have been reported to lack fluoridation (O’Sullivan, 2015). The proportion of soldiers recruited from rural communities is not recorded but a proportion of soldiers are recruited from Northern Ireland, which lacks community water fluoridation, and there has been an increase in the number of soldiers from EU and non-EU nations who may be recruited from non-fluoridated communities.

In the 2000 adult survey, respondents were classified as part-fluoridated if they had between one- and 35-years coverage, an extensive range considering the reporting ages (Whelton, 2007). Respondents who were part-fluoridated had fewer teeth than fully fluoridated respondents in the 35 to 44 years age group, fewer SUNT and higher DMFT scores. The DMFT scores of part-fluoridated respondents approximated those of the non-fluoridated respondents, which showed the benefits of lifetime fluoridation. Soldiers spend time on deployment to non-fluoridated locations and in effect those from fluoridated communities become part-fluoridated. In addition, there had been an increase in the proportion of Irish people who consumed bottled water, estimated as 23% using as a sole supply and 34% using occasionally (An Foram Uisce, 2023), an unknown proportion of which is fluoridated. In the Army, water is provided in bottles on exercise and on deployment where tap water is unavailable or unsafe to drink. These practices may foster a culture of bottled water use that impacts oral health but the prevalence of these practices in the Army was unknown.

Surprisingly little data has been published on the prevalence of proximal oral health risk factors in the national data and their association with clinical indicators. In 2000 the prevalence of smoking and consuming alcohol was reported and showed that smokers had a higher prevalence of periodontitis, as has been reported widely elsewhere (Bergström, 1989, Albandar et al., 2000, Bergstrom, 2014, Eke et al., 2015), but in the interim updated data have not become available. The prevalence of brushing twice a day or more was reported in 1990 and 2000, as displayed in Table 2-6, and showed little difference but the linkage with clinical indicators was not reported nor has an updated estimate of the national prevalence been published.

Table 2-6: Prevalence of brushing at least twice a day, national studies 1990 and 2000 (O'Mullane and Whelton, 1992, Whelton, 2007)

Age group (years)	Year	
	1990	2000
16 to 24	68.5%	59%
35 to 44	71%	63%

The national survey in 2000 reported that a quarter of 16 to 24 year old respondents ate sugary foods five or more times daily (Whelton, 2007). In 2018, the Healthy Ireland survey reported that a third of younger people reported eating sugary foods daily, with higher consumption in older people (Dept. of Health, 2018). Although not immediately comparable by frequency with the data from 2000, the fact that two thirds of younger people were not eating cariogenic foods daily may translate into better oral health in recruits on entry. Sugary drink consumption by contrast was reported to be highest in younger people and decreased with age, with a reported prevalence of at least once daily of 9% in younger respondents (Dept. of Health, 2018). Daily consumption has been reported to have decreased from 37.4% in 2002 to 5.7% in 2018 (Chatelan et al., 2022) which might suggest a basis for better oral health in soldiers in 2020 but data were not available. However, caution must be exercised when interpreting these results due the problem of under-reporting of socially undesirable practices (Parry and Crossley, 1950, Warner, 1978).

Aside from the normative assessment of need and the assessment of the determinants of oral health, little has been published in relation to self-reported measures of oral health. In the TILDA survey (Naseer, 2020) 81% reported their oral health as “excellent”, “very good” or “good” and in the Healthy Ireland report in 2018 (Dept. of Health, 2018) 79% reported their oral health as “very good” or “good” which showed that the vast majority viewed their oral health in a positive manner. In both surveys more women than men reported better oral health but the difference was small. Self-reported oral health was also lower in older age, in smokers and in respondents living with disadvantage. The limited data available means that inferences about a younger pool of young men as are found in the Army are not possible.

Only the 2000 survey reported an OHRQoL measure and used the OHRQoL-UK instrument to assess impacts. Unlike reports from the literature (Locker and Slade, 1994, Nuttall et al., 2011, OHID, 2024), the survey reported greater negative impacts in older adults, which may have been related to extreme tooth loss in this group. Greater negative impacts were also reported in Medical Card holders and again may have reflected greater tooth loss in this group. However, this instrument is not in widespread use and comparison with other surveys is problematic.

Overall, the results show a move by the national surveys from a purely normative assessment of need to subjective assessments which included self-reported and OHRQoL measures. The published data as presented was very limited in scope and most was not contemporaneous, limiting its applicability to serving soldiers.

2.6.5 International surveys

A summary of the extent of reporting of normatively assessed treatment need, determinants of oral health and impacts associated with oral health in high-income countries is displayed in Table 2-7. International comparisons are fraught with differences in population characteristics, the age groups examined, the age bands reported, examination criteria, oral health outcomes and other factors. However, due to the paucity of data and the limited approach to the recording of determinants of oral health in the Irish national surveys, international surveys provided trends and data for comparison with and contextualisation of available Irish Army data. These international surveys will be reviewed in the next section.

2.6.5.1 Canada 2007-2009

A national survey examined 5600 Canadian subjects between six and 79 years of age in mobile dental platforms (Cooney, 2010). The WHO criterion for caries diagnosis was used at the level of cavitation and was limited to 28 teeth by excluding wisdom teeth, which may have reduced the prevalence of caries. The periodontal examination was on index teeth which may have introduced bias in the prevalence estimates of moderate and severe pocketing (Tran et al., 2013). The survey design noted (p21) that the data collected should be adequate for “policy decision making, not at the level that would be the standard of clinical research”. A range of oral health outcomes were reported including number of teeth, caries, periodontal disease and prevalence of dentures and complex prosthodontics. The clinical indicators were reported using the demographic characteristics of age and gender. The age ranges did not match those used in the Irish surveys but were useful as they demonstrated trends that could be compared to national reports. A large number of intermediate determinants were used to report the potential social gradients of oral health including income, insurance, education and dental visiting frequency. A limited number of proximal determinants were reported (smoking, brushing and interproximal cleaning) but only clinical indicators by smoking status were reported. The impacts of oral health were recorded as pain, self-reported oral health and certain impacts such as avoiding foods because of problems in the mouth.

2.6.5.2 UK 2009

Between 1968 and 2009 a series of national survey were conducted every ten years in the UK, of which the most recent was in 2009 (Steele and O’ Sullivan, 2011). An extensive oral health assessment reported on the prevalence of tooth loss, caries, periodontal disease, tooth wear, pain, and restorative treatments including implants, dentures crowns and bridges. In a break from previous surveys, caries was reported at the level of visual detection in 2009, which

might be more readily compared with the results of the Irish 2002 survey (Whelton, 2007) or a proposed Army survey. The severity of decay was reported by recording teeth with extensive dentinal caries. An index used to record the impacts of severe caries, using an acronym of the symptoms *viz.* pulpal involvement, ulceration of the soft tissues from sharp edges of broken teeth, fistula formation or an abscess (PUFA) was also reported (Monse et al., 2010). The survey reported using the same age bands reported in the Irish national surveys and also reported by gender. The clinical indicators were reported using specified occupations as proxies for social class and by dental visiting and by dental anxiety. A feature of the report was the extensive reporting of proximal determinants including smoking, fluoride use, diet, brushing and interproximal cleaning. Subjective measures of oral diseases were reported as pain, self-reported oral health and by using the OHRQoL measures OHIP-14 and OIDP.

2.6.5.3 New Zealand 2009

A nationally representative survey was undertaken in New Zealand in 2009 and included 3475 adults (Ministry of Health, 2010). Standard oral health outcomes including number of teeth, caries at the level of visual detection and periodontal pocketing were reported. The data were reported using a number of determinants including gender, age group and deprivation quintile. The recency of last visit and type of visiting behaviour was recorded. Few proximal risk factors were recorded with only toothbrushing and fluoridation status reported. Impacts were reported as pain, self-reported oral health and OHIP-14.

Table 2-7: Reporting of normatively assessed treatment need, determinants of oral health and impacts of oral health in high-income countries (Cooney, 2010, Ministry of Health, 2010, NHS, 2011a, Elani et al, 2018, CDC, 2019, Eke et al., 2020, Public Health England, 2020, Peres et al, 2020, Ha et al., 2020, Luzzi et al., 2020, Al Waheidi et al., 2021, Aldosari et al., 2021, OHID, 2024)

Country	Canada	NZ	UK	US	Australia	England	
Year	2007	2009	2009	2011-2018	2018	2018	2021

Normatively assessed oral health

Tooth number	✓	✓	✓	✓	✓	✓	
Caries	✓	✓	✓	✓	✓	✓	
Periodontal health	✓	✓	✓	✓	✓	✓	
Tooth surface loss			✓	✓			
Dentures	✓		✓			✓	
Complex prosthodontics	✓		✓	✓		✓	
PUFA/ unrestorable teeth			✓			✓	

Intermediate determinants of oral health

Social position or income	✓		✓		✓		✓
Insurance class	✓			✓	✓		
Deprivation level		✓			✓	✓	✓
Education level	✓				✓		
Dental visiting	✓	✓	✓	✓	✓	✓	✓
Anxiety			✓				✓

Proximal determinants of oral health

Smoking	✓		✓	✓	✓	✓	✓
Alcohol						✓	✓
Fluoride		✓	✓				✓
Diet			✓	✓			
Brushing	✓	✓	✓		✓		✓
Interproximal cleaning	✓		✓	✓	✓		✓
Mouthwash			✓		✓		✓

Impacts of oral health

Pain	✓	✓	✓	✓	✓	✓	✓
Self-reported oral health	✓	✓	✓	✓	✓		✓
OHRQoL		✓	✓		✓	✓	✓

2.6.5.4 US NHANES data

The Centre for Disease Control (CDC) has established national surveillance programmes for oral health in the United States as part of the National Health and Nutrition Examination Survey (NHANES). Detailed datasets have become available that are reported both by the CDC (CDC, 2019) and by end-users carrying out secondary analysis of the datasets (Elani et al., 2018) (Alwaheidi et al., 2021) (Aldosari et al., 2021). NHANES data cycles have been captured annually since 1999 and are reported biannually (Dye et al., 2019). The oral health component has included dental health continuously since 2011 and included reporting on caries (CDC, 2019), periodontal disease (Eke et al., 2020) and TSL (Alwaheidi et al., 2021). The caries data were reported at the level of cavitation for adults between the ages of 20 and 64 years, with the most recent data collected between 2011 and 2016 (CDC, 2019). The examination of patients for the presence of periodontal disease included full mouth six-point probing protocols of all teeth except for third molars. Only respondents over the age of 30 years were examined to reduce the risk of over-diagnosis in younger people. The results have allowed comprehensive estimates of the prevalence of periodontitis in the US population (Eke et al., 2018) that may be used to compare with Irish national data. The results indicated that an increase in periodontitis has been driven by an increase in the proportion with moderate disease while the proportion with mild and severe disease remained relatively steady. In the reporting of TSL, the Smith and Knight tooth wear index was used (Smith BG, 1984), which examined the occlusal surfaces of upper and lower first molars, as well as the lingual and incisor surfaces of twelve upper and lower anterior teeth (Alwaheidi et al., 2021), with reporting at the threshold of moderate wear.

The demographic characteristics used to report clinical indicators included age, gender and race, which reflected the more heterogeneous population. The survey reported by unique age groups that were different from Irish and UK standards, but clear trends seen in the data by age were comparable to the Irish and international results. The social gradient in oral disease was recorded by reporting intermediate determinants such as education, income relative to the federal poverty line and dental attendance. A limited number of proximal determinants were reported and included smoking, diet and the use of dental hygiene measures. Impacts including pain and self-reported oral health were also reported.

2.6.5.5 *England 2018*

National surveys have not been undertaken in the UK since 2009. In 2018, a practice-based epidemiological survey was undertaken in England (Public Health England., 2020).

Calibrated examiners collected data in general dental practices and recruited patients who were attending the practice for routine appointments; this methodology may have affected the results as patients with avoidant behaviours may not have been recruited and are typically reported to have a higher prevalence of untreated disease (Crocombe et al., 2012b). Caries data were collected and reported at the level of visual detection and only bleeding on probing was reported as a marker of periodontal inflammation. In addition to number of teeth, decayed and filled teeth, the survey reported the presence of PUFA, dentures, crowns and bridges. The data were reported using the demographic characteristics of age and ethnicity but the only intermediate determinants reported were deprivation quintiles and recency of last dental visit. The proximal determinants reported were smoking and alcohol use. The impacts reported pain prevalence and selected questions from the OHIP-14 instrument. The data set is relatively recent and from a country with common cultural norms to Ireland but in contrast to Ireland only an estimated 9.1% of the population had community water fluoridation with a concentration greater than 0.7mg/ L (Nyakutsikwa et al., 2022). Data were also presented in tables without clear recording of the values and direct comparison can only be made by inferences from the tables.

2.6.5.6 *Australian national survey 2017-2018*

A national oral health survey was undertaken in Australia on dentate adults over the age of 15 years between 2017 and 2018 (Ha et al., 2020, Luzzi et al., 2020, Peres et al., 2020). A little over half of the 5022 participants were 55 years of age or older which means that a degree of caution is required when comparing results with the Irish army. The survey reported standard oral health indicators such as number of teeth, caries at the level of visual diagnosis, presence of dentures, incisor wear and the presence of periodontal pocketing greater than 4mm.

Reporting was by gender and by age in 20 year age bands from 15 years of age, which did not correspond to the age groups reported in the Irish surveys but could be used to identify trends in the data. The survey reported extensively on the impact of intermediate determinants on clinical indicators: income; education; deprivation tertile; urban/ rural background; dental insurance and dental visiting pattern. Proximal determinants reported included toothbrushing, use of floss and use of mouthwash. Reported impacts included toothache, self-reported oral health and a number of impact questions from the OHIP-14 questionnaire.

2.6.5.7 Adult oral health survey England 2021

Due to the restrictions of the COVID pandemic a national survey of oral health in England was undertaken without an accompanying clinical examination (OHID, 2024). In total 6343 responses were collected using web and paper-based responses. The survey collected a broad range of self-reported clinical indicators including: number of natural teeth; number of fillings; presence of crowns, bridges or dentures; presence of broken teeth or restorations and a number of questions derived from NHANES designed to identify the presence of periodontal disease (Eke et al., 2013).

Data were reported by gender and using the age range from previous Irish and UK surveys. A number of intermediate determinants (income, geographic area and deprivation quintile) were used to report the clinical indicators and the survey included data on dental visiting and dental anxiety. A large range of proximal determinants were reported (smoking, alcohol, toothbrushing, use of fluoride toothpaste, interdental aids, mouthwash use) and reported data not available in Irish surveys. The impacts of oral health were recorded using self-reported oral health status and two measures of OHRQoL, the OHIP-14 and Oral Impacts on Daily Performance (OIDP) instruments. The survey was limited by the lack of normatively assessed need that might allow ready comparison with previous surveys but provided a wide range of data on proximal determinants and impacts that was unavailable in Ireland.

2.6.5.8 Summary of the surveys from high-income countries

The surveys outlined above have the advantage of being published more recently than the Irish national data and present the possibility that they may reflect changes in oral health that are more relevant to the Army in 2020. However, these surveys typically represent populations with very different demographic composition to that found in the Army, with wider age ranges, a more equal distribution of men and women and ethnic compositions that differ markedly from the Irish composition. As such, although trends may be applicable to the Army, care must be taken when making definitive comparisons.

These surveys reported standard clinical indices such as number of teeth, DMFT scores, number of decayed teeth and prevalence of periodontal disease. The results of the main indices are displayed in Table 2-8 and show slight variation, particularly in the reporting of populations means of components of DMFT scores in England (Public Health England., 2020) and the UK (White et al., 2011). In these surveys the mean number of teeth was very similar across the surveys, with a high proportion with a functional dentition between 81.9%

in England (Public Health England., 2020) to 88.6% in New Zealand (Ministry of Health, 2010). The prevalence of edentulousness also appeared to have decreased over time, with lower values in later surveys. These results indicated that dental systems were generally effective at retaining teeth in high-income countries in the years after the Irish national surveys were conducted and indicate that a contemporaneous survey in Ireland may demonstrate similar trends in relation to retention of teeth and a reduction in edentulousness.

Table 2-8: Prevalence of oral diseases in the surveys of high-income countries (Cooney, 2010, Ministry of Health, 2010, NHS, 2011a, Elani et al, 2018, CDC, 2019, Eke et al., 2020, Public Health England, 2020, Peres et al, 2020, Ha et al., 2020, Luzzi et al., 2020, Al Waheidi et al., 2021, Aldosari et al., 2021)

Country	Canada	NZ	UK	US	Australia	England
Year	2007	2009	2009	2011-2018	2018	2018
Number of teeth	24.5	25.9	25.7	25.5	26.2	24.9
Functional dentition	85.4%	88.6%	86%	-	89.9%	81.9%
% edentulous	6.4%	9.4%	6%	2.2%	4%	1.1%
Prevalence caries	19.7%	35.3%	31%	15.9%	32.1%	27%
Mild/moderate periodontitis	16%	28.4%	37%	38.4%	28.8%	-
Severe periodontitis	4.1%	5.1%	8%	7.8%		-
DMFT	10.7	13.9	-	9.3	11.1	-
DT	0.6	0.8	0.8	0.9	0.8	-
MT	2.1	4.6	-	1.9	4.4	-
FT	8.0	8.5	7.2	6.5	5.9	7.2

The global prevalence of caries (Kassebaum et al., 2015, Peres et al., 2019) has been estimated to be 35.4%, with little change since 1990 and a lower prevalence (22%) in high-income parts of North America. The prevalence in New Zealand (Ministry of Health, 2010), UK (White et al., 2011) and Australia (Peres et al., 2020) approximated these estimates, with a recent practice-based survey in the UK being a little lower at 27% (Public Health England., 2020). The prevalence of caries was lower in the surveys in Canada (Cooney, 2010) and the US (Gupta et al., 2018) but in these surveys the threshold for diagnosis was at the level of cavitation. Similar results were present in the national Irish data when comparing 1990 to 2000 results and suggests that an Army survey should report at the threshold of visual diagnosis of caries as international trends suggests that caries remains a public health problem in adults. Only the Canadian survey reported the prevalence of respondents with a DMFT score of zero, which was 8.8% for respondents between 20 and 39 years but dropped to zero in the group over 60 years of age (Cooney, 2010), showing the continued exposure to the risk of developing caries over a lifetime.

No consensus was present in the methodological approach for the measurement of periodontitis in these international surveys. In the US the NHANES project conducted full mouth periodontal probing and reported a prevalence of 42.2% in adults over 30 years of age (Eke et al., 2020) which was similar to the 45% value reported in the UK by dental teams using a threshold of 4mm and examining index teeth (White et al., 2011). In Australia (Ha et al., 2020), the prevalence when reported on a patient level as the presence of a single site $\geq 4\text{mm}$ was 28.8% but using the CDC/ AAP diagnostic criteria (Page and Eke, 2007) the prevalence differed only slightly at 30.1%. Given the significant resources and time required to conduct full-mouth probing, the investment may be difficult to justify in the Army survey as an aid to planning of service delivery.

The global prevalence of severe periodontitis has been estimated as 11.2%, with little difference since 1990 (Kassebaum et al., 2014), and slightly lower prevalence in high-income regions in western Europe (9.4%) and North America (7.2%). The results for the prevalence of periodontitis in the surveys in high-income countries approximated these estimated global values. NHANES data in the US has reported an increase in the prevalence of periodontitis, driven by an increase in moderate disease (Eke et al., 2020). There was a gradient in the proportion with total periodontitis from Canada in 2007 (Cooney, 2010) to the US in 2014 (Eke et al., 2020) but this may reflect the different reporting mechanisms including the use of index teeth in the Canadian survey.

Only the UK survey (White et al., 2011) and the US NHANES survey (Alwaheidi et al., 2021) have reported the prevalence of tooth surface loss. Although reporting using different thresholds, 17% of the UK respondents and 12.2% of the US respondents had moderate or severe TSL. The results suggest that prevalence of TSL in high-income populations is extensive enough to warrant inclusion in a survey in the Irish Army given the potential for preventative interventions and the need for planning for the management of complex cases.

The effect of age reported in these surveys mirrored the trends reported in the Irish national surveys, with an increase in the number of teeth lost and prevalence of edentulousness; increased DMFT and FT scores; decreased DT scores; increase in the prevalence of periodontitis and an increase in the prevalence of TSL (Cooney, 2010, Fuller et al., 2011, Eke et al., 2015, Public Health England., 2020, Ha et al., 2020, Amarasena et al., 2021). In addition, the international surveys reported an increase in the prevalence of complex prosthodontic devices (Cooney, 2010, Steele et al., 2011b), which might be relevant to older soldiers.

A common feature across the surveys in these high-income countries were attempts to determine whether social gradients existed in the health outcomes. There was no consensus on the indicators used and surveys commonly reported using two or more including national deprivation groups (Ministry of Health, 2010, Jamieson et al., 2021), occupation (White et al., 2011), income (Cooney, 2010, CDC, 2019, Jamieson et al., 2021), insurance class (Cooney, 2010, Jamieson et al., 2021), education (Cooney, 2010, CDC, 2019) and ethnicity or race (Ministry of Health, 2010, CDC, 2019). There was broad agreement that social gradients existed across all of these indicators in number of teeth retained, active caries, presence of periodontitis and other measures and agreed with the national findings by Medical Card status. These results show that despite improvements in oral health subsections continue to experience poorer oral health and indicates that potential measures of disadvantage in the Army should be selected for inclusion in the survey.

Although measures of dental attendance were utilized in all of these surveys, a number of approaches were used for reporting. Frequency of attendance was most commonly reported and generally as over or under one year previously (Cooney, 2010, Ministry of Health, 2010, Gupta et al., 2018). In the UK (Morris et al., 2011) and England (Public Health England., 2020, OHID, 2024) the frequency was segmented into groups between six months and two years, with the UK data recording further categories up to 10 years. The reason for attending was recorded in New Zealand (Ministry of Health, 2010), the UK (Morris et al., 2011) and England (OHID, 2024), typically attempting to differentiate between problem-based attendance and routine attendance. In Australia these differences were categorized as “favourable”, “intermediate” and “unfavourable” in the reporting of clinical data (Peres et al., 2020). A critical aspect of the dental examination in the Army is the retention of a forensic record, which indicates that frequency and recency of visiting is an important metric.

Dental anxiety is an important driver of dental attendance (Armfield et al., 2007) but only the UK (Freeman et al., 2011) and England (OHID, 2024) included a measure of dental anxiety. Both surveys reported using the Modified Dental Anxiety Score (Humphris et al., 1995) and both reported a population prevalence of 12% for severe dental anxiety (phobia). Secondary analysis of the UK data reported that women and younger people had a higher prevalence of phobia (Humphris et al., 2013). As the Irish Army was mainly composed of young men, inferences about the possible proportion with phobia from international data were difficult to make. In the UK in 2009 the prevalence was reported to be unaffected by social status

whereas an association was reported in England in 2021 with lower family income and deprivation (OHID, 2024) and requires exploration in the Army survey in light of the anecdotally reported recruitment of soldiers from areas with disadvantage.

Despite the known links between proximal determinants and oral health and the need to develop responsive preventative programmes (Petersen, 2005), only in the UK (Steele et al., 2012) and England (OHID, 2024) has extensive reporting of proximal determinants been undertaken. Smoking prevalence was widely reported (Cooney, 2010, Ministry of Health, 2010, Chadwick et al., 2011, Eke et al., 2018, Jamieson et al., 2021, OHID, 2024), which was unsurprising given its links with periodontal disease (Bergstrom, 2014) and oral cancer (Sadri and Mahjub, 2007), but only in England was alcohol use reported (Public Health England., 2020, OHID, 2024). Since alcohol is a known risk factor for oral cancer (Turati et al., 2013) and rates of alcohol misuse, including binge drinking, are reported to be high in Ireland (Dept. of Health, 2018), collection of both smoking and alcohol data in an Army survey should be considered.

Few surveys collected data about proximal determinants that could be used in the development of preventative programmes for caries and periodontal disease. The prevalence of disease in fluoridated and non-fluoridated communities was reported in New Zealand (Ministry of Health, 2010) and brushing with fluoridated toothpastes was recorded in New Zealand (Ministry of Health, 2010), the UK (Chadwick et al., 2011) and England (OHID, 2024). Only in the UK was the role of diet extensively explored (Chadwick et al., 2011) and in the US secondary analysis of NHANES data has reported carbonated drink consumption as a risk for TSL (Alwaheidi et al., 2021). In the UK about half of the respondents were reported to have a high-risk diet, which might be thought to translate into risk in Ireland given the common social framework. There was good reporting of the frequency of toothbrushing, with most surveys reporting at the threshold of twice a day or more (Cooney, 2010, Ministry of Health, 2010, Chadwick et al., 2011, OHID, 2024) but Australia reported at the threshold of once per day (Jamieson et al., 2021). The proportion who brushed twice a day ranged from 69% in New Zealand (Ministry of Health, 2010) to 77% in England (OHID, 2024), which indicates a large section of high-income countries who brush less than optimally. Measures used to report interdental cleaning included use in the last week (Jamieson et al., 2021) (Eke et al., 2018), items commonly used (Chadwick et al., 2011, OHID, 2024) and floss used five or more times in the previous week (Cooney, 2010), with typically a little less than a third of the respondents reporting such use. These results would seem to indicate that a reasonably

large section of high-income countries had increased risk of developing caries and periodontal disease based on oral hygiene practices (Løe, 2000, Kumar et al., 2016) but little data has been published that might allow planning for the delivery of preventative programmes in the Army based on these results.

An interesting difference between the studies in high-income countries and the Irish surveys was the emphasis placed on self-reported impacts. All of the surveys reported pain in some fashion, as current pain (Nuttall et al., 2011, Brennan et al., 2020, Public Health England., 2020), pain the last four weeks (Ministry of Health, 2010), pain within the previous year (Aldosari et al., 2021) or by using pain questions drawn from the OHIP-14 questionnaire (Cooney, 2010, OHID, 2024). The survey in England in 2021 also asked a merged question about the presence of teeth painful to bite on or cracked or broken as a measure of teeth requiring intervention (OHID, 2024). The wide range of pain questions makes comparison difficult. The range of pain within the previous four weeks (including current pain) was 9% (Nuttall et al., 2011) to 25.4% (Ministry of Health, 2010), constituting a significant range between surveys. Probable reasons include underlying disease rates and access to services – factors that should be investigated in the Army. Consistent findings across these surveys was that pain prevalence decreased with older age and was higher in women than men, which may have relevance to a younger, predominantly male Army (Cooney, 2010, Ministry of Health, 2010, Nuttall et al., 2011, Brennan et al., 2020, Aldosari et al., 2021). Pain prevalence was lower in more frequent attenders and in more affluent respondents, which indicates that pain prevalence should be investigated in the Army using markers of social advantage, including rank, as more senior ranks may have fewer barriers to access for care.

Self-reported oral health was reported from “excellent” to “poor” in Canada (Cooney, 2010), Australia (Brennan et al., 2020), New Zealand (Ministry of Health, 2010) and the US (Li et al., 2019) and from “very good” to “poor” in the UK and England (Nuttall et al., 2011, OHID, 2024). These surveys dichotomized the results into the reporting of better (“excellent” to “good”) or worse (“fair” or “poor”) oral health, with a reported range of poorer oral health from 23.9% in Australia (Brennan et al., 2020) to 38% in the US (Li et al., 2019), with an outlier of 15.5% in Canada (Cooney, 2010). The utility of self-reported oral health is that it has shown good correlation with clinically assessed oral health (Atchison et al., 1993), including in the UK national survey (Nuttall et al., 2011), and might be used to identify personnel at higher risk of a dental emergency. In general, self-reported oral health was reported to decrease with age as tooth loss and the accumulated impact of caries and

periodontal disease became apparent (Nuttall et al., 2011, Brennan et al., 2020, OHID, 2024). The results in New Zealand were an outlier as the prevalence of reporting poorer oral health peaked in the 35 to 44 years age group and was lowest in older age, for reasons that are not evident from the clinical indicators (Ministry of Health, 2010) but may simply show that these reports are very specific to the population under observation. In these surveys women and more affluent respondents reported better oral health than men or poorer respondents which might indicate poorer results in the Army.

OHRQoL was measured using OHIP-14 in the UK (Nuttall et al., 2011), England in 2021 (OHID, 2024) and New Zealand (Ministry of Health, 2010) with selected questions used in Canada (Cooney, 2010) and England in 2018 (Public Health England., 2020). The prevalence of impacts at “occasional” or above reported in the OHIP-14 instrument ranged from 15.6% in New Zealand in 2009 to 47% in England in 2021 (OHID, 2024), a wide range suggesting that international results cannot readily be used to estimate the prevalence in the Army. As was the case for the prevalence of pain and self-reported oral health, the prevalence of impacts decreased with age, were higher in women than men and were highest in the respondents with markers of disadvantage. As such, there was a consistency between the symptoms, self-reported health status and OHRQoL measures coherent with the model developed by Wilson and Cleary, that suggests that it has potential use for framing the analysis of impacts in the Army (Wilson and Cleary, 1995).

Overall, these surveys reported a wider range of results than Irish national surveys in terms of the clinical indicators, personal and social determinants and impacts. However, although they showed interesting trends in the data, which typically accorded with the findings of the Irish national surveys where available, the demographic composition of the populations was markedly different from the Irish Army and it was not possible to use these reports to estimate the prevalence of diseases or conditions in the Army.

2.6.6 Irish Military studies and data

Limited data reporting the oral health of Irish Army personnel was available for inspection and was many decades old. In the interim, national surveys have indicated that the oral health of the population has improved (O'Mullane and Whelton, 1992, Whelton, 2007, Naseer, 2020), at least for large sections of the population. The studies reviewed below outline the data available and were compared to national civilian data available for inspection.

2.6.6.1 70th Infantry Battalion UNIFIL, 1992

For many years the Irish Army collected practice-based data about the oral health of military units by submitting a dedicated Army form that recorded the following oral health outcomes: number of DT, MT, FT and DMFT; number of extractions and fillings required; scalings required and upper or lower dentures required. These data were collected in triplicate and used to plan the delivery of services locally. A copy of the data form was forwarded to the Chief Dental Officer who retained summarized data about the oral health status of units across barracks in Ireland and in deployed locations overseas. All of these data have now been lost save for a single record of the oral health status of a deployed infantry battalion in Lebanon in 1992. These data were entered into an SPSS database for the development of descriptive statistics.

The data from the 70th Infantry was collected by a Dental Officer deployed with the unit who examined and reported on the status of 293 personnel in The Lebanon in March 1992. Data were collected without the use of radiographs, as these were not available in the surgery at that time. The Dental Officer was not calibrated for the collection of data but was clinically experienced with over 20 years postgraduate experience and it is likely that he was internally consistent. These data may be described as a pragmatic record of one Dental Officer's finding and is indicative of the caries experience in serving soldiers at that time. Similar approaches to data collection have been used in data collection in England (Douglas et al., 2023) and Scotland (NHS, 2019) in recent years. The data have the advantage of being recorded at the level of visual detection of caries and collected by rank.

The data relating to the 70 Infantry Battalion are displayed in Table 2-9 and Table 2-10. In this unit there was a large unmet treatment need, with high caries rates in all groups; only 34.5% were free of decay and 30.7% had three or more decayed teeth. The deployed Dental Officer identified treatment need in 86.7% of personnel, including 27 personnel who needed 21 upper and 15 lower dentures and three others who needed a bridge. The majority of

personnel were recorded as needing a scaling. Fifteen personnel were recorded with 25 teeth that required extraction. By any standard, this group of personnel had high unmet treatment needs and the system of care did not address these needs before deployment.

Table 2-9: Mean (95th CI) number of DT, MT, FT and DMFT reported in the 70 Infantry Battalion, UNIFIL 1992 N=293

Rank	n	DT	MT	FT	DMFT
Private	160	2.2 (1.9, 2.5)	5.4 (4.7, 6.0)	5.4 (4.7, 6.1)	12.9 (12.0, 13.9)
NCO	104	2.3 (1.7, 2.8)	6.8 (5.9, 7.6)	6.6 (5.8, 7.5)	15.7 (14.6, 16.8)
Officer	29	0.8 (0.2, 1.3)	5.7 (4.3, 7.2)	12.6 (10.8, 14.4)	19.0 (17.0, 21.1)
All	293	2.1 (1.8, 2.4)	5.9 (5.4, 6.4)	6.5 (6.0, 7.1)	14.5 (13.8, 15.2)

Table 2-10: Prevalence of decayed teeth and treatment need, in the 70 Infantry Battalion, UNIFIL 1992, N=293

Rank	n	D=0	D=1/2	D≥3	Scalings required	Any treatment required	Dentures required
Private	160	47 (29.4%)	59 (36.9%)	54 (33.8%)	118 (73.8%)	160 (100%)	13 (8.1%)
NCO	104	38 (36.5%)	31 (29.8%)	35 (33.7%)	82 (78.8%)	91 (87.5%)	12 (11.5%)
Officer	29	16 (55.2%)	12 (41.4%)	1 (3.4%)	22 (75.9%)	25 (86.2%)	2 (6.9%)
All	293	101 (34.5%)	102 (34.8%)	90 (30.7%)	222 (75.8%)	254 (86.7%)	27 (9.2%)

There was a marked difference in the oral health status of personnel by rank. There were statistically significant differences between officers and the enlisted ranks of NCOs (non-commissioned officers) and private soldiers in the number of decayed teeth (Kruskal-Wallis, $p<0.001$) and the number of filled teeth (Kruskal-Wallis, $p<0.001$) which might suggest better access to treatment by respondents with greater authority. The higher DMFT scores in officers than in the enlisted ranks (Kruskal-Wallis, $p<0.001$) also suggests that the officers were a treated group (Sheiham et al., 1985).

Private soldiers had fewer missing teeth than NCOs (Kruskal-Wallis, $p<0.008$) but the differences between privates and officers were not statistically significant. In general, private soldiers are younger than NCOs, as the latter are promotion ranks from the private rank, but the officers in a deployed battalion are of all ages, depending on the position in the hierarchy. Thus, while the differences between privates and NCOs may be explained by differences of age, this would not be so readily explained in the comparison with the officer ranks and suggests a social gradient by rank. Since officers could avail of funded endodontic therapy for all teeth but private soldiers (and NCOs) were confined to anterior teeth at that time, access to therapy may have partly explained the differences.

In summary, this snapshot of a single battalion deployed overseas in 1992 showed the prevalence of untreated disease present in the Army at that time. The data complements the results of Hayden, below, which in the main reports recruits' data. The high prevalence of untreated disease showed the need for deployed dental support at that time to relieve pain and manage urgent dental problems, creating risks for the effectiveness of the military operation. The high prevalence of observed disease suggests that at that time the Army dental service was not meeting the preventive and treatment need of serving soldiers. There were indications of a social gradient by rank as enlisted personnel had more decayed teeth, a higher proportion with three or more decayed teeth and fewer filled teeth than officers.

2.6.6.2 1990 Irish Army survey

In parallel with the 1990 national population survey (O'Mullane and Whelton, 1992) a survey was undertaken of Army personnel using the criteria of the national survey, notably with caries diagnosed at the threshold of cavitation. Calibrated examiners examined 1043 personnel in four locations. The results were reported by age groups: 16 to 24 years, 25 to 34 years and 35 to 44 years. All the personnel in the 16 to 24 years and 25 to 34 years age groups were recruits and all but four of the 35 to 44 years age group were serving military personnel in the trained strength, which allowed differentiation between the groups as well as noting differences in the trained strength following years of exposure to the military system of care. There were only 39 female personnel in the sample, mainly cadets in the Curragh Camp. The sample was not representative of women in the Army or of soldiers in the trained strength whereas the numbers of recruits examined suggests that a representative sample was examined.

A summary of the key findings in the data are displayed in Table 2-11 and shows the degree of untreated disease and the experience of disease in personnel in 1990. As was reported in the national surveys (O'Mullane and Whelton, 1992, Whelton, 2007), the number of teeth decreased with age but in every age category the recruits and soldiers had more teeth than civilian peers, which may have been a result of the requirement in the Army to have a minimum of 22 functionally opposed teeth on entry. Further evidence for the effect of a recruitment standard was evident in the proportion with a functional dentition of 21 or more teeth as 99.5% of the 16- to 24-year-old group and 97% of the 25 to 34 years old recruits had a functional dentition whereas the proportion in civilians in 1990 was 98.8% and 87.7%. Interestingly, not all recruits met the entry standard (0.5% of the 16 to 24 years group and 3%

of the 25 to 34 years group), which might indicate that some soldiers had been given a derogation on the basis of bridges or other devices being present or may reflect a degree of pragmatism by Dental Officers at the time of assessment.

Table 2-11: Summary of Army data 1990 (Hayden, 1995)

Group		Recruits		Trained strength
Age range		16 to 24 years	25 to 34 years	35 to 44 years
No teeth (95% CI)		28.1 (27.9, 28.3)	26.5 (25.7, 27.3)	23.8 (23.2, 24.4)
DMFT (95% CI)		6.6 (6.3, 7.0)	12.8 (11.4, 14.2)	16.4 (15.7, 17.1)
DT (95% CI)		1.9 (1.7, 2.1)	1.6 (1.1, 2.1)	1.5 (1.3, 1.7)
≥21 teeth (%)		99.5%	97%	71%
≥18 sunt (%)		91.3%	59.1%	29.5%
PSR	PSR 3 (%)	30%	52%	57.8%
	PSR 4 (%)	0%	0%	15.6%
Denture (%)		1.2%	3%	34%

The mean number of decayed teeth was highest in the 16 to 24 years age group and decreased only slightly in the 25 to 34 and 35 to 44 years age group. These results showed that both recruits and serving soldiers had a high degree of untreated disease, as was described in the practice-based report of the 70th Infantry Battalion. These results and the data reported for the soldiers in the 70th Infantry Battalion show that the system of care present at that time was not successful in controlling disease in soldiers in the Irish Army at that time.

The mean number of decayed teeth was lower in the 1990 survey than the soldiers of the 70th Infantry Battalion but this may simply show the difference between using cavitation as a threshold in the epidemiological survey and a practice-based assessment of need using visual detection in the 70th Infantry Battalion. In all the age groups, the mean number of decayed teeth was higher in soldiers in 1990 than in age matched civilian peers. The fact that DMFT scores were also lower in the Army recruits and soldiers in 1990 than age matched civilians showed that both the recruits and the soldiers had the features of an untreated group (Sheiham et al., 1985) and confirm the findings in the 70th Battalion. Soldiers also had a higher proportion with 18 or more SUNT than age-matched civilian peers, which may have been a result of lower levels of treatment in a dentally unfit group.

If the purpose of the entry standard was to reduce reliance on dentures in recruit training, the standard appeared to have the desired effect. While there was little difference between the

proportion with a denture in recruits and civilians in the 16 to 24 years age group (1.2% and 2%, respectively), there was a larger difference in the 25 to 34 years age group (3% and 14%, respectively). However, in the 35 to 44 years age group there was a similar proportion, with about a third of soldiers and civilians recorded having a denture. The fact that dentures were provided for free in the Army and the inability of most soldiers to avail of endodontic therapy may have been factors in the rapid acquisition of dentures after entry.

The prevalence of periodontitis was again difficult to explain as no severe cases were recorded in either the 16 to 24 or 25 to 34 years age groups. This was almost certainly the consequence of under-diagnosis of disease. The results for severe disease prevalence were very similar to the results of age-matched civilian peers (O'Mullane and Whelton, 1992), which may mean that the calibration of disease was an issue. By contrast with the civilian results, there was a very high prevalence of untreated mild to moderate disease in all the age groups, from 30% in the 16 to 24 years age group to 57.8% in the 35 to 44 years age group. The value in the 35 to 44 years age group was far greater than the 12% value recorded in age matched civilians in the national study (O'Mullane and Whelton, 1992) but may have been a result of determinants such as smoking in the Army.

2.6.6.3 Summary of Irish Army data

The data reported in the Irish Army had many of the same drawbacks found in the national data. The results were several decades old and of limited value in the assessment of current oral health status, given the changes reported both anecdotally in the Army and in published results in selected age groups in the civilian community (Harding, 2016, Naseer, 2020). The data indicated that soldiers at that time were broadly an untreated group with more decayed teeth and periodontitis than their civilian peers, whereas by contrast soldiers in 2020 were exposed to a system that attempted to make them dentally fit before deployment overseas. There was little examination of the effects of determinants of oral health. The effects of age in the 1990 survey showed a pattern similar to those reported in the civilian survey in 1990. Rank was examined in the 1992 practice-based survey and showed a statistically significant gradient in oral health, with better oral health in officers than enlisted personnel, who had fewer decayed teeth and almost double the number of filled teeth than enlisted personnel. Proximal determinants underlying these differences were not explored in the surveys. Overall, the data from the Irish Army was limited in scope and underlines the need for collection of updated epidemiological data and associated determinants.

2.6.7 International military publications

A large number of international military publications existed, and it was useful to examine trends in military oral health internationally and also explore the way in which data were collected. These publications formed three broad categories. Firstly, as reported above, there were a large number of publications reporting emergency rates of personnel at home and on deployment (Alexander, 1996, Jelaca-Bagic et al., 1997, Mahoney and Coombs, 2000, Chaffin, 2001, Dunn, 2004, Richardson, 2005, York et al., 2008, Gunepin et al., 2011, Simecek et al., 2014). These publications did not report representative data from the populations from which they were drawn. Nonetheless these publications were useful in the planning of the epidemiological survey as they clearly linked the experience of caries and other conditions to the subsequent development of problems that required emergency appointments.

The second type of publication that existed within the military literature reported the normative treatment need, typically of recruits, that was necessary to make personnel fit for deployment (Cassidy et al., 1973, Christen et al., 1979, Ankkuriniemi and Ainamo, 1997, Chaffin et al., 2003, Moss, 2011, Patankar, 2014). In general, these publications reported data in a derived fashion or categorized according to the NATO fitness classification scheme. For instance, in a large study of 5835 recruits in the US military, designed to be representative of the recruit population, the data were reported as the mean number of extractions required, restorations required and other operative treatments required to make recruits fit to the NATO standard (NATO, 2017). As such, the data typically could not be used for direct comparison with epidemiological surveys.

The third category of publication that existed within the military literature reported epidemiological data that might be compared with other surveys, with an emphasis on dental health data. Most of these reports were of recruits' oral health, perhaps because of an assumption that soldiers in the trained strength should be treated to deployable standards. It is also possible that reporting in detail on the trained strength has been suppressed for security reasons as it may inadvertently release sensitive data such as the strength in barracks or similar data. It is likely that the data are collated and reported internally, aided by modern computer systems that can collect this data at the point of care, but has not been released.

A number of countries including Norway, Finland, and Switzerland had national conscription of males and the sample sizes were large enough to be representative both of the recruit population and of the young men in the community from which they were drawn (Asmyhr et al., 1994, Ankkuriniemi and Ainamo, 1997, Röthlisberger et al., 2007, Kamppi et al., 2013).

For instance, a series of surveys were carried out in Norway between 1968 and 1990 that examined between 3742 and 4883 recruits, which corresponded to over 95% of the recruit intake population (Asmyhr et al., 1994). A series of surveys in the US were also designed to be representative of the recruit (York et al., 1995, Moss, 2011) and trained strength (York et al., 1995) population and although most data were reported in a derived manner, some basic epidemiological data are available. Other than these specific publications the surveys were convenience samples and caution must be exercised in the interpretation of the data. In addition to the limitations posed by convenience sampling in the interpretation of the data, few report examiner training or calibration (York et al., 1995, Vered and Sgan-Cohen, 2003, Vered et al., 2008, Moss, 2011) and the criteria for detection of caries or periodontal disease was typically not reported, with an assumption that the detection was based on clinical observation.

The oral health outcomes in hard tissue and periodontal health in recruits and the trained soldiers are displayed in Table 2-12 to Table 2-15. The oral health outcomes reflected national consumption patterns of cariogenic foods, smoking habits, gender distribution, age range in the military under observation, ethnic composition and other determinants of diseases and conditions at certain timepoints. Direct comparison with the results of the Irish Army must be guarded due to these differences and the time between the survey and these reports. It was not clear from the military surveys that oral health of soldiers was improving over time to the degree seen in the national surveys. For example, in the UK survey in 2011 the mean number of decayed teeth in recruits was 0.8 (White et al., 2011) whereas soldiers in a convenience sample in the British Army had 2.6 decayed teeth in 2011 (Elmer et al., 2011). In the trained strength, as displayed in Table 2-13, the mean number of decayed teeth appeared in general to be lower than that reported in recruits but in many countries there was still a high burden of untreated disease in the trained soldiers (Sgan-Cohen et al., 1999, Skec et al., 2002) that reflected policies in relation to dental fitness. The periodontal data in Table 2-14 and Table 2-15 had the same reporting problems identified in civilian publications with possible under-reporting in young adult recruit populations (Ankkuriniemi and Ainamo, 1997, Röthlisberger et al., 2007) and there was an enormous range in the trained strength from 10.1% with total periodontitis in Spain in 2008 (Mombiedro Sandoval and Llena Puy, 2008) to 95.9% in Spain in 2020 (García et al., 2020). Limited numbers of publications had time series that demonstrated changes in recruits' oral health over time. However in Finland and Norway a decrease in caries experience in recruits in high-income countries with good social

oral healthcare systems was reported (Asmyhr et al., 1994, Ankkuriniemi and Ainamo, 1997).

Table 2-12: Dental data, recruits international military, high-income countries

Country	Year	DMFT	DT	MT	FT	Source
Norway	1968	19.7	4	2	13.7	(Asmyhr et al., 1994)
Denmark	1974	16.6	2.5	2	12.1	(Antoft et al., 1974)
Finland	1976	15.8	1.1	1	10.3	(Ankkuriniemi and Ainamo, 1997)
Norway	1978	17.2	4.3	1.2	15.1	(Asmyhr et al., 1994)
Finland	1981	14.5	2.6	0.5	11.4	(Ankkuriniemi and Ainamo, 1997)
Switzerland	1985	10.1	4.2	0.5	5.4	(Menghini et al., 2010)
Finland	1986	11.2	1.7	0.1	9.4	(Ankkuriniemi and Ainamo, 1997)
Norway	1990	10.2	0.9	0.1	9.2	(Asmyhr et al., 1994)
Finland	1991	7.3	1.3	0.1	5.9	(Ankkuriniemi and Ainamo, 1997)
US	1994		3.5			(York et al., 1995)
Switzerland	1996	5.3	1.2	0.4	3.7	(Menghini et al., 2010)
US	2000		2.8			(Moss, 2011)
Israel	2004	6.8	2.7	0	4	(Levin and Shenkman, 2004)
Croatia	2006		5.8	2.2		(Skec et al., 2006)
Switzerland	2006	3.6	0.7	0.5	2.4	(Menghini et al., 2010)
US	2008		3.4			(Moss, 2011)
Croatia	2009	7.3	3.2	1.3	2.9	(Badel et al., 2014)
UK	2011		2.6			(Elmer et al., 2011)
Finland	2013	4.1	1.5			(Kamppi et al., 2013)
Croatia	2014	8.6	3.4	1	4.2	(Spalj et al., 2014)
Israel	2020	2				(Yavnai et al., 2020)
Canada	2021	5.6				(Batsos et al., 2021)
New Zealand	2023	3	0.6	0	2.4	(Naysmith et al., 2023)
Finland	2023	3.2	1.1	0.2	1.9	(Patinen et al., 2022)

Table 2-13: Dental data, trained soldiers, high-income countries

Country	Year	DMFT	DT	MT	FT	Source
US	1995	8.8	0.7	0.7	7.4	(York et al., 1995)
Israel	1999	11.7	1.4	2.4	7.9	(Sgan-Cohen et al., 1999)
Israel	2000	8.5	2.3	0.3	6	(Sgan-Cohen et al., 2000)
Croatia	2002	9.6	2.3	2.3	5	(Skec et al., 2002)
Israel	2003	8.3				(Vered and Sgan-Cohen, 2003)
Israel	2003	11.7	1.4	2.4	8.0	(Horev et al., 2003)
Croatia	2006		2.7	5.1		(Skec et al., 2006)
Germany	2011	11.8	0.5	1.3	10.7	(Ziebolz et al., 2011)
Portugal	2018	4.6				(Azevedo et al., 2018)

Table 2-14: Periodontal data, recruits, international military publications

Country	Year	PSR 3	PSR 4	Source
Finland	1976	1.1%		(Ankkuriniemi and Ainamo, 1997)
Finland	1981	6.9%		(Ankkuriniemi and Ainamo, 1997)
Switzerland	1985	15.0%		(Röthlisberger et al., 2007)
Finland	1986	3.9%		(Ankkuriniemi and Ainamo, 1997)
Finland	1991	1.6%		(Ankkuriniemi and Ainamo, 1997)
US	1994	31.3%	2.7%	(York et al., 1995)
Switzerland	1996	4.5%		(Röthlisberger et al., 2007)
US	1997	25.3%	3.30%	(Diefenderfer et al., 2007)
US	2000	20.3%	4.7%	(Moss, 2011)
Switzerland	2006	3.8%		(Röthlisberger et al., 2007)
US	2008	9.6%	0.9%	(Moss, 2011)

Table 2-15: Periodontal data, trained strength, international military publications

Country	Year	PSR 3	PSR 4	Source
US	1994	45.9%	9.5%	(York et al., 1995)
Israel	2000	49.9%	17.5%	(Sgan-Cohen et al., 2000)
Israel	2003	52.1%	19.1%	(Horev et al., 2003)
Spain	2008	7.8%	2.3%	(Mombiedro Sandoval and Llena Puy, 2008)
Germany	2011	64.3%	20.5%	(Ziebolz et al., 2011)
Serbia	2015	51.0%	22.0%	(Kovačević et al., 2015)
Spain	2020	58.8%	37.1%	(García et al., 2020)

In addition to reporting epidemiological data, albeit often in a derived manner, the military publications also reported determinants of oral health, referenced in Table 2-16. Common themes reported in international studies of oral health ‘civilian literature’ described above and Table 2-8 were also reported in the military literature such as increased tooth loss with age, increased DMFT scores with age, gender differences in the experience of disease and the negative effect of disadvantage as recorded by social class, education or parental income on disease experience.

Despite the importance in a military environment neither rank (Gaare et al., 1989, Marker et al., 1997, Horev et al., 2003, Skec et al., 2006, Mahoney et al., 2008, Mombiedro Sandoval and Llena Puy, 2008, Jasmin and Jaafar, 2011, Wahid et al., 2014) nor years of military service (Mahoney et al., 2008) were commonly investigated as risk factors. Where reported,

officers consistently had better oral health than enlisted personnel but whether this was a result of improved access, better education or better early life advantage was not clear.

Little has been written about subjective assessments of oral health in the military. Self-reported periodontal health was compared to normative need in Israel (Vered and Sgan-Cohen, 2003) and a number of publications have reported OHRQoL, all of whom reported using the OHIP-14 instrument (Kudo et al., 2011, Crocombe et al., 2012a, Crocombe et al., 2013, Spalj et al., 2014, Crocombe and Mahoney, 2016). All the military publications reported at the threshold of “occasionally” or above, which probably reflected the need to capture less frequent impacts that might identify groups more likely to seek an unscheduled appointment. The scores were considerably lower than in the UK civilian population. For instance, the severity scores ranged from (5.0 [4.4, 5.6]) in the Australian Army to (9.7 [3.1, 16.3]) (Spalj et al., 2012) in the Croatian Army but these were considerably lower than the severity scores of 17.4 and 19.7 in the UK and English civilian populations (Nuttall et al., 2011, OHID, 2024). These differences may reflect the gender differences in military and civilian populations or a degree of psychological resilience in soldiers.

The military literature was limited in scope, heavily focussed on recruit oral health and the majority were convenience samples without standardization or calibration of examiners or reporting. The determinants of oral disease were similarly reported in a manner that makes it difficult to apply to the Irish Army and few publications exist that have reported impacts. The strength of the data was that it provided an oversight of recruits to the military and indicated that they may be drawn from a subsection of the population with a high need for basic dental care, which accorded with the anecdotal observations of dental teams in the Irish Army.

Table 2-16: Military publications reporting factors associated with oral health

Factor		Reference
Demographic characteristics	Age	(Gaare et al., 1989, Marker et al., 1997, Rababa'h et al., 1998, Sgan-Cohen et al., 1999, Katz et al., 2000, Hopcraft and Morgan, 2003a, Hopcraft and Morgan, 2005, Müller and Ulbrich, 2005, Mahoney et al., 2008, Mombiedro Sandoval and Llena Puy, 2008, Hopcraft et al., 2009, Jasmin and Jaafar, 2011, Azevedo et al., 2018, Naysmith et al., 2023)
	Gender	(Sgan-Cohen et al., 1999, Katz et al., 2000, Sgan-Cohen et al., 2000, Hopcraft and Morgan, 2003a, Hopcraft and Morgan, 2005, Mahoney et al., 2008, Mombiedro Sandoval and Llena Puy, 2008, Vered et al., 2008, Yavnai et al., 2020, Lim et al., 2022).
Social determinants	Income	(Ceylan et al., 2004, Bastos et al., 2007)
	Deprivation	(Antoft et al., 1974, Hopcraft and Morgan, 2003a, Hopcraft and Morgan, 2005, Hyman et al., 2006, Hopcraft et al., 2009, Elmer et al., 2011, Naysmith et al., 2023)
	Education	(Sgan-Cohen et al., 1999, Katz et al., 2000, Sgan-Cohen et al., 2000, Hopcraft and Morgan, 2003a, Horev et al., 2003, Ceylan et al., 2004, Hopcraft and Morgan, 2005, Bastos et al., 2007, Vered et al., 2008, Tanner et al., 2015, Lim et al., 2022, Naysmith et al., 2023)
	Attendance	(Chisick, 1995, Chisick et al., 1996, Chisick et al., 1997, Zadik et al., 2009, Wahid et al., 2014)
	Anxiety	(Cohen, 1985, Eitner et al., 2006, Grimshaw et al., 2012, Edwards, 2023).
	Rank	(Gaare et al., 1989, Marker et al., 1997, Horev et al., 2003, Skec et al., 2006, Jasmin and Jaafar, 2011, Mahoney et al., 2008) (Mombiedro Sandoval and Llena Puy, 2008, Wahid et al., 2014)
	Military service	(Mahoney et al., 2008)
Proximal determinants	Water fluoridation	(Hopcraft and Morgan, 2003b, Hopcraft et al., 2009, Kamppi et al., 2013, Batsos et al., 2021).
	Smoking	(Machuca et al., 2000, Sgan-Cohen et al., 2000, Kelbauskas et al., 2005, Vered et al., 2008, Menghini et al., 2010, Campus et al., 2011, Wahid et al., 2014, Kovačević et al., 2015, Tanner et al., 2015, Yavnai et al., 2020);
	Alcohol	(Tanner et al., 2015)
	Diet	(Johansson et al., 1996, Johansson et al., 1997, Johansson et al., 2002, Ceylan et al., 2004, Menghini et al., 2010, Kovačević et al., 2015, Tanner et al., 2019, Lim et al., 2022)
	Oral hygiene	(Anagnou-Vareltzides et al., 1982, Ankkuriniemi and Ainamo, 1997, Levin and Shenkman, 2004, Kelbauskas et al., 2005, Bastos et al., 2007, Menghini et al., 2010, Wahid et al., 2014, Tanner et al., 2015, Khalilazar and Khoshdel, 2016, Azevedo et al., 2018, Lim et al., 2022)

2.7 Summary of the literature review

The Army dental service has specific service aims that aim to collect timely and accurate forensic charts that may be used in forensic identification as well as making personnel dentally fit in order to reduce the likelihood of dental emergencies. In order to plan for the delivery of healthcare services and develop preventative programmes robust epidemiological data are required. However, much of the data available nationally is several decades old (O'Mullane and Whelton, 1992, Whelton, 2007) and although these surveys indicated improvements in oral health between 1990 and 2000, the oral health status of Irish personnel, from whom soldiers are drawn, was unknown. About two thirds of Irish 12-year-old children living in fluoridated communities and about half living in unfluoridated communities were reported to be caries free in recent years (Harding, 2016), which might be expected to translate into better oral health in soldiers. Anecdotally, dental teams in the Army have reported a sizeable proportion of the recruit pool was caries free but definitive data were unavailable. A more recent evaluation of the oral health of community dwelling older adults between 50 and 64 years of age showed improvements in oral health between 2000 and 2015 but not all respondents had optimal oral health, including a third with a denture and over half with periodontal disease (Naseer, 2020). These data showed that improvements in oral health had not extended to all parts of the community but the extent to which this applied in the Army was unknown.

Army data were collected and reported in a survey in 1990 (Hayden, 1995) and a practice-based assessment was conducted in 1992. Both of these surveys reported a high prevalence of untreated disease in recruits and serving personnel in the Army. Anecdotally, Dental Officers have reported that a large proportion of recruits continue to attend with untreated disease, some of whom have extensive treatment need. In the intervening years since these Army surveys were conducted strategies have been put in place to reduce disease prevalence by the provision of accessible free oral healthcare to serving soldiers and the anecdotal experience of dental teams was that soldiers presenting for pre-deployment assessments had a low prevalence of active disease, particularly untreated caries. However, epidemiological data reporting the oral health of recruits and serving soldiers was unavailable that might be used in planning for service delivery.

International civilian surveys (Cooney, 2010, Steele and O' Sullivan, 2011, Eke et al., 2015, Aldosari et al., 2021) have described the association between oral health and personal, intermediate and proximal determinants of oral disease (Watt et al., 2019b) in national

populations, with reporting of data that was unavailable in Irish national surveys. These have identified high-risk behaviours associated with poorer oral health such as infrequent attendance, dental anxiety and a range of proximal behaviours including less frequent toothbrushing with fluoride toothpaste, high-risk diet and smoking. In addition, these surveys have reported the association between social disadvantage and oral health, as measured by a range of measures including education, occupation and income. In the Irish Army little was known about the influence of these determinants of oral health and suggests the need for collection of a broad range of determinants in an epidemiological survey.

An underlying concern existed that military service is associated with risk, including exposure to unfluoridated environments on overseas service or over-treatment by exposure to mandated dental health assessments. Social gradients in oral health are known to exist in Ireland, as reported by Medical Card use (Whelton, 2007) and have been reported by rank in the international military literature (Gaare et al., 1989, Marker et al., 1997, Horev et al., 2003, Skec et al., 2006, Jasmin and Jaafar, 2011, Mahoney et al., 2008, Mombiedro Sandoval and Llena Puy, 2008, Wahid et al., 2014). A practice-based assessment of oral health status in the Irish Army conducted in 1992 reported better oral health in officers than enlisted personnel. Whether these differences were due to enhanced access to treatment by officers as a result of power disparities or underlying proximal risk factors was unknown. It is possible that optimal access to oral healthcare while in service may offset these risks or reduce the social gradient by rank but suitable data were unavailable to evidence this.

In 2021, the deployment of a dental team overseas during the Covid pandemic reported dental emergencies at an annualized rate of 377 per 1000 troops per year, whereas a well-prepared force may be expected to have approximately 150 emergencies per 1000 troops per year (Chaffin and Moss, 2008). The data suggested that despite the well-funded dental treatment programmes, proximal determinants associated with oral health resulted in degradation of oral health in a short time and resulted in an increase in dental emergencies. Programmes to deliver preventative interventions and oral healthcare advice have not been developed in the Army and required secure epidemiological data to determine the prevalence of suboptimal health behaviours in the population. An understanding of the prevalence of these determinants would allow the dental service to develop a risk rating that may be used in conjunction with the NATO classification (NATO, 2017).

The international military literature, although diverse, suggests that the role of the oral health in the military has evolved from a functional one (for example, removing pins from grenades) to a key component of ensuring fitness for day-to-day duties, deployment and combat. While the Irish Army dental service strives to meet the treatment needs of personnel, the efficiency of dental service delivery in the Irish Army has been sub-optimal due to a focus on ‘treatment’ for dental diseases that are preventable, under-utilisation of the wider dental team and providing non-clinically urgent ‘unscheduled’ appointments within an already busy clinical workload. International military publications have also begun to consider the impacts of oral health (Kudo et al., 2011, Crocombe et al., 2013, Crocombe and Mahoney, 2016), which the Irish Army has not yet evaluated.

2.8 Overall conclusions of the literature review

While the emphasis on addressing dental treatment needs will remain a key requirement for the Irish Army Dental service, contemporary approaches to securing oral health require a range of approaches and interventions: a focus on oral health promotion, targeted prevention based on individual risk assessment, triage of urgent and routine dental care and provision of effective evidence based dental care using the wider dental team (Watt et al., 2019a).

Delivering on this contemporary vision for the Irish Army Dental Service requires up to date epidemiology to inform strategic direction, optimize service delivery and allow evaluation in terms of impact on oral health outcomes. The choice of epidemiological oral health outcomes must therefore include clinical and patient-based outcomes, including the impact of oral health on quality of life.

Accurate oral health data are required to inform and update the forensic record of all serving personnel. It is recognised that while the presence of personnel with DMFT scores greater than zero is an accurate metric for identification, increasingly in the younger age cohorts the recruits and cadets present as caries free and untreated, thus alternative individual oral health markers are required. At the other end of the spectrum there are serving individuals who remain reliant on dentures, though the prevalence of edentulousness is unknown. More appropriate methods of making and updating the forensic record are required taking account of both those with little hard tissue disease, and those who have lost most of their teeth.

The international and Irish evidence indicates that rates of caries and periodontal disease are very high in military communities and may be higher than in civilian counterparts. It is unknown if this is the case in the Irish Army but anecdotal evidence suggests that while caries

prevalence may be low overall in younger cohorts, many of whom may have been life-time residents in fluoridated communities, there remain individuals who present with severe dental disease and who continue to require extensive dental treatment throughout their military career. While describing the distribution of dental disease in the military is important, it is also important to understand the known risk factors associated with developing oral diseases and their association with Irish military oral health. A large number of risk factors exist for dental disease in the military and these have not been fully investigated previously. Lack of exposure to fluoride on deployment may pose a heretofore unexplored additional risk burden. In order for the dental service to plan targeted prevention and oral health promotion, it is important to have a detailed understanding of the proximal and distal risk factors associated with dental disease.

Normative assessment of need is limited by the differential impacts that similar diseases and conditions may have on patients (Locker and Slade, 1994). Measures such as self-reported oral health and oral-health related quality of life may be used to interpret the effect that expectations, beliefs and other factors have in the impact of oral health. Identification of groups with a higher prevalence or severity of impacts may help to tailor services to provide emergency services to respondents with a higher degree of impacts, particularly those reporting pain. The collection of impact data will allow the service to evolve from reflexive delivery of operative care to a service that tailors supports for personnel with behaviours and risk factors that adversely affect oral health.

2.9 Aims and objectives of the epidemiological survey

2.9.1 Evaluate the oral health status of the Irish Army

International evidence (Chaffin and Moss, 2008) and limited evidence from the deployment of Irish soldiers (Dept. of Defence, 2022a) has consistently reported that dental emergencies on deployment are related to the burden of disease, and particularly untreated caries, experienced by soldiers. However, little has been published nationally (Whelton, 2007, Naseer, 2020) that could be used to estimate the prevalence of diseases and conditions in Irish soldiers. As a consequence, the first aim of the survey was to evaluate the oral health status of the Irish Army.

Objectives:

1. To estimate the number of teeth in the Army and the proportion with at least 21 teeth to assess the requirement for the provision of dentures or other devices.
2. To estimate the prevalence of oral health outcomes that might require treatment to make personnel dentally fit for deployment.
3. To estimate the prevalence of oral health outcomes that might require emergency treatment.
4. To estimate the prevalence of personnel without any caries experience (or with dentures) and the implications for forensic charting.

2.9.2 Evaluate the determinants of oral health in the Irish Army

National surveys (O'Mullane and Whelton, 1992, Whelton, 2007), the 1990 Army survey (Hayden, 1995) and international evidence (Peres et al., 2019) have indicated that oral diseases are not distributed evenly throughout populations. These reports indicate that a higher burden of disease is experienced by disadvantaged groups and there was anecdotal evidence that disease experience in recruits was greater than might be expected from the improvements in oral health reported in Irish children (Harding, 2016). In addition, a broad range of demographic factors and social determinants have been reported in national surveys to be associated with a higher prevalence of oral diseases (O'Mullane and Whelton, 1992, Whelton, 2007, White et al., 2011). As such, the second aim of the survey was to evaluate the determinants of oral health associated with oral diseases and conditions prevalent in the Irish Army.

Objectives:

1. To determine whether social gradients existed in key oral health outcomes by rank, education and area deprivation.
2. To determine the effect of recency of dental attendance on key clinical outcomes.
3. To estimate the proportion with dental anxiety as a risk for deployment.
4. To estimate the prevalence of oral health related behaviours and the implication for development of a preventatively-oriented service.

2.9.3 Evaluate the subjective experience of oral health in the Irish Army

The service provision model of the dental service in the Irish Army was heavily focussed on the treatment of normatively determined need as a means of fulfilling occupational requirements. However, the dental service was aware that it needed to move to a system of care that incorporated patient reported measures as this might identify groups who had decreased subjective oral health. Therefore, the third aim of the survey was to evaluate the subjective experience of oral health in the Irish Army.

Objectives:

- 1 To estimate the prevalence of pain that might require urgent dental care appointments.
- 2 To estimate the prevalence of poorer self-reported oral health and the association with normative need and oral health related quality of life.
- 3 To estimate the prevalence, extent and severity of oral health related quality of life and the association with normatively assessed need.

3 Materials and methods

3.1 Introduction

The literature review identified the need for the Army and the dental service to collect comprehensive epidemiological data that would allow planning to meet the service aims of collecting timely and accurate forensic charting, relieving personnel of dental pain as quickly as is possible and minimizing the number of lost workdays as a result of dental disease. In order to fulfil these aims, the Army needed to collect basic epidemiological data about the prevalence of common oral diseases and conditions that may require to be treated to make personnel dentally fit for duty at home or overseas.

In addition to fulfilling service aims, the dental service was aware that in its current format it was reactive in nature and examined patients with a view to identifying those treatments required to reduce the likelihood of a dental emergency while on duty at home and overseas. In order to pivot the system of care to one of preventative orientation it was necessary to collect suitable risk factor data that would allow the service to classify personnel on the basis of the likelihood of the development of future disease. These patients could then be offered suitable preventative therapies and oral health promotion that would allow them to reduce their overall risk rating.

An important part of service delivery is to understand the impacts that diseases and conditions have on patients. This is particularly important in an organization such as the Army that had compulsory dental examinations and a requirement for dental fitness. To this end, this survey collected information about the impacts of oral diseases and conditions by using self-reported periodontal data, a global question on oral health and the Oral Health Impact Profile 14 questionnaire. These data were used to assess the impacts across subgroups within the Army identified as having a higher disease burden in the basic epidemiology.

The following sections outline the methods used to collect the data required to address the aims of the survey, outlined above and stated at the end of the literature review. The survey collected a large volume of risk factor data, not all of which was reported within the body of this document due to the restrictions on word count in the thesis and the following sections note these data. The first section reports the steps taken to establish the survey, including consent, sampling and examiner calibration. The second section reports the criteria used to identify diseases and conditions necessary to fulfil the first aim of the survey. The third

section reports the mechanism used to collect social and personal risk factor data. The fourth section outlines the tools used to collect information about the impacts of diseases and conditions. The final section reports the management of data, including the statistical techniques used.

3.2 Establishment of the epidemiological survey

3.2.1 Overview of the survey

The epidemiological survey was made up of two parts: a clinical oral health assessment and a self-completed questionnaire of participants who consented to take part in the survey. Both the questionnaire and clinical examination drew on methods and materials from previous population surveys (Whelton, 2007, Steele and O' Sullivan, 2011).

The examinations were carried out by three Dental Officers and two civilian practitioners working in seven military barrack locations. All clinicians underwent training in the diagnostic criteria used, calibration in hard and soft tissue recording and training in the reporting mechanisms.

All serving personnel attending for routine dental examinations were invited to participate. A representative sample of the Army was examined during the course of the survey. All recruits and cadets are examined as a matter of course on entry to the Army and were invited to participate in the study.

The oral health assessment, risk factor and impacts of oral health data collected were recorded on pro forma data collection sheets designed for the study and attached to the participant questionnaire for subsequent anonymisation, data entry and analysis. The survey ran from September 2019 to March 2020. In total, 777 personnel who were examined and completed the questionnaire were included in the survey.

3.3 Research design and methodology

This research was undertaken using quantitative research methodology to report on the oral health status of Army personnel. Two instruments were used to conduct this research. The first instrument was an oral health clinical assessment, using standard valid oral health outcomes. The second instrument used in this research was a detailed self-completed questionnaire (Appendix 4) that captured social and personal risk factors and behaviours

associated with dental disease; dental care utilisation; the self-rating of oral health and impacts of oral health on quality of life.

3.3.1 Stakeholder engagement

Prior to the start of the study, the study design was discussed with the Director of the Medical Branch and the Officer Commanding the Central Medical Unit. These Officers have responsibility, respectively, for medical policy and the implementation of medical and dental services in the Defence Forces. Formal permission to proceed was given by the Army and by the Department of Defence Policy Branch.

The survey was conducted on behalf of the Irish Army so that data could be collected that could be used in needs analyses, workforce planning, development of strategic approaches that would fulfil dental service aims and the formulation of appropriate policy. Funding for the course of the survey was provided by the Army and the Department of Defence who authorized the use of clinic and administrative time for data collection, collation and analysis.

3.3.2 Principal investigator

The principal investigator (PI) of the research was the author who, in his role as Chief Dental Officer, was responsible for the formulation of dental policy in the Irish Army as well as oversight of policy implementation. The PI liaised with military management during the establishment of the survey, received formal permission to proceed and was responsible for the conduct and outcomes of the survey. The PI assisted in the calibration of operators, was the gold-standard calibrator for the conduct of the survey and visited the survey locations during the survey to support the operators. The data forms were collated by the PI, who undertook the data entry, data cleaning, data analysis, descriptive and other statistical analyses and detailed reporting.

3.3.3 Project timeline

The project timeline is displayed in Table 3-1. Preplanning began in March 2018, data collection began in Sept 2019 and ceased in March 2020 prior to the lockdown associated with the COVID-19 pandemic. By that date, the required sample size had been exceeded. Centralization of data collection forms was impeded by the lockdown but was resolved by June 2020.

Table 3-1: Project timeline for the epidemiological survey

Programme element	Date
Design	March 2018 to December 2018
Ethics application	January 2019
Ethical approval	May 2019
Examiner training and calibration	June to August 2019
Data collection	September 2019 to March 2020
Data analysis	June 2020 to June 2021
Reporting	June 2021 to June 2022

3.3.4 Ethical approval

Ethical approval was granted prior to the start of the survey in May 2019 by the Joint Research Ethics Committee based in Tallaght Hospital (Appendix 1). The ethics committee reviewed the participant information leaflet (Appendix 2), consent form (Appendix 3), and questionnaire (Appendix 4). The research conforms to the research principles of the Helsinki declaration of the World Medical Association (World Medical Association, 2019).

3.3.5 Consent

Positive written informed consent was collected from all personnel prior to participation. Consent was sought for the collection and use of self-reported and clinical data which would be irrevocably anonymized on data entry. Demographic categories were selected to reduce the risk of inadvertent identification.

As part of the consent process, a dental nurse in each location acted as the Gatekeeper and explained the purpose of the survey to potential participants to avoid pressure to participate. Participants were advised that refusal to consent would be accepted without affecting further care. Interested participants were given a patient information leaflet (Appendix 2) and if willing to consent were asked to complete a consent form (Appendix 3). Dentists collecting data were asked insofar as was possible to record the number of personnel declining consent and their rank. These data were planned to be used to determine the extent to which response bias might have affected the validity of the results.

The clinical and self-completed questionnaire data recorded and collected were subsequently entered into an Access database. At that stage all data entered were irrevocably anonymized. The data return forms, consent forms and questionnaires were stored separately in locked cabinets in the office of the Chief Dental Officer and will be held for 7 years and destroyed at that time, in line with Defence Forces policy.

3.3.6 Pilot study

The lead examiner (John Crotty) undertook a pilot study of the examination, questionnaire and data collection process in the Defence Forces Training Centre by an initial examination of ten patients. Patient feedback included altering the font size on some of the questions for readability. In addition, a number of small changes in the layout of the data collection form were made to aid in the flow of information from the clinical point of view.

3.3.7 Sampling procedures

3.3.7.1 Sample population

The survey population was composed of serving Army personnel including those who had just joined as cadets or recruits. Serving personnel and applicants were adult males and females between the age of 18 and 65 years of age. Most personnel were, however, under 45 years of age. Total population size in the Army at the time of survey was 7079 personnel. The sample size was generated to provide a sample that was representative of the Army population at the time of data collection.

Sampling of the population was also undertaken to determine whether differences in oral health status existed for different rank groups. Rank is a primary defining demographic characteristic in the Army, is related to educational opportunities, pay and potential length of service. Internationally, lower rank has been associated with poorer health outcomes (MacLean and Edwards, 2010), including oral health outcomes (Horev et al., 2003). Dental Officers have reported perceived differences in the rates of smoking and caries by rank and have observed greater levels of untreated disease in cadets and recruits on entry than was observed in the serving personnel. The rank groups chosen reflected the defined boundaries that existed within the social structure of the Army at the time of survey sampling.

Rank was also chosen as a stratification methodology because reliable oral health data for the age-matched civilian population was not available that might be used to determine means and standard deviations that could be used in Neyman or optimal allocation. In addition, the extent to which the rank bands were homogeneous enough to justify optimal allocation was unknown.

At the time of sampling, the Army was composed of approximately 7% females and 11% of Army came from the officer class. From the outset, it was clear that a representative sample would not be achievable within a reasonable timeframe as it would require examination of

approximately one half of the female soldiers for representativeness within the Army and almost all of the female soldiers to identify differences between ranks. It was not considered possible to recruit this proportion of any small group given geographical distribution, deployments overseas, long-term sick leave, career breaks and other difficulties in access. Consequently, no attempt was made to recruit a representative number of women in the sampling process.

3.3.7.2 Inclusion and exclusion criteria

3.3.7.3 Inclusion criteria

- Adults 18 years of age or older who gave consent to participate
- Adults who agreed to both completing the self-reported questionnaire and undergoing the clinical examination
- Adults who could-read English and respond to the questionnaire in writing
- Adults with all permanent teeth partially or fully erupted or with partial dentitions or who were edentulous

3.3.7.4 Exclusion criteria

- Adults who declined to consent
- Pregnant or breastfeeding women
- Deciduous teeth were not included in the reported clinical assessment
- Partially erupted teeth were not examined for the presence of periodontal disease

3.3.7.5 Sample size

Statistical advice about the sample size was provided by the DDUH statistician (Dr Maria Van Haartan). Prior to the collection of data, the assumption was made that the Army data were normally distributed, based on a random sample with a 95% confidence level and a 5% Type I error rate. The total sample figure of 364 personnel in the Army corresponded to 5% of the Army strength. The sample was collected on a proportional allocation basis, corresponding to the number of personnel in each rank group in the Army in September 2019, as displayed in Table 3-2. The sample numbers required to detect differences between rank groups using 7 rank bands and one-way ANOVA is also displayed in Table 3-2. This was based on a random sample with a moderate effect set at 0.2, with a 95% confidence level and a 5% Type I error rate. The total target figure of 532 in the Army corresponded to 8% of the Army strength in September 2019 and was set as the sampling target.

Table 3-2: Sampling frames for the Army sample

Rank	n	%	Representative sample	Between rank group
Recruit	194	3%	10	15
Cadet	78	1%	4	6
Private	3466	49%	178	260
Junior NCO	2117	30%	109	159
Senior NCO	341	5%	18	26
Junior Officer	488	7%	25	37
Senior Officer	395	6%	20	30
Total	7079	100%	364	532

3.3.8 Data collection locations

The data were collected over a six-month period between September 2019 and March 2020 in five fixed dental surgeries and in two barrack locations using a mobile dental chair, as tabulated in Table 3-3. The lead examiner visited all locations during the course of the survey to discuss examination criteria, identify issues arising during the course of the survey and ensure fidelity to criteria over the course of the survey.

Table 3-3: Data collection locations

Barracks	Location	Type
Logs Base Hospital, St Bricin's	Infirmery Road, Dublin	Fixed
Curragh Camp	Defence Forces Training Centre, Kildare	Fixed
Custume Barracks	Athlone, Co Roscommon	Fixed
Collins Barracks	Military Road, Cork	Fixed
Haulbowline	Haulbowline Island, Cork	Fixed
Sarsfield Barracks	Lord Edward Street, Limerick	Mobile
Lynch Camp	Kilworth, Co Cork	Mobile

3.3.9 Equipment

The equipment used in this survey included standard Planmeca and Heka dental units and a mobile dental chair (Denta Chair 303) manufactured by BPR, Switzerland. These units used a variety of LED lights ranging from 50,000 to 70,000 lux that had adequate lighting for examination under all conditions.



Figure 3-1: Mobile dental system as provided by BPR⁵

The examination equipment included standard dental mirrors in re-useable and disposable formats. The periodontal status was assessed using UNC-15 probes, colour coded from 4 to 5mm. Standard examination techniques were utilized by examining teeth wet. Dental radiographs were not taken to augment the clinical oral health assessment.

3.3.10 Infection prevention control protocols

Standard infection prevention control protocols were used throughout the course of the study and conformed to the Irish Dental Council's code of practice in relation to infection prevention and control (IDC, 2015). All equipment used during the examination was fully traceable to the point of sterilization by recording of the pack number on the patient notes. All examinations were carried out using a new set of sterilized equipment for each patient. Gloves were replaced between each patient and facemasks were changed as required. The chair and all surfaces including light handles were disinfected between patients as per Defence Forces cross-infection protocols.

3.3.11 Examiner calibration

Five examiners examined personnel and collected data, including the author as the lead examiner. The initial calibration exercise was undertaken before the project started under the supervision of Dr Brett Duane an experienced epidemiologist from Dublin Dental University

⁵ Image courtesy BPR (available at: https://www.bpr-swiss.com/wp-content/uploads/2021/09/Catalogue_mobile_and_portable_units_EN_04.2021-1.pdf)

Hospital and consisted of calibration of two of the Dental Officers (EG and PM) against the lead examiner (JC). Further calibration exercises were subsequently undertaken to recalibrate these operators (PM and EG) and to calibrate an additional operator (KMcL) to the lead examiner before commencement of the main study and data collection. A final calibration exercise was undertaken in Cork to calibrate an operator who was collecting data for a parallel project in the Naval Service who also collected some data for Army patients based in Cork (LB).

The format of the calibration exercise was a discussion about the diagnostic strategy, definition of diagnostic criteria and clinical examination of a series of patients, with observation by other dentists during the process to develop a consistent approach. In each case calibration continued until agreement was achieved. The results of the final sample of 10 patients were used to calculate kappa scores for agreement in the number of decayed, missing and filled teeth, as displayed in in Table 3-4. The agreements were “substantial” or “almost perfect” when using the arbitrary scheme developed by Landis and Koch and the range of values estimated by Munoz and Bangdiwala (Landis and Koch, 1977, Munoz and Bangdiwala, 1997)

Table 3-4: Kappa scores for decay, fillings and missing teeth

Examiner number	Decay	Fillings	Missing
Examiner 1	1	0.98	0.93
Examiner 2	0.8	0.98	0.92
Examiner 3	0.85	0.97	0.94
Examiner 4	0.7	0.67	0.91

Examiner calibration for PSR scores and for BEWE scores consisted of discussion of clinical cases following examination and agreement on the severity of the conditions detected.

The data from these patients were not included in the results of the epidemiology project. Duplicate examinations were not carried out as part of the process due to the practicalities of recalling personnel from peripheral barracks, the fact that many were serving overseas, and the costs associated with removing personnel from duty. The lead examiner visited all locations during the data collection process to monitor the data collection process and reaffirm diagnostic criteria.

3.3.12 Communication of clinical results to patients

Patients examined during the survey attended for a clinical oral health assessment and clinical results were communicated directly and immediately to the patient within the context of a routine dental examination. Where treatment was required, patients were facilitated in accessing services in-house or externally, as appropriate.

3.4 Clinical examination methods and data collection

The clinical oral health assessment of the oral cavity conducted during the survey constituted a part of the standard examination for the presence of diseases and conditions undertaken by Army dentists. It included a standard clinical oral health assessment of the hard tissues, periodontium and oral mucosa but adapted for the purpose of the survey and used valid oral health outcome measures. A summary of the clinical data collected and the data reported is tabulated in Table 3-5.

Table 3-5: Summary of clinical data collected and data reported

Indicator	Data collected	Data used in report
Dental status	Number of teeth	Number of teeth
		Prevalence of ≥ 21 teeth
	Number SUNT	Number SUNT Prevalence SUNT ≥ 18 teeth
Decayed teeth	Number of decayed teeth	Number of decayed teeth
		Prevalence of decayed teeth
Missing teeth	Number of missing teeth	Number of missing teeth
Filled teeth	Number of filled teeth	Number of filled teeth
DMFT	Number DMFT	Number DMFT
		Prevalence of DMFT=0
Unrestorable teeth	Number of unrestorable teeth	Prevalence of unrestorable teeth
PUFA	Number of PUFA teeth	Prevalence of PUFA
Dentures	Denture present	Prevalence of dentures
Crowns	Number of crowns present	Prevalence of crowned teeth
Bridges	Number of bridges present	Prevalence of bridges present
Implants	Number of implants present	Prevalence of implants
Advanced prosthodontics	Presence of any denture, crown, bridge or implant	Prevalence of advanced prosthodontics
Periodontitis	PSR codes 0 to 4	Prevalence of PSR codes
TSL	BEWE codes 0 to 3	Prevalence of BEWE ≥ 2
		BEWE summed score

Oral mucosal lesions were not reported in the survey data, but these clinical data were recorded and patients were informed and referred for assessment as appropriate. Similarly, disorders of the TMJ or conditions such as apical pathology only identifiable by use of radiographs were not reported as part of the survey data.

The examiners were at all times accompanied by a dental nurse who recorded the clinical data and prompted inclusion of all items. The clinical oral health assessment data were then transcribed onto a pre-designed data collection sheet by the dental examiner.

3.4.1 Dental status

The number of teeth present is an important metric as it is associated with a functional dentition and is a measure of the success of preventative and treatment programmes and changed treatment approaches to carious teeth. These data may also be readily compared with former national and Army surveys (O'Mullane and Whelton, 1992, Hayden, 1995, Whelton, 2007). All permanent teeth present in the mouth were recorded, whether fully or partially erupted. Deciduous teeth were not counted in the survey.

The number of Sound, Unfilled Natural Teeth (SUNT) was calculated by subtracting the DMFT score from the total number of teeth present. The prevalence of ≥ 21 teeth and ≥ 18 SUNT to allow comparison with previous national surveys.

3.4.2 The presence of caries and its sequelae

Dental caries and its sequelae represent the single greatest risk of a dental emergency on deployment and as such warrant inclusion in the clinical examination (Chaffin and Moss, 2008). Permanent teeth were examined for the presence of caries and its sequelae but deciduous teeth were not included in the survey results. Diagnostic criteria and examination criteria as outlined in the UK Adult Oral Health Survey 2009 were used in this study (Pitts et al., 1997) and examiners were trained and calibrated to report caries at the threshold of visual caries extending into dentine. Dental caries was reported as the prevalence of decayed teeth and the number of teeth affected by caries. In unfilled teeth the result was recorded as primary caries and in filled teeth as secondary caries. Teeth with temporary restorations of any type were recorded as decayed teeth on the basis that the restoration was not a permanent filling. The number of decayed surfaces was not recorded, to allow comparison with previous national surveys (O'Mullane and Whelton, 1992, Whelton, 2007).

Only teeth extracted as a result of caries were recorded as missing. Teeth extracted for orthodontic reasons or following a known history of trauma were not recorded as missing. Teeth replaced by implants or by bridge pontics were recorded as missing teeth. The results were reported as the number and prevalence of missing teeth.

Filled teeth were recorded regardless of the number of surfaces restored or the number of individual restorations present. Crowned teeth and bridge retainers were recorded as filled teeth. The results were reported as the number and prevalence of filled teeth.

The number of decayed, filled and missing teeth was recorded as the summed score, which represented the sum total of caries experience. The prevalence of respondents with a summed score of zero was recorded as these patients do not have clinical characteristics that will allow forensic identification using traditional dental charting.

3.4.3 Unrestorable teeth and teeth with signs of severe caries

Unrestorable teeth represent an end stage of the restorative cycle and can lead to emergency visits as a result of pain, chipping or breaking of the remaining tooth structure or other impacts. The number of teeth that, in the opinion of the examiner, were unrestorable and that the only available treatment was extraction, were recorded as such. The results were reported as the number and prevalence of unrestorable teeth.

Personnel were examined for the presence of pulpal exposure, soft tissue ulceration, fistulas and abscesses (PUFA) as a result of severe caries in permanent teeth. These are important markers of urgent problems that might lead to a dental emergency and were reported using the PUFA criteria (Monse et al., 2010). Each tooth was scored individually, and the summed score reported to a maximum score of 32. Individual teeth were scored a maximum of one regardless of the number of associated complications. The results were reported as the number and prevalence of PUFA affected teeth.

3.4.4 Complex prosthodontics

The presence of dentures was an important metric to record not alone as the prevalence was a marker of the relative oral health of the Army population by comparison with 1990 but also because of the impacts on oral health (Preshaw et al., 2011) and the potential for loss or fracture on operations that might affect the ability of a soldier to carry out their duties. Dentures might also be used as a form of forensic identification by the inclusion of identity markers at the time of manufacture. Dentures were reported in the survey if one or more denture was present in the oral cavity at the time of examination.

Crowns, bridges and implants represent a level of restorative complexity that requires specialized support to maintain and replace that may be difficult or impossible to provide in

austere environments such as occur on deployment. Crowns, bridges and implants were reported if one or more were present in the oral cavity. Temporary crowns or bridges were reported as decayed teeth. The total number of units of crowns and bridges and the total number of implants were recorded as the prevalence and summed score. The percentage of the population with any complex prosthodontic device was reported as a guide to the complexity of maintenance and the requirement to provide this type of service.

3.4.5 Periodontal status

The periodontal health of Army personnel was assessed using the Periodontal Screening Record (Khocht, 1995) as a reporting tool. The PSR screening tool has defined thresholds, displayed in Table 3-6, below. From the point of view of population health, codes 0,1 and 2 correspond to conditions without bone loss that may be managed by routine dental interventions, including scale and polish, whereas codes 3 and 4 represent patients who need advanced care, including subgingival debridement.

Table 3-6: Meaning of clinically detected PSR codes (Khocht, 1995)

PSR code	Clinical signs	Interpretation
0	Periodontal health	Gingival and periodontal health
1	Bleeding after gentle probing	Initial signs of inflammation without bone loss
2	Supragingival calculus or other plaque retention factors	Initial signs of inflammation with pockets below 4mm and a requirement for scaling
3	Pockets between 4mm and 6mm	Mild to moderate periodontitis
4	Pocketing greater than 6mm	Severe periodontitis

In this survey periodontal disease was reported when a respondent had at least one site greater than or equal to 4mm (PSR code 3) or at least one site greater than or equal to 6mm (PSR code 4). These readings roughly correspond to the Community Periodontal Index of Treatment Need index used in previous national surveys (O'Mullane and Whelton, 1992, Whelton, 2007). More complicated thresholds developed by the European Federation of Periodontology (Tonetti et al., 2005) or the Centres for Disease Control (Page and Eke, 2007) were not utilized as the time required to carry out full mouth probing of each respondent was not possible within the context of the survey. In addition, the Army did not have enough hygienists that could be used to collect these data.

Personnel were examined using UNC-15 probes, as these were the standard probes used for periodontal examinations in the Defence Forces. These have a convenient black band from

4mm to 5mm from the tip that can be used to demarcate PSR codes 3 and 4 from other criteria. The probing mechanism involved the use of a light force of no more than 20g. The procedure involved “walking” the probe around the tooth by introducing the probe at the disto-buccal aspect of the second molar in the first sextant and moving the probe around the surface of the tooth in a series of vertical motions while moving the probe to the mesio-buccal surface. The probe was then moved in a series of similar steps to the mesial of the first premolar, if present and then moved to the palatal surface and returning to the disto-lingual of the second molar. The examiner then moved to the next sextant and continued the examination in the same fashion.

The probe was used to examine all teeth and the results were reported by sextant. By convention, if there was only a single tooth in a sextant, the sextant was recorded as absent and the tooth was added to the adjoining sextant for recording purposes. Third molar teeth were not recorded where these were partially erupted. The highest score in any sextant was recorded as the score for the entire sextant. Since code 4 was the highest score recorded, if any site was detected with a 6mm pocket or greater, the operator recorded the sextant as such, ceased examination of that sextant and moved to the next sextant.

In the reporting, the prevalence of disease was reported as the single highest score from zero to four, corresponding to the highest PSR score in any sextant.

3.4.6 Tooth surface loss (TSL)

Anecdotally, Dental Officers had reported that few personnel presented with such severe tooth wear as would require restorative intervention. However, the prevalence of tooth wear in the Army and the national population was unknown at the time of data collection.

Respondents were examined for the presence of tooth surface loss using the diagnostic criteria developed by Bartlett et al for the Basic Erosive Wear Examination (BEWE) (Bartlett et al., 2008) as displayed in Table 3-7.

Table 3-7: BEWE codes and clinical signs (Bartlett et al., 2008)

BEWE code	Clinical signs
0	No tissue loss
1	Initial loss of surface texture
2	Hard tissue loss <50% of the surface
3	Hard tissue loss ≥50% of the surface

The examination was undertaken in a manner similar to the PSR examination, with each tooth surface examined for the single worst score and the worst score per sextant recorded for each of the six sextants. Tooth surface loss was reported at the patient level at the threshold of at least one sextant with a score of two. The sum total of the sextants was used to indicate the severity of tooth surface loss according to the following scheme recommended by Bartlett:

Table 3-8: Risk categories in BEWE assessment (Bartlett et al 2008)

Summed score	Risk level	Additional management
≤2	None	None
3 to 8	Low	Diet and hygiene advice
9 to 13	Medium	Diet, hygiene and fluoride advice. Monitoring with study casts or other tools
≥14	High	As above but with restoration as required

An important metric for the Army to record was the prevalence of personnel in the high-risk group as management of these cases may require specialist intervention.

3.5 Determinants of oral health

Descriptive statistics about the oral health of the Army may be reported following collection of the clinical data, outlined above. However, in order to understand the risk factors associated with diseases and conditions in the Army, it was necessary to collect information on the determinants of oral health of soldiers. Although the Army has a narrow demographic in terms of age and gender, it was not homogenous and analysis of the potential determinants could allow the identification of groups who may be at higher risk of diseases and conditions; these groups could then be targeted for specific oral health interventions. In addition, previous national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) and the Army survey in 1990 (Hayden, 1995) reported clinical data using age bands, gender and proxies for socio-economic status such as Medical Card use and it was necessary to collect this data to enable useful comparison.

Mapping determinants of oral health to disease requires utilization of an underlying framework to develop a consistent reporting methodology. In this survey the framework developed by Watt *et al.* was used, which describes categories of determinants that were applicable to collection of risk factor data in the Army (Watt et al., 2019b). Demographic characteristics (age and gender) are biological in nature and immutable characteristics whose linkage with oral health was described in previous national surveys (O'Mullane and Whelton, 1992, Whelton, 2007).

Structural determinants impact oral health outcomes by shaping the broader socioeconomic, political, and societal policies, which in turn affect the welfare supports provided, the physical environment in which people live and the opportunities in training or education that are available. Collection of these data are outside the scope of this survey but must be borne in mind when analysing the results.

Intermediate determinants reflect the social position of respondents and the material resources available to support oral health. A strong measure of social position in the Army is rank, given the explicit hierarchy. An allied measure was length of military service and number of overseas missions as these may provide insight into the relative advantages provided by military experience in the Army. In addition to these measures, this survey reported the novel use of small area deprivations scores in oral health data, described below (Haase, 2017).

A large range of personal behaviours, labelled as proximal determinants, were described by Watt *et al.* as those “directly involved in disease processes” (Watt et al., 2019b) and include smoking, alcohol use, diet, health status and preventative measures. These are direct targets for clinical staff in the dental surgery but information on the prevalence in the Army was unknown.

Data on demographic variable and intermediate and proximal determinants of oral health were collected using two complementary mechanisms. Firstly, the dental teams collated information about age, gender, home address and rank from data held on the clinical record. Data about alcohol consumption was routinely collected by dentists at every examination. Secondly, patients completed a dedicated risk factor questionnaire which enquired into specified intermediate and proximal determinants of oral health associated with disease and the use of dental services. The detailed self-reported questionnaire is described in Appendix 4. The key sections and variables of these data collection methods are highlighted in the

following sections. A summary of the determinants and the mode of capture is displayed in Table 3-9.

Table 3-9: Determinants of oral health reported in survey

Metric		Mode of collection	Data collected	Data used in report
Demographic	Age	Examiner	Age in years	Age in years
				Age bands
	Gender	Examiner	Gender	Gender
Intermediate	Rank	Examiner	Rank	Rank bands
	Deprivation index	Examiner	Deprivation index	Deprivation bands
				Mean score
	Education	Self-report	Education level	Education bands
	Military service	Self-report	Months of military service	Military service bands
			Number of overseas missions	No. of overseas missions
			Months on overseas service	Months on overseas service
	Dental visiting pattern	Self-report	Recency of visits	Visiting bands
	Dental anxiety	Self-report	Modified dental anxiety scale	Prevalence, extent and severity
				Item frequency response
				Factor analysis
Proximal	Health status	Examiner	Health status	ASA bands
	Alcohol	Examiner	Number of units	Prevalence of high risk
	Smoking	Self-report	Smoking status	Smoking status
	Diet	Self-report	Frequency of consumption	Prevalence of high-risk
	Brushing	Self-report	Brushing frequency	Prevalence of high-risk
	Interdental	Self-report	Frequency	Frequency
	Mouthwash	Self-report	Frequency	Frequency
	Fluoride	Self-report	Consumption of bottled water	Prevalence of use
			Source of water supply	Prevalence of use
			Use of fluoridated toothpaste	Prevalence of use
	Cumulative number of risk factors	Self-report of: current smoking; high-risk alcohol; high-risk diet; non-fluoridated toothpaste or water; brush <2 per day or interdental <7 per week		Number

3.5.1 Demographic characteristics

3.5.1.1 Age and age group

Age has been proven to be an important demographic characteristic in the accumulation of caries, periodontal disease and tooth surface loss in the national population (O'Mullane and Whelton, 1992, Whelton, 2007). Age bands were used as a primary reporting tool in the previous Army survey (Hayden, 1995), national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) and international surveys in high-income countries (Cooney, 2010, Ministry of Health, 2010, Eke et al., 2015, Amarasena et al., 2021) although the brackets utilized were not always comparable.

In this survey the examiner asked the patient for their age and it was recorded by convention as the number of years rounded down to the nearest whole number regardless of proximity to birthday. The age was transferred into age categories to correspond with reporting in the Irish national studies as bands between 18 and 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years and 55 to 65 years.

3.5.1.2 Gender

Clinical indicators were recorded by gender in previous national surveys (O'Mullane and Whelton, 1992, Whelton, 2007). In the Army, at the time of data recording, the Defence Forces only recognized gender within the context of capacity for military fitness, using the gender assigned at birth. In the survey the examiner recorded gender as either male or female.

3.5.2 Intermediate determinants of oral health

Markers of social position and circumstances have long been known to present as risk factors for the development of oral diseases. In Ireland, Medical Card status has been widely used in Irish dental studies as a proxy for inability to pay for dental care and for material deprivation and was associated with tooth loss and the development of caries (O'Mullane and Whelton, 1992, Whelton, 2007). In the UK, where occupation was used as a marker of social position, a higher prevalence of disease was present in manual workers than managers and professional workers (White et al., 2011). In the Army, social position is marked by rank and social class is defined by the distinction between officers, NCOs and private soldiers. The results by rank were an important outcome to determine whether social gradients in oral disease existed in the Army.

Income, education level and deprivation level have been reported as risk factors for oral disease in national surveys in high-income countries (Cooney, 2010, Ministry of Health, 2010, Amarasena et al., 2021). Career development in the Army typically requires upskilling with in-house and external qualifications available. In this survey the education level of respondents was recorded by using the education level established by the national framework of qualifications. Home addresses were used to provide a small area deprivation score for respondents to determine whether a gradient by deprivation score existed in the Army population.

The length of military service was recorded as it may have been a modifier of oral health in the Army as positive results may have accrued from free oral healthcare whereas negative results may have accrued from time spent on deployment in non-fluoridated areas or by adoption of negative health behaviours. Length of service may also point to an effect related to a supportive environment, sense of inclusion, access to supports or services and an overall sense of coherence that are regarded as positive attributes of social position and circumstances (Poursalehi et al., 2021). Similarly, deployment overseas is preceded by checks of dental fitness and it is possible that these mandatory visits improved oral health.

3.5.2.1 Rank and rank bands

Rank in the Army is a marker of social position and is associated with socio-economic indicators including level of education and pay. In addition, higher rank affords power of control over subordinates, which has been reported to affect access for treatment (Vinson, 2022) and may result in better oral health in senior ranks by comparison with junior ranks. At the time of data collection, rank also affected the entitlements to the treatment of certain treatments, including access to molar endodontics, and was thought to be likely to impact on the number of teeth present. As such rank groups were a subject of interest for analysis in the survey.

In the military a number of classes of rank are recognized in Ireland and internationally and have been codified for high-income countries by a NATO standardization agreement, STANAG 2116 (NATO, 2021). The following classes are recognized:

- 1) Officer ranks: these encompass junior to senior leaders in the Army, from Lieutenants to Generals in the Irish Army. In Ireland (and elsewhere) Officers are provided with a commission from the President that provides the legitimate authority within the context of

military law. Officers in the Irish Army are typically inducted through a military college as officer cadets, have a university degree and hold considerable power and authority. A small cohort of soldiers may be commissioned from the enlisted ranks. Specialist dental, medical, engineering, legal and other technical professionals may be commissioned directly into dedicated roles within the Army but may only be promoted within their technical stream. At the time of the survey design (2018) officers had access to a full suite of private medical care, including specialist dental treatment, such as molar endodontics, that may have optimized oral health.

- 2) Enlisted personnel: All soldiers in the Army not holding commissioned ranks. These soldiers begin their military careers as recruits rather than cadets, transition to Army privates within a short period of time (28 weeks) and may be deployed overseas shortly after recruit training. At the time of survey design Enlisted personnel had access to basic dental care, advanced periodontal care and comprehensive oral surgery but did not have access to a full suite of private medical care. In particular, lack of access to specialist molar or other endodontics was considered to increase the possibility of tooth loss in the enlisted ranks. In the Irish Army the enlisted ranks included:
 - a) Private soldiers: Constituted 50% of the Army and formed the entry grade for soldiers of enlisted ranks. On recruitment, did not require a minimum standard of education but must have been able to satisfy a certain level of literacy and numeracy. Promotion to NCO rank was dependent on experience and leadership capacity.
 - b) Non-Commissioned officers (NCOs): Junior and senior leaders within the enlisted ranks and promoted from within those ranks. Many have considerable experience and authority but are subordinate to all Officers, including the most junior Officers.
- 3) Recruits and cadets: Recruits and cadets formed a distinct group within the military system. Both groups were recently civilians and may have lacked access to basic or advanced dental care. On entry, recruits and cadets are examined to assess their dental fitness. Anecdotal observation by Dental Officers reported an increased prevalence of disease in recruits, in particular, by comparison with soldiers.
- 4) New entrants and the trained strength: For monitoring purposes, the Army allocates soldiers to specific roles within a human resources framework. However, soldiers in training (the recruits and cadets) are not capable of being allocated to specific roles as

they are in training. The Trained Strength of the Army refers to all soldiers who have completed basic training and may be allocated an HR role. As such the Trained Strength is the number of soldiers on the payroll minus number of cadets and recruits. In this thesis recruits and cadets were combined and termed ‘New Entrants’.

In the formulation of the sample size, certain rank categories were used to ensure that the sample was representative of the Army, as displayed in Table 3-10 and corresponded to classes of ranks in use in the Army. When personnel presented for examination, the examiner recorded the rank category on the data return sheet and the numbers of each rank category were collated on a weekly basis to monitor the success of sampling of each rank category.

Table 3-10: Ranks and rank categories present in the Army

Group	Ranks	Rank category
Enlisted	Recruit, Private 2*	Recruit
	Private 3*	Private
	Corporal, Sergeant	Junior NCO
	Company Sergeant, Company Quartermaster, Battalion Quartermaster, Sergeant Major	Senior NCO
Officer	Cadet	Cadet
	2 nd Lieutenant, Lieutenant, Captain	Junior Officer
	Commandant, Lieutenant-Colonel, Colonel, General ranks	Senior Officer

Table 3-11 displays the merged rank categories that were used for reporting in the majority of this survey. The Junior NCO and Senior NCO ranks were merged and the Junior Officer and Senior Officer ranks were merged into ‘NCO’ and ‘Officer’ groups, respectively. These groups corresponded to naturally occurring social classes in existence in the Army at the time of the survey. In addition, since Private soldiers accounted for 49% of the Army strength and Junior NCOs accounted for another 30%, the numbers of personnel in the remaining ranks were small and the merged groups of ‘NCOs’ and ‘Officers’ represented distinct entities with increasing power and cultural influence that were deserving of comparison.

Table 3-11: Merged rank categories used in the analysis

Rank category	Rank groups	Rank status
Recruit	New entrants	New entrants
Cadet		
Private	Private	Trained strength
Junior NCO	NCOs	
Senior NCO		
Junior Officer	Officers	
Senior Officer		

An important distinction in the analysis was made between ‘new entrants’ and the ‘trained strength’. Cadets and recruits were classified as ‘New Entrants’ and for the purposes of the survey were distinguished as personnel who had newly joined the organization and who did not have access to the benefits of the free oral healthcare system. All other personnel were described as belonging to the Trained Strength and had access to the free oral healthcare system. The term ‘Trained Strength’ was in common use in the Army in relation to the employee control framework to distinguish soldiers in training (recruits and cadets) from trained personnel who could be deployed as required.

3.5.2.2 *Military service*

Military service may have presented an independent risk factor either by reducing risk through access to free basic dental care or by increasing risk by deployment to non-fluoridated operational areas or by adoption of smoking or other health damaging behaviours. Respondents were asked to report the number of months of military service and this was banded into bands corresponding to re-engagement for enlisted personnel, who formed 90% of the Army at the time of survey: 0 years; 1 to 5 years; 6 to 12 years; 13 to 21 years and ≥ 21 years.

An additional factor was to consider the number of overseas deployments and the time spent on overseas deployment. In the Irish Army, deployments overseas are typically of six months duration in a three-year cycle. Deployments are to camps with no access to fluoridated water and where toothpastes on sale may have sub-optimal levels of fluoride thereby increasing the risk of developing caries. Behavioural patterns may also change on deployment with observations by deployed Dental and Medical Officers that this may include increased consumption of carbonated drinks and increased smoking. Dental fitness is a requirement prior to overseas service to reduce the risk of dental emergencies on deployment, which conversely may result in dental over-treatment. Respondents were asked to report their number of overseas missions and the time spent on overseas service in months.

3.5.2.3 *Deprivation index*

International data has indicated that socio-economic status may affect the rates of disease in military personnel (Sgan-Cohen and Eldad, 1999, Bastos et al., 2007, Elmer et al., 2011) as has been reported in national surveys, using Medical Card status as a proxy for deprivation (O'Mullane and Whelton, 1992, Whelton, 2007). In the years since the national surveys were published, deprivation scores for small areas with a mean of 100 households have been

created utilizing data from national censuses (Haase, 2017). The deprivation scores included information from the census about the demographic, social class and labour market composition of households in each of these small areas. The deprivation scores associated with 18488 small areas derived from the 2016 national census are available on the Pobal website (Pobal, 2020). The deprivation scores utilized in this map are relative scores with a mean score set at zero and a standard deviation of one set for each of the reporting censuses from 2006 to 2016. The standard deviation scores were converted to deprivation scores by multiplying by a factor of ten. The absolute scores nationally had fallen by a mean value of 3.6 from 2006 to 2016, reflecting the adverse downturn in the economy experienced in the recession. The model followed the normal distribution with 69%, 95% and 99% living within 1, 2 and 3 standard deviations of the mean, respectively. Thus 68.8% lived within the +10 to -10 relative index score of marginally above or marginally below the national average. The meaning of the scores is tabulated for reference in Table 3-12 (Haase, 2017).

Table 3-12: Deprivation scores, associated labels in the Pobal website and merged categories used in the analysis (Haase, 2017)

Score	Standard Deviation	Label	Merged categories
over 30	>3	extremely affluent	Greater than one standard deviation above the mean
20 to 30	2 to 3	very affluent	
10 to 20	1 to 2	affluent	
0 to 10	0 to 1	marginally above average	Within one standard deviation of the mean
0 to -10	0 to -1	marginally below average	
-10 to -20	-1 to -2	disadvantaged	More than one standard deviation below the mean
-20 to -30	-2 to -3	very disadvantaged	
below -30	< -3	extremely disadvantaged	

In the survey, home addresses were provided by participants on the clinical record. The examining dentist entered the home address into the Pobal website and the deprivation score for the selected area was entered onto the examiner data sheet. No record of the home address was entered on the examiner data sheet. Personnel with a home address in Northern Ireland or outside the Republic of Ireland could not be assigned a deprivation score and were reported separately. Table 3-12 shows the merged categories used in the analysis and discussion of the Army results which differentiated between those personnel within one standard deviation of the mean and personnel more or less affluent.

3.5.2.4 Education level

Education level has been reported as a risk factor for caries (Schwendicke, 2015) and periodontal disease (Hakeem, 2019) and has been reported as a risk factor in the military (Sgan-Cohen and Eldad, 1999, Sgan-Cohen and Eldad, 2000, Kelbauskas et al., 2005). Education levels as reported in the 2016 census were used to record the highest level of educational attainment for each respondent as per the National Framework of Qualifications, as displayed in Table 3-13 (QQI, 2020). For the purposes of comparison, education levels were merged to create education categories that corresponded to naturally occurring thresholds in the training of personnel in the Army.

Table 3-13: National Framework of Qualification levels, national qualifications and merged categories (QQI, 2020)

Level	Qualification	Merged categories
3	Junior Certificate	Some secondary education
4	Leaving Certificate	Completed secondary education
5	Leaving Certificate	
6	Advanced certificate/ higher certificate	Some college education
7	Ordinary Degree	
8	Honours degree/ higher diploma	Honours degree of Masters
9	Masters' degree/ postgraduate diploma	
10	Doctorate	Doctorate

3.5.2.5 Last dental visit

The frequency of dental visits has been associated with the prevalence, extent and severity of oral disease in international surveys (Cooney, 2010, White et al., 2011, Public Health England, 2020) and with periodontal stability (Trombelli, 2020). A set of questions reproduced from the UK Adult Dental Health survey of 2009 (Office for National Statistics, 2009) was used to record the timing of the last dental visit and the reasons for non-attendance if the visit was longer than two years previously. Respondents were given the option of recording in free text additional reasons for non-attendance not suggested in the options. The results were categorized into three groups: those who had attended within the previous year; those who had attended between one and two years previously two years and those whose last visit had been over two years.

3.5.2.6 *Modified dental anxiety score*

Dental anxiety can be a significant barrier to access for care and has been reported to be associated with untreated caries in a military study (Eitner and Holst, 2006). The provision of a sedation service in the Army is predicated on the evaluated need for such a service. Limited data on dental anxiety rates in the Irish population was available (Brady et al., 2012). The Modified Dental Anxiety scale was used to record levels of dental anxiety in respondents (Humphris et al., 1995). The responses were converted from a Likert scale to a number format and summed. The summed response was used to assign to a category of anxiety from none to phobic. The data were reported as descriptive statistics. The categories were reported as no anxiety, anxiety less than phobia and phobia and dichotomized into phobia and no phobia when reporting clinical indicators, proximal determinants or subjective measures of oral health.

3.5.3 Proximal determinants associated with oral disease

3.5.3.1 *Alcohol consumption*

The consumption of alcohol is a known risk factor for the development of oral cancer and is also associated with tooth surface loss (Robb and Smith, 1990). Excessive alcohol consumption may also be as a risk factor for the development of caries (Enberg et al., 2001, Manicone, 2017). In the Army, the declared number of units of alcohol consumed per week was recorded routinely by Dental Officers as part of the clinical examination. In the survey, the number of units was recorded by the examiner in whole units using the following scheme for a single unit (HSE, 2024):

1. a pub measure of spirits (35.5ml)
2. a small glass of wine (12.5% volume)
3. a half pint of normal beer
4. an alcopop (275ml bottle)

Consumption of alcohol has been classified as high-risk in Ireland by the Health Service Executive (HSE, 2024) using on the following classification.

- women: more than 10 units per week
- men: more than 16 units per week

Based on the classification above, respondents were dichotomized on the basis of their gender and consumption as high or low risk users and reported as such.

3.5.3.2 Smoking

Smoking is a known risk factor for caries (Jiang et al., 2019), periodontal disease (Genco and Borgnakke, 2013) and tooth surface loss (Jiang et al., 2011). Smoking has also been reported as a risk for these diseases in the military (Machua, 2000, Kelbauskas, 2005). In this survey a series of questions about smoking habits were reproduced from the National Health and Nutrition Examination Survey questionnaire (Centre for Disease Control, 2015). The selected answers were reported as descriptive data. All questions with numerical answers were recorded as whole numbers. Numerical answers in relation to time were converted for analysis to number of months.

Considerable data in relation to smoking was recorded, including the age when started, time to first cigarette in the morning, age when started, quitting and e-cigarette use. However, full analysis of these data is outside the scope of this survey and will be reported at a later date. In this survey respondents were reported in the following groups: current daily smokers, current occasional smokers; ex-smokers and non-smokers.

3.5.3.3 Diet

The association between diets rich in refined carbohydrates and dental caries has been described in the literature (Sheiham and James, 2015, Moynihan, 2016) and in the UK national surveys (White et al., 2011) but has not been reported in the military internationally or in the Irish Army. Links between carbonated drink consumption and tooth surface loss have been described in US national surveys and in a number of military reports (Johansson et al., 1996, Johansson et al., 1997, Johansson et al., 2002, Lim et al., 2022) but the prevalence in the Irish Army was unknown. Respondents were asked to complete a set of questions reproduced from the UK Adult Dental Health survey of 2009 (Office for National Statistics, 2009) that recorded the frequency of intake of a number of foods and beverages associated with caries and TSL. In addition, a significant social aspect of Army life was morning coffee-time at 1030 or 1100, depending on rank and service location; non-attendance at coffee for officers could raise queries about whether personnel were at work. As a result, the survey asked an additional question about tea and coffee habits, including use of sugar. For reporting purposes, respondents were dichotomized into a low-risk group who neither had sugar in tea

or coffee nor consumed the cariogenic foods or drinks more than 6 times a week and the high-risk group with alternate dietary behaviours.

3.5.3.4 Fluoride

The appropriate exposure to fluoride is associated with significant reductions in caries experience, as has been reported in national surveys (Whelton, 2007). In Ireland, access to fluoridated water through main supply is available for about 70% of the population (Harding, 2016). Personnel may reduce their fluoride exposure by drinking bottled water, using non-fluoridated toothpaste or by accessing water through a non-mains supply. In order to assess the impact of fluoridation measures in the Army, personnel were asked, firstly, whether they mainly used tap or bottled water; secondly, the source of their tap water supply (mains, private well, group scheme etc) and thirdly, whether they used fluoridated or non-fluoridated toothpaste. The intention from these questions was to classify personnel as fully, part or non-fluoridated but the large proportion who responded that they didn't know the answers to these questions made such categorization impossible. As a consequence, the data were presented in descriptive terms only.

3.5.3.5 Oral hygiene practices

Toothbrushing has been promoted as a health gaining activity insomuch as removal of plaque can reverse gingivitis (Loe, 1965) and low frequency brushing is associated with the development of periodontitis (Zimmermann et al., 2015). In the management of caries toothbrushing efficacy is derived from the delivery of fluoride in toothpaste (Hujoel et al., 2018) and in the national survey in 2000 more frequent brushers had more teeth and more SUNT (Whelton, 2007). Conversely, toothbrushing with fluoride toothpaste may increase TSL (Oudkerk et al., 2023) through the abrasive action of toothpaste. The use of interdental aids in plaque removal can assist in the management of periodontitis (Worthington et al., 2019) but there is little evidence that use affects caries incidence (Amarasena et al., 2019).

Little was known about the prevalence rate of toothbrushing in the national population or the Army. In the survey a series of questions about oral hygiene practices were asked that were derived from a set created and used in the NHANES surveys (NHANES, 2012). These asked about the frequency of toothbrushing and frequency of use of floss or any other type of interdental device in the previous week. The data were dichotomized as those who brushed twice a day or more for reporting purposes. The questionnaire also asked about the frequency of use of mouthwash or other oral rinse as no national data was available on this subject since

2000, which reported that 28.1% of the 16 to 24 years and 27.5% of the 35 to 44 years age group used mouthwash (Whelton, 2007). In this survey the mean number of times a day that interdental devices or mouthwash was used were reported.

3.6 Cumulative proximal determinants of oral health

Proximal determinants of oral health include behaviours that also impact general health, such as the link between diet and diabetes or smoking and cancer, which can be addressed through a common risk factor approach (Sheiham & Watt, 2000). International studies indicate that multiple determinants can have a cumulative effect, increasing morbidity, reducing quality of life (Khaw et al., 2008; Fransen et al., 2014), and raising mortality rates (Loef & Walach, 2012). In the UK, an estimated 5% of the population engaged in all four major negative lifestyle behaviours—smoking, excessive alcohol consumption, poor diet, and lack of exercise—while only 6% avoided all of them, highlighting their widespread nature (Buck & Frosini, 2012). A key challenge is determining which behaviour to target first, with strong evidence suggesting that smoking should be the prioritized due to its significant impact on health (Evans & Buck, 2018).

Data reporting cumulative proximal determinants of oral health were not available for the Irish population or in the military. The summed total of the following proximal determinants was collated for the Army sample, as these represented the range of topics that a general dentist may consider when providing preventative advice to a patient (Dental Health Foundation, 2013).:

- Smoking: Current smoking (daily or occasionally)
- Alcohol: Alcohol consumption above HSE safe limits
- Diet: High-risk diet
- Fluoride: Use of non-fluoridated toothpaste or consumption of bottled water
- Hygiene: Brushed less than twice a day or used interdental devices less than seven times a week.

The results were reported as the number and prevalence of proximal determinants of oral health and displayed by demographic, intermediate and proximal determinants of oral health.

3.7 Subjective experience of oral diseases and conditions

An important part of the purpose of the survey was to transition the dental service from paternalistic concepts of oral health set by Dental Officers to a patient-centred model of care that would include an appreciation of the subjective impact that oral health may have on quality of life. Equally importantly, in a military organization system outcomes should align with patient outcomes to ensure that oral health is optimized. When considering the Wilson and Cleary HRQoL model (Wilson and Cleary, 1995), only professionally recorded oral health status was adequately recorded in the system of care at the time of survey even though a stated goal of the Defence Forces dental service was to provide a service that returned personnel in pain to duty as quickly as was possible. In order to measure the impacts of diseases and conditions in the Army, the survey examined a number of measures including reported pain; a global self-rating of oral health, and OHRQoL using OHIP-14.

3.7.1 Pain

A stated outcome of the dental service is to return personnel with pain to duty as quickly as is possible. However, the prevalence of pain of dental origin in Ireland or in the Army was unknown. In the survey pain prevalence was captured by specific pain questions and by questions embedded in the OHIP-14 instrument.

The presence of current pain of oral origin was recorded using two questions reproduced from the UK Adult Dental Health survey of 2009 (Office for National Statistics, 2009). The first question asked whether the respondent had pain or a problem in their mouth and the second question asked whether the pain if present originated from teeth. These questions about current pain experience were complemented by the questions in the physical pain domain of the OHIP-14 instrument that ask about pain experience in the preceding twelve months. The results were presented using descriptive statistics and compared to estimate the prevalence of dental pain in the Army population.

3.7.2 Global self-rating of oral health

Global self-rating of oral health was of interest because clinical examinations are time consuming and costly and may not have the capacity to reach all members of society in an equal fashion. Clinical examinations are not without subjective elements, including the determination of what constitutes a caries lesion (Baelum, 2010) or a periodontal case (Khocho et al., 1996, Bassani et al., 2006). Global self-rating of oral health has been reported to correlate well with clinically observed oral health status (Atchison et al., 1993, Nuttall et

al., 2011) and serve as anchors for OHRQoL measures in conceptual models (Wilson and Cleary, 1995).

A series of questions about self-reported periodontal health were reproduced from the National Health and Nutrition Examination Survey (Centre for Disease Control, 2015). The questions included a Global self-rating of oral health. The selected answers were reported as descriptive data and dichotomized into “excellent/ very good/ good” and “fair/ poor” for reporting purposes.

3.7.3 Oral health related quality of life: OHIP-14

Clinical data collected by examiners reports normative need but does not include subjective assessments of the impacts based on expectations, social status or individual capacity. These matters are of special interest in the Army as rank or other barriers may exacerbate the impacts of oral diseases. In the military setting, lower severity scores have been reported in dentally fit soldiers than in dentally unfit soldiers (Spalj et al., 2012). In the Australian Army, OHIP-14 severity scores were lower in soldiers than in age-matched civilians and this may partly be a result of access to care (Crocombe and Waller, 2013).

The OHIP-14 instrument has been used in civilian (Nuttall et al., 2011, OHID, 2024) and military studies (Kudo et al., 2011, Spalj et al., 2012) to report the impacts of oral disease and was used in this survey (Slade, 1997). The responses on the Likert scale were converted to a number format and the data was reported using the following scheme:

- Prevalence: the percentage of the respondents who answered “occasionally” or “fairly often” or “very often” to any one of the items.
- Extent: the summed number of items answered “occasionally”, “fairly often” or “very often”.
- Severity: the summed score of the responses.

3.8 Data management

3.8.1 Data protection

The requirements of data protection, as outlined in the General Data Protection Regulations and the Data Protection Act 2018 (Government of Ireland, 2018) were adhered to throughout the survey. The data return forms, consent forms and questionnaires were securely stored in locked filing cabinets in the locked office of the Chief Dental Officer in Dublin. These will be

destroyed after seven years, in line with Defence Forces policy. The collated data were held in Access databases and Excel spreadsheets that were located on secure military servers, accessed via password protected PCs. Passwords were changed routinely in line with Defence Forces security policy.

3.8.2 Data processing

The data from the data return forms and questionnaires were entered into a purposely designed Access database at which point the data became irrevocably anonymized. The anonymized data were exported to SPSS version 26 or R Studio version 4.0.3 for data analysis. Fully anonymized data sheets were exported to DDUH statisticians for aid with regression analysis in a password protected format. All analyses were held on password protected computers to which only the PI had access.

3.8.3 Data cleaning

At the time of data entry, data were assessed for internal consistency. An error detected in eight data return forms was an inconsistency between reported age in years and number of years of military service. These errors were rectified by returning the form to the examiner for clarification. A further seventeen forms, as displayed in Table 3-14, were found to be from Air Corps personnel on temporary duty appointments in the Army and were excluded as the health status of the Air Corps was not part of the current study.

Table 3-14: Air Corps personnel excluded from the study

Rank	Number
Pte	12
Junior NCO	3
Senior NCO	0
Junior Officer	2
Senior Officer	0

A random selection of 75 forms was selected for audit and no further clerical errors were detected.

3.8.4 Samples not included in the data reporting

One respondent with a unique sample demographic that could lead to their identification was excluded on the basis that their anonymization could not be guaranteed.

3.8.5 Non-consenting personnel

Eight personnel refused to consent to be part of the study and their number was recorded by rank group and displayed in Table 3-15, below. The low number of personnel that refused to take part in the study most likely reflects the underlying military culture of compliance and has been reported in other surveys in the Irish Army and in the British Army (Edwards et al., 2022).

Table 3-15: Personnel who refused to be included in the study, by rank group.

Rank	Army
Pte	2
Junior NCO	4
Senior NCO	0
Junior Officer	2
Senior Officer	0

3.8.6 Sample weighting

A sampling frame was developed using rank as a discriminator to aid in the collection of a representative sample. It was estimated that a sample of 364 personnel would be required to provide a representative sample of the Army with a 95% confidence level and a 5% Type I error rate and that 532 samples would be required to allow for inter-rank discrimination. As sampling progressed certain ranks (including recruits and cadets) were easier to access than others (including senior officers) and over-sampling of the former occurred. The geographic spread of data collectors using paper forms also meant that sampling continued for a short time while samples were being collated. Ultimately the final sample included 777 personnel as tabulated in Table 3-16, below.

A consequence of the over-sampling was the need to weight samples during the reporting of the Army data so that skewing of the data by the over-sampling of certain ranks would not occur. The estimated sample size, collected sample size and weighting applied when reporting on the Army results is displayed in Table 3-16. Weighting was not applied when reporting by rank group or individual risk factors.

Table 3-16: Number of personnel examined by rank band and the applied weighting

Rank	Estimated sample size	Sample size collected	Weighting
Recruit	10	140	0.071
Cadet	4	84	0.048
Private	178	264	0.675
Junior NCO	109	169	0.644
Senior NCO	18	33	0.531
Junior Officer	25	55	0.456
Senior Officer	20	32	0.635
TOTAL	364	777	

3.8.7 Data analysis

3.8.7.1 Descriptive statistics

Data were converted to number format where required and reported using descriptive statistics. The descriptive data were reported for the Army weighted by rank group. In the reporting by risk factors the data were reported unweighted by rank. The statistical significance level was set as $p < 0.05$. The relationship between the risk factors and dependent variables was reported using the Mann-Whitney/ Kruskal-Wallis tests for continuous dependent variables and the Chi-squared test for categorical variables.

3.8.7.2 Regression analyses

Binary regression analyses at a significance level of $p < 0.05$ were conducted on the dependent variables of more than or less than 21 teeth; more than or less than 18 SUNT; presence of DMFT=0; DT>0; FT>0; MT>0; presence of PSR 3 or 4 and presence of BEWE $\geq$ 2. The analyses were conducted for the social gradients by rank, level of education and area deprivation, adjusted by age, gender and last dental visit.

3.8.7.3 Factor analysis of the MDAS instrument

An important aspect of the model of dental care in the Army was the almost exclusive outsourcing of primary dental care to civilian contractors whereas in-house dental teams were almost wholly occupied by occupational assessments. Dental teams had raised concerns that personnel undergoing simple examinations in-house without the implication of immediate dental treatment may have less anxiety than those undergoing examinations in the civilian out-sourced setting and that, as a consequence, the prevalence of phobia might be underestimated during the survey process.

In order to resolve this question, factor analysis was carried out for the results of the MDAS using exploratory factor analysis in SPSS. The number of eigenvalues was selected using Horn's technique (Horn, 1965) by selecting only those whose magnitude was greater than the values generated from a randomly generated correlation matrix calculated using the number of variables and sample size entered into an online resource (Vivek, 2017). The number of dimensions was confirmed using Confirmatory Factor Analysis in SPSS AMOS. The reliability of the questionnaire was tested by calculating Cronbach alpha scores in SPSS.

3.8.8 Statistical advice

Initial statistical advice about the estimation of sample size was provided by Dr Maria van Haarten. Descriptive and regression statistics were conducted by the principal investigator using SPSS version 26. Statistical advice was provided by Dr Bahman Honori and Dr Erica Donnelly-Swift, who supervised the regression models and associated outputs.

3.8.9 Management of incomplete data

Incomplete data are not reported in the descriptive analysis. In the statistical analysis, missing data were excluded pair-wise from the analysis rather than list-wise. This approach maximized the sample size in variables unaffected by incomplete data, thereby improving statistical power. The effect of missing data was reduced in the Army reporting by the overall high level of compliance and the weighting of over-sampled rank categories.

4 The oral health status of Irish Army personnel

The Army makes personnel dentally fit to reduce the impacts of and number of lost workdays attributable to oral disease. Current planning for the delivery of service, including issues such as workforce numbers, rationale for outsourcing and requirement for preventative services are dependent on epidemiological data. However, such data were not available either in the Army or in the civilian community and was provided by the present survey.

Although over-sampling of every rank group occurred during data collection, the greatest over-sampling occurred in the recruit and cadet groups, necessitating weighting of the data when reporting the distribution of diseases and conditions in the Army. In this chapter both weighted and unweighted data are displayed for comparison, where necessary.

Army studies (Hayden, 1995), national civilian (O'Mullane and Whelton, 1992, Whelton, 2007) and international civilian (Cooney, 2010, White et al., 2011, Amarasena et al., 2021, CDC, 2019) surveys have highlighted that certain groups are at higher risk of disease, particularly those at risk of economic disadvantage. Despite anecdotal observation by Dental Officers that certain groups may be at higher risk of disease, no data was available to confirm these observations. In this survey, rank, level of education and small area deprivation were used to determine whether social gradients in disease experience existed.

Important differences in the distribution of data emerged between new entrants (recruits and cadets on entry without exposure to the military system of care) and the trained strength (officers and soldiers who had completed cadet and recruit training and who had access to the military system of care) and the results of these groups were presented for comparison, where relevant.

Comparative national and international data in military and civilian publications were presented where possible. The comparative data is severely limited by the paucity of data, with no nationally representative data sets available for comparison in Ireland since 2000 (O'Mullane and Whelton, 1992, Whelton, 2007). In addition, comparison with the Army as a group with national data was limited by the reporting of national data by age groups. Little has been published in the military domain that allows for comparison with the Army data, either nationally or internationally. Where published, most report the oral health of recruits and are compared where available. Since these data comparators were not available, international comparative data were used as a frame of reference. National data sets were

available in Canada (Cooney, 2010), New Zealand (Ministry of Health, 2010), the US (CDC, 2019, Jamieson et al., 2021) and the UK (Public Health England., 2020, OHID, 2024) and were presented for comparison where relevant. Although there were elements reported by all the surveys, such as the number of teeth present and number of decayed teeth present, each country reported a different suite of data, which made consistent comparison impossible. In addition, these surveys reported in populations with a much wider demographic spread in age, gender, ethnicity and other metrics and these differences must be borne in mind when comparing with the Army data.

The difficulties in comparison presented above highlight the paucity of data available for meaningful comparison with the Army sample. These difficulties also indicate the usefulness of the data reported below in establishing a baseline with which future Army studies may benchmark without the difficulty of interpretation against less-than-ideal comparators. The survey will also present data for a group of mainly young men which is not readily available nationally or internationally.

4.1 Sample characteristics

The characteristics of the Army sample are summarized in Table 4-1 and display the results for the weighted sample, the unweighted Trained Strength (all soldiers in the Army except cadets and recruits) and the unweighted New Entrants (cadets and recruits). Statistically significant differences between the Trained Strength and New Entrants are annotated, where present.

Table 4-1: Distribution of demographic variables and determinants of oral health in the weighted Army, trained strength and new entrants. Statistically significant differences between Trained Strength and New Entrants reported (*= $p<0.05$; **= $p<0.01$; ***= $p<0.001$)

Risk factor			Weighted Army (n=364)	Trained strength (n=553)	New entrants (n=224)
Demographic variables	Age	Mean age	32.7 (31.8, 33.7)	33.4*** (32.7, 34.2)	20.8*** (20.5, 21.1)
	Age groups	18 to 24 years	18.6%	15.2%***	90.6%***
		25 to 34 years	46.2%	47.2%***	9.4%***
		35 to 44 years	22.9%	24.1%***	0%***
		45 to 54 years	9.4%	10.3%***	0%***
		≥55 years	2.9%	3.3%***	0%***
	Gender	Male	97.2%	97.6%**	93.3%**
		Female	2.5%	2.4%**	6.7%**

Intermediate determinants	Rank groups	New entrants	3.8%	0%***	100%***
		Private	49%	47.7%***	0%***
		NCO	34.7%	36.5%***	0%***
		Officer	12.5%	15.7%***	0%***
	Deprivation ⁶	Mean value	-1.9 (-2.8, -0.9)	-1.7 (-2.5, -0.9)	-1.3 (-2.8, 0.1)
	Deprivation groups	Outside State	2.1%	1.6%***	13.4%***
		<1 SD below mean	18.6%	18.1%	16.5%
		Within 1 SD of mean	70%	70.7%***	58.5%***
		>1 SD above mean	9.3%	9.6%	11.6%
	Education ⁷ groups	Some secondary	8.9%	8.3%	12.5%
		Completed secondary	36.3%	33.5%***	68.3%***
		Some college	31.9%	32.5%***	5.4%***
		Honours degree or Masters	18.1%	21%***	12.5%***
	Last dental visit ⁸	<12 month	80.2%	81.2%***	52.7%***
		12 to 24 months	8.8%	8.3%***	24.2%***
		>24 month	11%	10.5%***	22.8%***
	MDAS ⁹	Mean value	9.2 (8.7, 9.7)	9.2** (8.8, 9.5)	10.2** (9.6, 10.8)
		Phobia	5.4%	5.2%	8%

Proximal determinants	Smoking	Daily	11.9%	11.4%	12.5%
		Occasional	8.8%	8.5%	12.9%
		Ex-smoker	24.8%	25.5%***	10.3%***
		Non-smoker	54.5%	54.6%***	64.3%***
	Alcohol	High risk	4%	3.8%**	9.4%**
	Diet	High risk	51.3%	50.5%*	58.5%*
	Brushing	High risk	14.5%	14.1%**	22.3%**

⁶ Missing cases: weighted Army n=8; Trained Strength n=9; New Entrants n=30

⁷ Missing cases: weighted Army n=17; Trained Strength n=26; New Entrants n=3

⁸ Missing cases: New Entrants n=1

⁹ Missing cases: weighted Army n=1; Trained strength n=1

4.1.1 Age

The mean age of the Army at 32.7 95% CI [31.8, 33.7] years was lower than the national average of 37.4 years in Ireland (CSO, 2016), due to recruitment and retention policies in the Irish Army. There were statistically significant differences between the Trained Strength and New Entrants in both age in years (Mann-Whitney, $p < 0.001$) and the distribution of the age groups ($\chi^2 = 392.7$, $df = 4$, $n = 777$, $p < 0.001$) that would be expected from the restricted age on entry for the majority of soldiers. Figure 4-1 displays the relative frequency distribution by age bands of the national population (CSO, 2016), the Army distribution as supplied by the HR branch (personal communication) and the weighted and unweighted samples. The weighted sample followed a profile remarkably similar to the Army population and indicates that sampling by rank was effective in collecting age-related data. The national population had a more even distribution among the age groups, with a lower peak in the 25 to 34 years age group and respondents over 65 years and below 18 years of age. The age distribution means that it may not be possible to generalize the findings in the Army sample to the national population. Other international military forces, such as the British (Defence Statistics, 2020) and U.S. (Dept of Defense, 2019) militaries, reported a similar age distribution, supporting the validity of comparisons in studies of oral diseases and conditions in military populations.

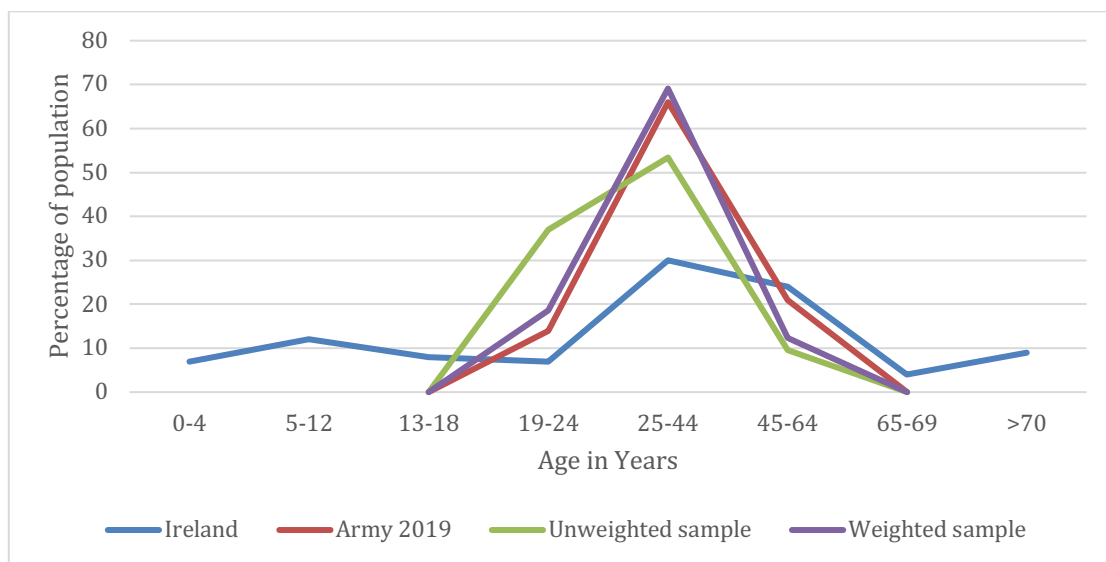


Figure 4-1: Relative frequency distribution of age bands in the national population (CSO 2016), Army population ($n = 7143$) (personal communication), weighted sample ($n = 364$) and unweighted sample ($n = 777$).

4.1.2 Gender

At the study design stage, the Army HR department advised that 7.4% of personnel serving at the time of survey were women (personal communication) corresponding to approximately 524 personnel. It was estimated that 42.4% of the serving women would be required to give a representative sample, with higher sampling rates required to be representative by rank. At that point that it was deemed not realistic to attempt to capture a representative number of female personnel and no targets were set. Ultimately, only 28 female personnel were examined, corresponding to 2.5% of the weighted sample. There were statistically significant differences ($\chi^2=8.7$, $df=1$ $n=777$, $p=0.003$) between the proportion of women in the Trained Strength (2.4%) and the New Entrants (6.7%), which might be expected to affect disease prevalence in the female sample. An important finding of the survey was that future surveys should aim to capture a representative sample of female soldiers, particularly in light of the commitment by government to increase the percentage of women in the Defence Forces to 35% of the trained strength by 2028 (Dept. of Defence, 2022b). The difficulty accessing the relatively small number of women in the Army to capture a representative sample is compounded by the geographical distribution and the lived reality of time outside service life as a result of maternity leave, career breaks and less frequent deployments. Liaison with the Senior Gender Advisor and team are required to formulate solutions to this problem.

4.1.3 Health status

In the survey, only three personnel declared a medical condition that classified them as ASA II and only one patient, with poorly controlled diabetes, was classified as ASA III. By contrast, the HSE reported in 2019 that 28.1% of men and 27.3% of women had a long-standing medical condition, including 13.8% of the 16 to 24 years men (Dept. of Health, 2019) and in the 16 to 44 years age group 2.5% of men and 2% of women reported that a medical condition caused severe limitations in their usual activities. No personnel were assessed as having a medical condition that affected salivary flow in either the weighted or unweighted samples. One individual, corresponding to 0.2% of the weighted sample and 0.1% of the unweighted sample had poorly controlled Type II diabetes that the examiner adjudged affected periodontal health. The relatively healthy status of the Army may be expected as there was an exclusionary medical system that prevented entry for persons with selected medical conditions and discharged personnel who fell below medical standards. The sample may have been slightly skewed by the attendance of personnel before deployment overseas who would have undergone extensive medical assessment. Nonetheless, the sample is not likely to be very different from the Army population. Since the numbers in this category were

very small and have minimal impact on the oral health status of the Army, no further analysis of this risk factor was undertaken.

4.1.4 Rank

The distribution of the rank groups corresponded to those collected for sampling purposes. The over-sampling of ranks resulted in a slightly higher proportion of Officers and NCOs and a lower proportion of Private soldiers in the unweighted Trained Strength than in the weighted Army. The key demographic characteristics and intermediate determinants of oral health are displayed in Table 4-2. Smoking and alcohol risk data are presented to highlight social gradients in the rank groups. The mean age of officers and NCOs was older than privates and new entrants (Kruskal-Wallis, $p < 0.001$), which underpinned a number of the differences in clinical indicators but an important measure, in light of findings reported below, was similar age of officers and NCO ranks.

Table 4-2: Key demographic characteristics and determinants of oral health in the rank groups, unweighted data (n=777)

Factor		Officers (n=87)	NCOs (n=202)	Privates (n=264)	New entrants (n=224)	p value
Age		36.2 (33.6, 38.8)	38.4 (36.9, 39.9)	28.7 (27.7, 29.7)	20.8 (20.5, 21.1)	<0.001
Gender	Male	96.6%	98%	97.7%	93.3%	0.03
	Female	3.4%	2%	2.3%	4.7%	
Deprivation	<1 SD	6.9%	14.4%	24.6%	16.5%	<0.001
	±1 SD	69%	72.8%	69.7%	58.5%	
	>1 SD	21.8%	11.4%	4.2%	11.6%	
Education ¹⁰	Some secondary	0%	8.4%	11.9%	12.5%	<0.001
	Completed secondary	1.1%	19.3%	59.4%	68.3%	
	Some college	8%	56.9%	23.8%	5.4%	
	Honours/ Masters	89.7%	12.9%	4.9%	12.5%	
Proximal determinants	Current smoking	10.3%	17.8%	24.6%	25.4%	0.009
	Alcohol risk	3.4%	4.3%	3.4%	9.4%	0.02
	Diet risk	42.5%	47.5%	55.3%	58.5%	0.02
	Brushing risk	11.5%	14.95	14.4%	22.3%	0.04

Social gradients existed between the rank groups, with a gradient in deprivation scores from Private soldiers to Officers and pair-wise differences between officers and the other ranks

¹⁰ 39 missing cases

(Kruskal-Wallis, $p < 0.001$). When examined by deprivation groups, 21.8% of officers were from the most affluent small areas, compared with 4.2% of private soldiers. Conversely, 6.9% of officers were from the least affluent small areas, compared with 24.6% of private soldiers. A strong social gradient existed by education ($\chi^2 = 532.8$, $df = 12$, $p < 0.001$) as most officers had an honours degree or Masters' degree, most NCOs had completed some college and most private soldiers and new entrants had completed their secondary education. The results provided evidence for the anecdotal observations about differences in social advantage between officers and other ranks and should be communicated to senior management as evidence of social patterning and potential advantage enjoyed by senior leaders.

The proximal determinants showed strong social gradient in smoking, alcohol misuse, diet and brushing. Current smokers formed 10.3% of the officer ranks, 17.8% of NCOs and about a quarter of privates and new entrants ($\chi^2 = 34.9$, $df = 9$, $n = 777$, $p < 0.001$). A rank gradient was also reported for smoking in the British Army where 40% of soldiers smoked but only 13.5% of officers smoked (Fear et al., 2010). There were differences in the mean number of units of alcohol consumed only between new entrants and Private soldiers (Kruskal-Wallis, $p = 0.005$) but the proportion of high-risk drinkers was much higher in the new entrants (9.4%) than in other groups ($\chi^2 = 10.0$, $df = 3$, $n = 777$, $p = 0.02$) and reflected reported alcohol misuse in young people in the national population (Dept. of Health, 2019). The prevalence of high-risk diet decreased from 58.5% of new entrants to 42.5% of officers ($\chi^2 = 9.5$, $df = 3$, $n = 777$, $p = 0.02$), which differed from the 2009 UK oral health survey that reported little difference by occupation (Chadwick et al., 2011). It is possible that a military influence was in effect, with fitness and BMI requirements shaping retention of compliant soldiers. In addition to the social gradients present, the results showed that new entrants consistently had a higher prevalence of risk behaviours that underpinned disease experience.

An additional consideration in the rank data was whether the differences in the rank originated on entry by selective selection of recruits and officer cadets. The data for these groups are presented in Table 4-3 and shows the extent to which the social patterning began on entry. One in five recruits were living in the most deprived areas and one in twenty were living in the most affluent areas whereas one in ten cadets were living in the most deprived areas and one in five were living in the most affluent areas. One in five of recruits had not completed secondary education by comparison with 5% of school leavers nationally (Dept of Education, 2018), demonstrating recruitment from a specific group in the national population. About a third of recruits were smokers, by contrast with 8.3% of officer cadets. In the remaining

proximal determinants, although the prevalence of risk behaviours was higher in recruits than cadets, the differences were not statistically significant.

Table 4-3: Key demographic characteristics and determinants of oral health in the new entrants, unweighted data (n=224)

Factor		Cadets (n=84)	Recruits (n=140)	p value
Age		21 (20.4, 21.5)	20.6 (20.3, 21)	0.57
Gender	Male	90.5%	95%	0.19
	Female	9.5%	5%	
Deprivation	±1 SD	8.3%	21.4%	<0.001
	>1 SD	63.1%	55.7%	
	<1 SD	21.4%	5.7%	
Education	Some secondary	0%	20%	<0.001
	Completed secondary	66.7%	69.3%	
	Some college	2.4%	7.1%	
	Honours/ Masters	31%	1.4%	
Proximal determinants	Current smoking	8.3%	35.7%	<0.001
	High-risk alcohol	7.1%	10.7%	0.38
	Diet risk	52.4%	62.1%	0.15
	Brushing risk	23.8%	21.4%	0.68

These results are, as far as the author is aware, the first that show the social gradients by educational attainment and small area deprivation that support and sustain the rank differences, particularly between officers and enlisted personnel.

4.1.5 Military service

At the outset of the survey, it was appreciated that military service presented a unique setting in Ireland with risks and opportunities that differed from civilian life. Interestingly, very little had been published in the international literature about the specific risks that may present within the military setting. Schindler *et al* reported that US veterans differed little from civilians in most clinical indicators but had more untreated periodontal disease and a higher number of filled teeth and total DMFT scores (Schindler et al., 2021); these results could be interpreted within the context of efforts to treat caries, knowing its links with dental emergencies on deployment (Chaffin and Moss, 2008). However, there were no extant papers reporting *per se* the risks associated with service, whether positive (eg access to treatment) or negative (over-treatment, high usage of refined carbohydrates on exercise etc).

In the formulation of the current survey, a number of potential military service indicators were considered: firstly, length of military service, as longer exposure to military systems may have had an effect independent of age; secondly number of overseas missions, to determine the positive or negative effects of pre-deployment readiness and thirdly, the time

spent on overseas deployment as it was unknown whether this may have had an effect that differed from the number of missions, particularly where personnel stayed overseas for substantially longer or had many shorter missions.

Initial statistical testing of the data showed that both number of overseas missions and number of months on overseas deployment had strong collinearity with age (dependent variable: DT, VIF 19.6 and 18.1, respectively). The results reflected the fact that with longer service and thereby older age personnel had more frequent deployments that arise on a periodic basis. Neither of these indicators offered data that was of additional benefit to the age data and further reporting is not included in the body of this thesis.

4.1.6 Deprivation

The summary statistics for deprivation scores are displayed in Table 4-4. The results of the weighted Army were normally distributed and shifted marginally lower than the national average. The range of values showed that personnel were living in some of the most and least affluent small areas of the State at that time.

Table 4-4: Summary statistics for deprivation scores

Sample	p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	0.08	356	-1.9	-2.9, -0.9	-1.1	12.9	-26.6	34.7
Unweighted	0.02	738	-1.6	-2.3, -0.9	-1.0	13.1	-26.6	34.7

The number and proportion of personnel in the sample living within the merged categories are displayed in Table 4-5. The unweighted sample had 39 missing addresses, corresponding to personnel with home addresses outside the Republic of Ireland. Although the size of this group was small, they included personnel who may have lacked the social networks or language proficiency that would facilitate resolution of oral problems.

Table 4-5: Number and percentage of personnel living in the defined deprivation groups

	<1 SD below mean	Within 1 SD of mean	>1 SD above mean	Outside State
Weighted (n=364)	68 (18.6%)	255 (70%)	34 (9.3%)	8 (2.1%)
Unweighted (n=777)	137 (17.6%)	522 (67.2%)	79 (10.2%)	39 (5%)

There were no statistically significant differences in the mean deprivation scores (t-test, $p=0.66$) between new entrants and the trained strength. There was a statistically significant

difference in the distribution of deprivation groups between new entrants and the trained strength ($\chi^2=48.4$, $df=3$, $p<0.001$) as a result of increased recruitment of soldiers from outside the Republic of Ireland in recent years.

The data confirmed anecdotal observations and international reports of the association between deprivation, education and rank (Lutz, 2008). A greater proportion of personnel living in more affluent small areas were officers with higher education whereas a greater proportion of respondents living in the poorest small areas were private soldiers with lower education. These differences were apparent in the new entrants as 18.9% of the poorest soldiers had “some secondary” education and none had an “Honours degree or Masters” and 26.9% of the most affluent had an “Honours degree or Masters” and only 3.8% had “some secondary” education. These indicate a social patterning in the Army that begins at recruitment and has been identified as a basis for the social classes that existed in the ranks (Dept. of Defence, 2023a).

4.1.7 Education

The highest level of educational attainment reported in the weighted sample of Army personnel is displayed in Figure 4-5, with, for comparison, the proportion in the adult population over 15 years of age provided by the 2016 census (CSO, 2016). In the Army sample 5% did not provide an answer and were excluded from the reporting as 20.6% were NCOs or officers who are required to have at least a level 6 qualification and therefore inferences about this group could be misleading. There were proportionally more soldiers in the “completed secondary” group, which reflected the relatively young age of the Army, and in the “college less than honours degree” group as these qualifications are often awarded for completion of technical qualifications in the Army.

Education has been reported as a proxy for social advantage (O'Connell et al., 2006, Ferguson and Michaelsen, 2015, Parsons, 2016, Doyle et al., 2021) and these data showed the advantages enjoyed by soldiers with higher levels of education. The gradient in deprivation scores from “some secondary” to “Honours degree or Masters” (Kruskal-Wallis, $p<0.001$) showed the association between educational attainment and economic advantage. In the “Honours degree or Masters” group 21% lived in the most affluent small areas, by comparison with 5% of the “some secondary” group. As was reported in the deprivation data, this social patterning was present on entry, as 25% of new entrants with an “Honours degree or Masters” lived in the most affluent small areas ($\chi^2=41.2$, $df=9$, $n=527$, $p<0.001$) and none

lived in the most deprived small areas. The association between educational attainment and rank ($\chi^2=532.79$, $df=12$, $n=527$, $p<0.001$) was evident as most personnel with an honours degree or Master's degree were officers (54%) and most personnel with "some college" courses were NCOs (60%). In the trained strength, the vast majority of personnel who had either "completed secondary" education (78.4%) or had "some secondary" education (63%) were private soldiers. The latter proved to be an important group to observe, as they were older, with a higher number of proximal determinants that affected oral health and poorer oral health outcomes.

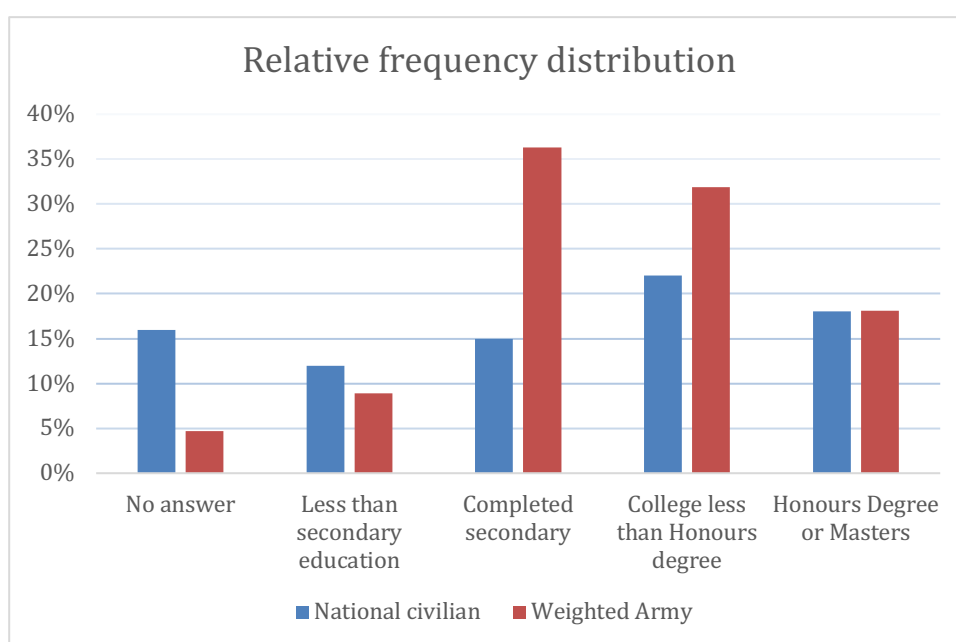


Figure 4-2: Relative frequency distribution of highest level of education in the weighted Army sample ($n=364$) and national civilian census data 2016

Gradients across the education groups in smoking, alcohol misuse and high-risk diet were present in the data, with the highest risk present in those with the lowest educational attainment. The group with "some secondary" education included 31% who smoked and 69% with a high-risk diet as well as 8% who consumed alcohol above recommended limits and 13% who brushed less than twice daily, showing the clustering of risks that may occur in patients. In general, the social gradients were wider in the new entrants than the trained strength. For instance, 3.6% of the new entrants with an "Honours degree or Master" were daily smokers and 42.9% had a high-risk diet whereas 39.3% of new entrants with "some secondary" education were daily smokers and 78.6% had a high-risk diet. The results are not abstract as evidence suggests education is at least correlated with improved health outcomes (Eide and Showalter, 2011) although a causal link may be difficult to specify (Mazumder,

2008). Studies in the US have reported poorer health outcomes in groups with less than college degree qualifications (Rosenbaum, 2012, Zajacova et al., 2012, Lawrence et al., 2016)

4.1.8 Last dental visit

As displayed in Figure 4-3, the majority of personnel in the weighted Army had attended within 12 months (80.2%), about double the rate reported for Irish civilians (Dept. of Health, 2018). The rate compared favourably with international military (Marker et al., 1997, Skec et al., 2006, Wahid et al., 2014, Azevedo et al., 2018, Eitner et al., 2006, Horev et al., 2003, Zadik et al., 2009, Chisick, 1995, Hyman et al., 2006) and civilian (Slade et al., 2004, Morris et al., 2011, Public Health England., 2020, Ministry of Health, 2010) reported attendance rates.

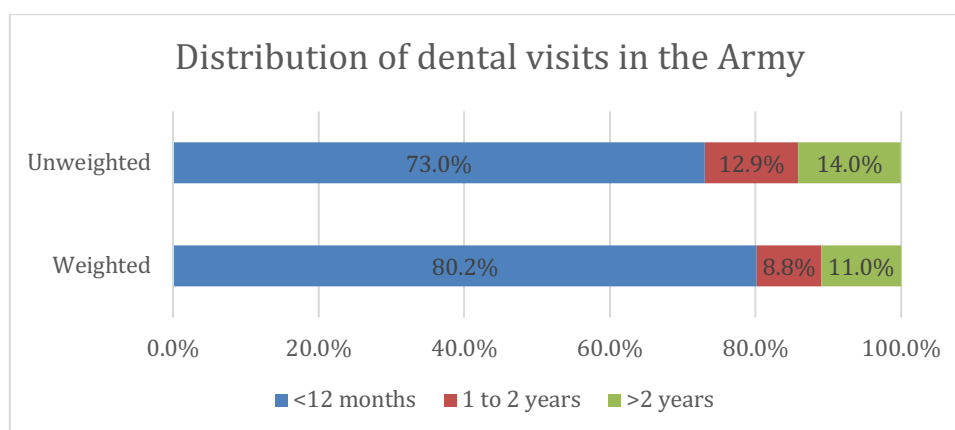


Figure 4-3: Recency of dental visits in the weighted (n=364) and unweighted Army (n=776, 1 missing case)

Only 11% of the weighted Army hadn't attended within two years and may have been at risk of an outdated forensic chart. The reasons stated for not attending over the previous 2 years are displayed in Table 4-6 and show that fear was stated as a reason by 12.1% of the respondents whereas in the 2002 Irish national survey the reported percentage for fear was 27.6% (Whelton, 2007). International evidence reports a higher prevalence of dental anxiety in women (Steele et al., 2012) and it may be the case that the lower prevalence reflected the higher proportion of men in the Army sample.

About one in twenty of the respondents who hadn't attended within 2 years stated that cost was a barrier to attendance. All of these personnel were recruits without access to free care in the Army. In the 2000 Adult Oral Health survey 17% reported that they hadn't attended due to costs (Whelton, 2007), 63% of UK respondents reported that cost was a reason for choosing NHS dental services and 20% reported not attending because of charges (Morris et

al., 2011). None of the trained strength who hadn't attended within two years stated that cost was a factor, as would be expected from a service provided free at the point of care for basic therapies.

Table 4-6: Reasons selected for not attending the dentist in the last 2 years, unweighted data

Reason	Number	% of sample
I am afraid of going to dentist	13	12.1
I can't afford charges	5	4.8
I haven't got the time	6	5.8
Keep forgetting	31	30.1
No need to go	39	37.8
None of these reasons	9	8.7
Total	103	

In the Army there were no differences in attendance by education level or deprivation group, which suggests that free access was successful in overcoming barriers reported in national civilian reports (Whelton, 2007, Dept. of Health, 2018). The prevalence of dental visiting in the trained strength and the new entrants is displayed in Table 4-7 and shows that fewer recruits had visited within 12 months and a greater proportion hadn't visited in over two years. The prevalence of recent visiting by new entrants was similar to that reported for civilians in the Healthy Ireland report (47%) (Dept. of Health, 2018).

Table 4-7: Prevalence of dental visiting groups in the new entrants and trained strength, unweighted data (n=777)

	<12 months	1 to 2 years	>2 years
Trained strength	81.2%	8.3%	10.5%
New entrants	52.7%	24.1%	22.8%
p value	<0.001		

4.1.9 Dental anxiety

4.1.9.1 Prevalence, extent and severity scores

The prevalence of dental anxiety in the weighted and unweighted sample is displayed in Table 4-8. The prevalence of anxiety in the weighted sample was 71.9%, comprising 66.5% with anxiety less than phobia and 5.4% with phobia, showing that phobia was confined to a very small part of the Army, as has been reported internationally (Silveira et al., 2021). The national survey in 2000 reported a prevalence of 8% with fear of the dentist but the severity was not graded (Whelton, 2007). The prevalence of phobia in the Army was lower than that reported in the UK national survey using the MDAS at 11.6% (Humphris et al., 2013) or the 16.8% value calculated for a convenience sample of Irish patients using the Corah scale (Brady et al., 2012), which might reflect the predominantly male Army population or an element of psychological resilience in soldiers. In the weighted sample, the mean extent of items at the threshold of “very anxious” or above was 0.5 95% CI (0.4,0.6) and the mean severity score was 9.2 95% CI (8.7, 9.7) and similar to the estimate for the UK population in 2009 of 10.7 95% CI (10.5,10.8).

Table 4-8: Summary statistics for the MDAS scores in the unweighted Army (n=776)

	Prevalence			Extent Mean (95% CI)	Severity Mean (95% CI)
	No anxiety	Anxiety less than phobia	Phobia		
Weighted	28%	66.5%	5.4%	0.5 (0.4, 0.6)	9.2 (8.7, 9.7)
Unweighted	25.7%	68.1%	6.1%	0.5 (0.5, 0.6)	9.5 (9.1, 9.8)

Dental anxiety severity tended to decrease with age (Kruskal-Wallis, $p=0.04$) and the extent (Kruskal-Wallis, $p<0.001$) and severity (Kruskal-Wallis, $p=0.005$) scores were higher in women than men. However, in the proximal and intermediate determinants of oral health only gender had a statistically significant difference in the reported prevalence of phobia ($\chi^2=12.1$, $df=1$, $p<0.001$). Putative links with ‘routine’ occupations were suggested in the UK (Heidari et al., 2015) as well as less regular attendance (Thomson et al., 1996, Schuller et al., 2003, Sohn and Ismail, 2005, Freeman et al., 2011) but these were not present in the Army sample. Generally, other than gender, the results showed that no inferences could be drawn about the composition of dental phobia groups in the Army.

4.1.9.2 Item frequency response

The item frequency responses are displayed in Table 4-9 for the unweighted sample. The majority of participants reported no anxiety about visiting the dentist, sitting in the waiting room or having a scale and polish and only 2% reported a phobia for these settings. Over one half of patients had no anxiety about attending for an examination or scale and polish, which is of relevance to a population recalled frequently for validation examinations. The use of the drill and receiving an injection elicited an extremely anxious response in 10% and 7% of respondents with corresponding decreases in the number reporting no anxiety. The use of a drill caused more anxiety in the grades “extremely anxious”, “very anxious” and “fairly anxious” than other activities.

Table 4-9: Item frequency distribution in the unweighted sample (n=776)

	Visit tomorrow		Waiting room		Use of drill		Scale and polish		Injection	
	n	%	n	%	n	%	n	%	n	%
Not anxious	452	58	457	59	251	32	419	54	307	40
Slightly	211	27	213	27	226	29	232	30	228	29
Fairly	63	8	65	8	152	20	74	10	116	15
Very	33	4	25	3	72	9	31	4	73	9
Extremely	15	2	16	2	75	10	19	2	52	7

Little has been published in Ireland that can be compared to these results, however the 1990 survey asked about ‘fear of the drill’ and stratified the answers in two relevant age groups (O'Mullane and Whelton, 1992). In the 16 to 25 years age group, 13% responded that they felt ‘worried’ and 19% responded that they felt ‘frightened/ sick’ with similar percentages in the 35 to 44 years age group at 12% and 14%, respectively. Although direct comparison is not possible, there was a sizeable group within both the 1990 civilian and 2020 Army samples who reported high levels of anxiety at the prospect of the dental drill.

4.1.9.3 Factor analysis of the MDAS instrument in the Irish Army

A number of Dental Officers had postulated that anxiety in the Army may have been a two-factor model, with fear of attendance and examination separated from fear of treatment, as has been reported elsewhere (Yuan et al., 2008). The implication would be that the assessment of anxiety by military dental teams might miss dental phobia in patients attending for occupational assessments. The psychometric properties of the MDAS instrument in the Irish Army setting were explored using Exploratory Factor analysis in SPSS. The results are contained within the appendices. A single factor had an eigenvalue greater than the randomly generated values, with an eigenvalue of 3.7 that accounted for 74.3% of the total variance.

Unidimensionality was confirmed using Confirmatory Factor Analysis in AMOS. The Cronbach's alpha scores for the items in the questionnaire were satisfactory (0.91) and indicated reliability in the use of the questionnaire in a single factor model. These results showed that only one factor was present and that military dental teams could continue to collect data about phobia in the Army as part of their routine workflow.

4.1.10 Summary of the sample characteristics data

The results showed that soldiers in the Army were generally younger than the national population and predominantly male. The distribution of deprivation data mirrored the national distribution and was normally distributed but showed that some soldiers were drawn from some of the least affluent areas of Ireland and others with home addresses outside the Republic of Ireland who may need additional supports to obtain optimal oral health. As a result of the young age, there was a higher proportion of soldiers whose highest level of educational attainment was secondary education and the sample included 9% with less than secondary education who may need additional supports. Dental attendance was high, aided by mandatory attendance and free basic dental care. A small proportion reported dental phobia, a known barrier to dental care (Appukuttan, 2016). These results show the unique characteristics of the Army in the Irish setting and provides a frame of reference for the clinical data reported throughout this chapter.

4.2 Total tooth retention

The endpoint of oral disease, which oral health interventions aim to avoid, is tooth loss. The Irish Army has been acutely aware of the devastating impact that severe tooth loss can have on well-being and readiness for duty both at home and abroad by setting a minimum entry standard of 21 teeth and by having a statutory scheme to provide dentures as replacement for missing teeth. The following sections report the number of teeth in the Army and the proportion with at least 21 teeth, which has been identified as a minimum number to avoid the need for dentures (Hobdell et al., 2003) and have a functional dentition (Käyser, 1981). Any participant with at least one natural tooth present was classified as dentate. These indicators have been reported in previous national and international surveys and form the basis for comparison with the oral health of the Irish Army.

4.2.1 Number of natural teeth

4.2.1.1 Summary statistics

The summary statistics for the number of natural teeth in the weighted and unweighted Army sample are displayed in Table 4-10. The number of natural teeth is presented as a mean and confidence interval (CI) The mean values were 28.2 95% CI [27.2, 28.5] and 28.2 95% CI [28.1, 28.4] in the weighted and unweighted samples.

Table 4-10: Summary statistics, number of teeth, weighted and unweighted Army sample

Data set	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	5.55×10^{-34}	364	28.2	27.9, 28.5	28	3	4	32
Unweighted	3.69×10^{-91}	777	28.2	28.1, 28.4	28	3	4	32

4.2.1.2 Comparison with previous surveys

The mean number of teeth in Ireland was not available for comparison as the data in previous national surveys was reported by age groups. The mean number of teeth reported by recent surveys in high-income countries (HIC) is displayed in Figure 4-4 and shows that the retention of 28.2 95% CI [27.9, 28.5] teeth in the Army was similar to the overall trend of increased tooth retention reported in high-income countries in recent years.

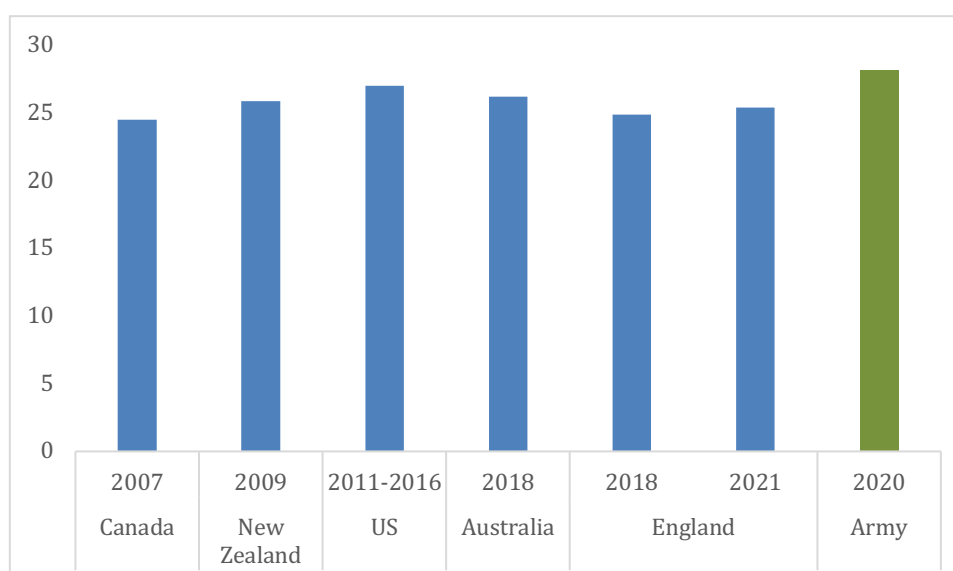


Figure 4-4: Mean number of teeth in international studies and Army 2020 study (weighted data, n=364) (Cooney, 2010, Ministry of Health, 2010, CDC, 2019, Jamieson et al., 2021, Public Health England., 2020, OHID, 2024)

4.2.1.3 Comparison between new entrants and the trained strength

The mean number of teeth in the Army did not differ much between recruits and the trained strength (Mann-Whitney, $p=0.85$), as displayed in Table 4-11. The data shows that improvements in oral health that have occurred in the last 30 years in Ireland have translated in the Army into tooth retention into older age and later military service.

Table 4-11: Mean number of teeth in the weighted Army, trained strength and recruits

Group	n	Mean [95% CI] no teeth
Weighted Army	364	28.2 [27.9, 28.5]
Trained strength	553	28.2 [27.9, 28.4]
New entrants	224	28.4 [28.2, 28.6]

4.2.1.4 Mean number of teeth displayed by demographic variables and intermediate determinants of oral health

The mean number of teeth in the unweighted Army sample is displayed in Table 4-12 by demographic and intermediate determinants. The mean number of teeth decreased with age (Kruskal-Wallis, $p<0.001$) as has been reported in national (Whelton, 2007, O'Mullane and Whelton, 1992) and international surveys (Cooney, 2010, White et al., 2011, Lin et al., 2019, Public Health England., 2020, Peres et al., 2020).

Table 4-12: Mean number of teeth by demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	28.5 (28.3, 28.7)	28.5 (28.2, 28.7)	28.2 (27.8, 28.7)	26.3 (25.2, 27.4)	26.0 (24.1, 27.9)	<0.001
Gender	Male (n=749)		Female (n=28)			0.96
	28.2 (28.1, 28.4)		28.3 (27.5, 29.1)			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.03
	28.4 (28.2, 28.6)	28.4 (28.1, 28.7)	27.7 (27.3, 28.1)	28.7 (28.3, 29.0)		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.80
	28.6 (28.1, 29.2)	28.1 (27.6, 28.5)	28.3 (28.1, 28.5)	28.1 (27.5, 28.7)		
Education categories ¹¹	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.03
	27.3 (26.4, 28.1)	28.5 (28.3, 28.7)	28.1 (27.7, 28.4)	28.5 (28.2, 28.8)		
Last dental visit ¹²	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)		0.07
	28.2 (28.0, 28.4)	28.6 (28.2, 28.9)		28.4 (27.7, 29.0)		
Phobia ¹²	No phobia (n=728)		Phobia (n=47)			0.53
	28.3 (28.1, 28.4)		27.7 (26.4, 29.0)			

There was evidence of a social gradient in the rank and education groups. By rank, there were differences between the NCO and Private ranks (Kruskal-Wallis, $p<0.05$), which could be expected by age. However, it was notable that the officers were not statistically different from private soldiers, despite their older age, suggesting a benefit conferred by officer rank. In the education categories, soldiers with “some secondary” education had fewer teeth than the other groups. (Kruskal-Wallis, $p=0.03$). However, unlike national (Whelton, 2007, O'Mullane and Whelton, 1992) and international surveys (Cooney, 2010, White et al., 2011, Lin et al., 2019, Public Health England., 2020, Peres et al., 2020) there were no differences by deprivation group, suggesting some benefit conferred by the Army system of care.

¹¹ 29 missing cases

¹² 1 missing case

4.2.2 Tooth loss

The minimum number of teeth in the sample was four teeth and there were no personnel who were edentulous. In 1990 the rate of edentulousness in the 35 to 44 years age group was 3.3% and in 2000 the rate was 4%, showing total tooth loss at a relatively young age for a subsection of the population (O'Mullane and Whelton, 1992, Whelton, 2007). Although data for age groups between 45 and 65 years was not reported in the national data in 2000, the rate of edentulousness increased to 40.9% in the 65 years or older age group, indicating a continued loss of teeth and accumulation of edentulousness in the 45 to 64 years age group. By contrast no personnel in the Army were edentulous in any of the age groups. These differences demonstrate the remarkable improvements in tooth retention that have occurred in the intervening years, at least for soldiers in the Irish Army.

The loss of teeth is a function of disease, with caries the main cause of tooth loss even in older age, and of treatment philosophy (Thorstensson and Johansson, 2010). These results suggest that improvements in tooth retention recorded since 2000 have been a result of a decrease in disease experience and a change from extraction-oriented practice resulting in retention of teeth into older age in soldiers. The most recent data in Ireland relating to community dwelling adults over 50 indicated they had a prevalence rate of edentulousness of 9.9% (Naseer, 2020) and a slightly lower rate of 6% was reported in a national survey using self-reported data reported in 2018 (Dept. of Health, 2018). These civilian data indicate a military effect that may be driven by the requirement for examinations periodically, earlier interventions in carious lesions and access to preventative advice and services that reduced the impact of caries in soldiers.

Figure 4-5 shows the relative frequency distribution of the number of teeth in the weighted sample to assess the number of respondents with limited numbers of teeth that might transition to edentulousness. In the sample, the next nearest number of teeth to four in the sample was sixteen teeth which implied that most soldiers would not become edentulous during military service. Although a Department of Defence (DOD) report stated that some soldiers had up to 43 years' service, the vast majority had far less with an average of 15 years for private soldiers and 19 years for corporals (these two rank groups formed 79% of the Army at the time of survey) (Dept. of Defence, 2018).

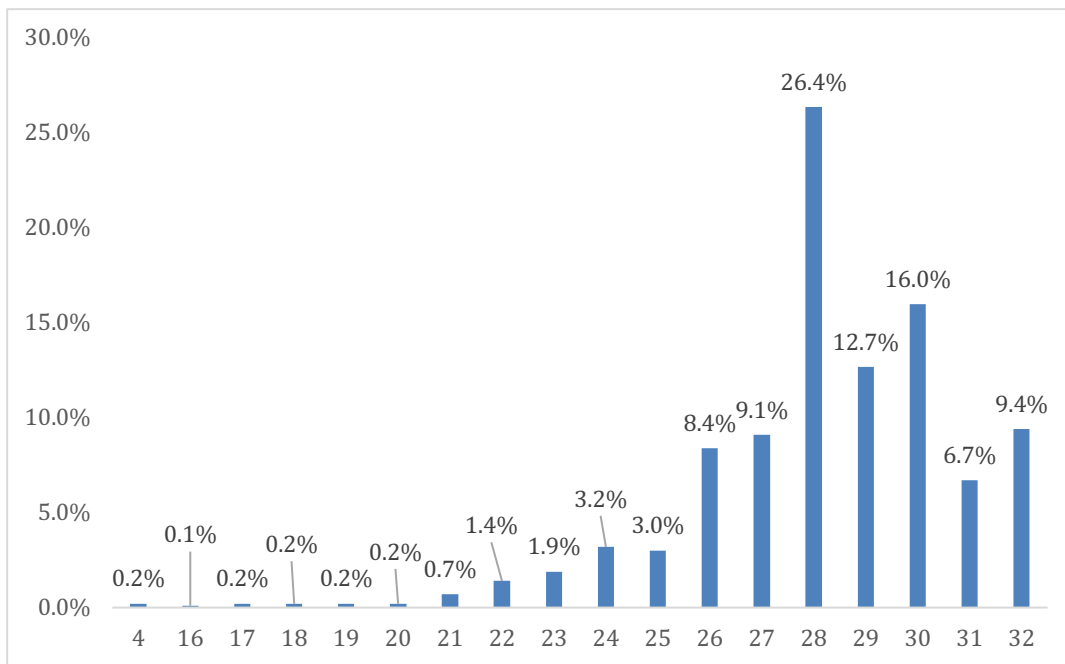


Figure 4-5: Relative frequency distribution of number of teeth, weighted sample (n=364)

4.2.3 Retention of ≥ 21 teeth (functional dentition)

4.2.3.1 Summary statistics

In the weighted and unweighted Army samples, 99.1% and 99.2% respectively had at least 21 teeth. The retention of ≥ 21 teeth is associated with the attributes of eating comfortably and socialising without embarrassment and is related to the number and distribution of teeth in a ‘functional dentition’ (Steele and O’ Sullivan, 2011). An effect of the high proportion of individuals retaining their natural teeth was that this had almost eliminated the requirement for dentures in the Army at the time of survey.

4.2.3.2 Comparison with previous surveys

The proportion with a functional dentition has not been reported in military studies and was reported by age group in the Irish national studies. In the absence of such data, the prevalence in the Army in 2020 and international surveys is displayed in Figure 4-6 and shows that the Army sample had similar levels of a ‘functional dentition’ when compared to adults in HIC. Notwithstanding the fact that the Army personnel were younger, the fact that 99% had sufficient teeth to have a functional dentition showed the improvements in oral health in Ireland of adult males in the last 30 years. It also shows that soldiers were being offered treatments that enabled them to avoid extraction and dentures as a solution to management of dental disease.

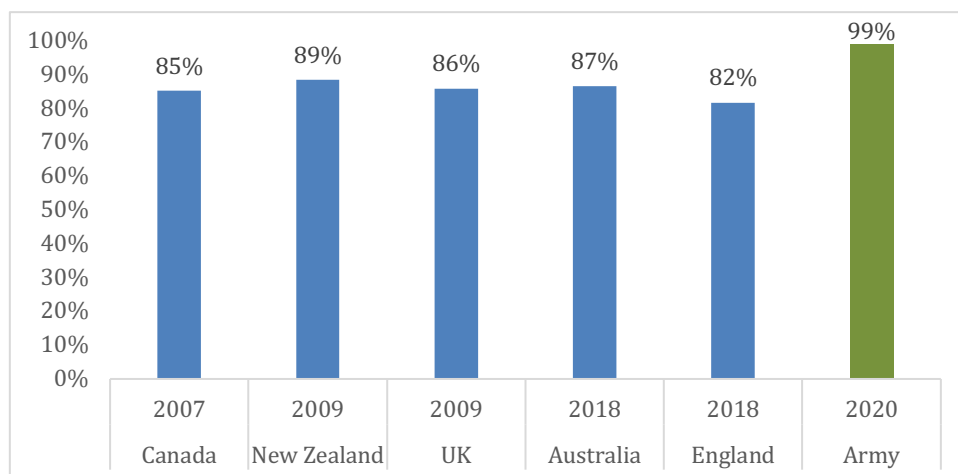


Figure 4-6: Percentage with 21 or more teeth in international civilian surveys and Army 2020 (weighted data, $n=364$)
(Cooney, 2010, Ministry of Health, 2010, Fuller et al., 2011, Jamieson et al., 2021, Public Health England., 2020)

4.2.3.3 Comparison between the new entrants and the trained strength

As displayed in Table 4-13 there was little difference in the percentage with 21 or more teeth ($\chi^2=0.22$, $df=1$, $n=777$, $p=0.12$) between the recruits and trained strength.

Table 4-13: Mean number of teeth in the weighted Army, trained strength and recruits

Group	n	≥21 teeth
Weighted Army	364	99.1%
Trained strength	553	98.9%
Recruits and cadets	224	100%

4.2.3.4 Prevalence of ≥21 teeth displayed by demographic variables and intermediate determinants of oral health

The percentage with a functional dentition of 21 or more teeth is displayed in Table 4-14 by the demographic variables and intermediate determinants of oral health. The proportion with 21 or more teeth decreased with age, as tooth loss progressed. There were no statistically significant differences between any of the other groups.

Table 4-14: Percentage with 21 or more teeth, demographic variables and intermediate determinants of oral health, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	100%	99.6%	99.2%	94.7%	94.4%	<0.001

Gender	Male (n=749)	Female (n=28)	p value
	99.2%	100%	0.63

Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	p value
	100%	99.2%	98%	100%	0.10

Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	p value
	100%	99.3%	99.2%	98.7%	0.91

Education categories ¹³	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	p value
	97.3%	99.7%	99.0%	100%	0.07

Last dental visit ¹⁴	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)	p value
	99.1%	100%	99.1%	0.64

Phobia ¹⁴	No phobia (n=728)	Phobia (n=47)	p value
	99.3%	97.9%	0.29

¹³ 29 missing cases

¹⁴ 1 missing case

4.2.4 Summary of tooth retention data

Soldiers in 2020 retained most teeth into older age, with a mean over 28 in the 18 to 45 years age groups reducing to over 26 teeth in the 45 to 64 years age groups. As such the results were markedly different from previous Army (Hayden, 1995), and national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) which showed progressive and severe tooth loss and showed the vast improvements in tooth retention since 1990. When compared with TILDA respondents (Naseer, 2020), soldiers had more teeth (25.9 95% CI [24.7, 27.1]) than civilians (21.3) and a greater proportion with 21 or more teeth (89.8% vs. 72.1%) which would suggest an additional benefit accruing from military service.

4.3 Sound and untreated natural teeth (SUNT)

4.3.1 Number of SUNT and percentage with ≥ 18 SUNT

The mean number of sound untreated natural teeth (SUNT) in the weighted and unweighted sample was 21.2 95% CI [20.55, 21.74] and 22.2 95% CI [21.79, 22.58] respectively, as displayed in Table 4-15. The minimum value in the sample was two and the maximum was 32 SUNT demonstrating the wide range of number of teeth in the sample affected by cavitated carious lesions or as a result of the wide range of dental treatment philosophies that exist in the management of non-cavitated carious lesions.

Table 4-15: Summary statistics, number of sound untreated teeth, weighted and unweighted Army samples

Data set	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	9.60×10^{-5}	364	21.2	20.6, 21.7	22	7	2	32
Unweighted	2.38×10^{-14}	777	22.2	21.8, 22.6	23	8	2	32

The cumulative percentages of SUNT in the weighted Army sample is displayed in Figure 4-7 and shows that 70.1% of personnel had 18 or more SUNT and only 7.6% had twelve or fewer SUNT. Overall, the data shows that not alone were personnel retaining more teeth but more of these teeth were also sound and untreated.

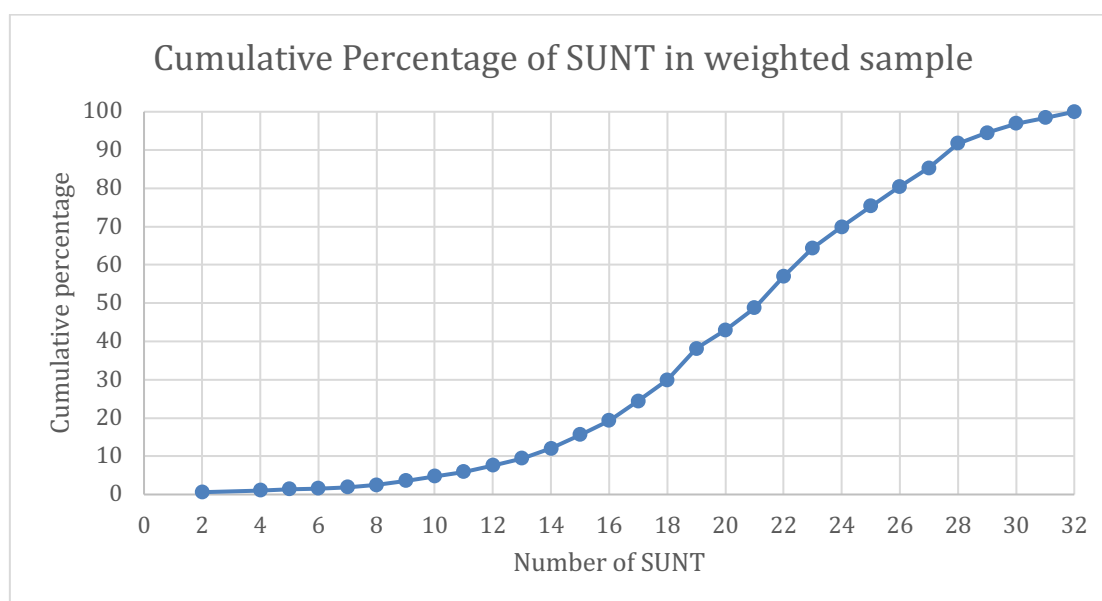


Figure 4-7: Cumulative percentages SUNT, weighted Army sample (n=364)

4.3.2 Comparison with previous surveys

The mean values of SUNT were not available for previous national or Army data. The results compared favourably with the reported population mean in the UK (17.9 SUNT) (Fuller et al., 2011) and New Zealand (16.5 SUNT) (Ministry of Health, 2010) but these surveys had vastly different demographic compositions. The percentage with 18 or more SUNT was reported by

age groups in previous Army (Hayden, 1995) and national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) . Little difference was present between this survey and previous surveys in the 18 to 24 years age group but the differences were greater in the older age groups and showed that the improvements in oral health in the intervening decades were not just in the retention of teeth but also in the retention of sound teeth, which may have been a result of lifetime fluoridation, changing treatment philosophies or access to services in the Army. For example, in the 35 to 44 years age group, 71.4% in the Army in 2020 had ≥ 18 SUNT whereas the percentage in the Army in 1990 was 29.5%. Soldiers in the 50 to 64 years age group in 2020 also compared favourably with age-matched civilians in the TILDA study in the retention of ≥ 18 SUNT as 51% of the former had ≥ 18 SUNT by comparison with 17.4% of the latter group (Naseer, 2020). The results suggest that benefits accrued to soldiers from an aspect of military service.

4.3.3 Comparison between new entrants and the trained strength

The mean number of SUNT and percentage with 18 or more SUNT respectively was greater in recruits (Mann-Whitney, $p < 0.001$) ($\chi^2 = 46.6$, $df = 1$, $n = 777$, $p < 0.001$) on entry than in the trained strength, as displayed in Table 4-16, as might be expected based on the age of the two groups. Within the Army system of care the decrease in SUNT over time may be a result of the expected increase in caries experience with age but may also be caused by a mandatory increase in exposure to dental services, some of whom may be using outmoded treatment philosophies or exposure to supplier-induced demand. The Army dental service has recognized that system aims can be complemented by the targeting of oral health improvements as intermediate health objectives, of which maintaining SUNT is a priority. Strategies to maintain SUNT include provision of sealants and other preventative therapies, patient education, setting the correct recall intervals and modifying payment schemes to encourage preventative rather than interventional procedures.

Table 4-16: Mean number of SUNT and percentage with 18 or more SUNT in the Army, trained strength and recruits

Group	n	Mean [95% CI] no SUNT	≥ 18 SUNT
Weighted Army	364	21.2 [20.6, 21.7]	70.1%
Trained strength	553	21.1 [20.5, 21.5]	74.7%
New entrants	224	25.1 [24.6, 25.6]	96%

4.3.4 SUNT displayed by demographic variables and intermediate determinants of oral health

The mean number of SUNT and the proportion with 18 or more SUNT are displayed in Table 4-17 and Table 4-18 by demographic variables and the intermediate determinants of oral health. The number and proportion of SUNT decreased with age, as has been reported in national (O'Mullane and Whelton, 1992, Whelton, 2007) and international surveys (Ministry of Health, 2010, Fuller et al., 2011). Social gradients were evident in the data as officers had a greater proportion with ≥ 18 SUNT and a higher mean number of SUNT than age-matched NCOs and the “some secondary” education group had the lowest proportion (59.5%). When analysed by last dental visit, the “within 12 months” group had fewer mean SUNT and a lower percentage with ≥ 18 SUNT, as might be expected from a treated population (Sheiham et al., 1985).

Table 4-17: Mean number of SUNT by demographic variables and intermediate determinants of oral health, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	24.7 (24.2, 25.2))	22.2 (21.5, 22.8)	19.7 (18.7, 20.6)	17.3 (15.8, 18.8)	17.3 (14.2, 20.5)	<0.001
Gender	Male (n=749)		Female (n=28)			0.11
	22.1 (21.7, 22.5)		23.7 (21.6, 25.8)			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		<0.001
	25.1 (24.6, 25.6)	21.7 (21.0, 22.4)	19.6 (18.8, 20.4)	22.3 (21.2, 23.4)		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.33
	23.0 (21.3, 24.7)	21.9 (21.1, 22.8)	22.2 (21.7, 22.6)	22.4 (20.8, 23.9)		
Education categories ¹⁵	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.001
	19.3 (17.9, 20.8)	23.6 (23.1, 24.1)	21.0 (20.1, 21.8)	22.3 (21.4, 23.2)		
Last dental visit ¹⁶	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		<0.001
	28.2 (28.0, 28.4)		28.6 (28.2, 29.9)	28.4 (27.7, 29.0)		
Phobia ¹⁶	No phobia (n=728)		Phobia (n=47)			0.38
	22.2 (21.8, 28.4)		21.5 (19.7, 23.3)			

¹⁵ 29 missing cases

¹⁶ 1 missing case

Table 4-18: Percentage with 18 or more SUNT by, demographic variables and intermediate determinants of oral health, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	94.4%	79.4%	71.4%	52.6%	44.4%	<0.001
Gender	Male (n=749)		Female (n=28)			0.50
	80.6%		85.7%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		<0.001
	96%	79.5%	63.4%	86.2%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.93
	84.6%	80.3%	80.8%	79.7%		
Education categories ¹⁷	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		<0.001
	59.5%	89.9%	74%	81.9%		
Last dental visit ¹⁸	<12 months (n=567)		12 to 24 months (n=100)		>24 months (n=109)	0.04
	78.7%		86%		87.2%	
Phobia ¹⁸	No phobia (n=728)		Phobia (n=47)			0.15
	81.3%		72.9%			

4.3.5 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of ≥ 18 SUNT and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=134.2$, $df=13$, $p<0.001$), explained 26% of the variance in ≥ 18 SUNT and correctly classified 81.8% of the cases. The results are displayed in Table 4-19 and show that rank, education and age were statistically significant. The social gradients evident in the descriptive data were present in logistic regression as the proportion of officers with ≥ 18 SUNT was not different from New Entrants, even when adjusted for age, and showed the benefit accruing to officer rank. Similarly, higher education was independently associated with retaining a greater proportion of ≥ 18 SUNT.

¹⁷ 29 missing cases

¹⁸ 1 missing case

Table 4-19: Binary logistic regression of ≥ 18 SUNT, unweighted Army (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.2 (0.1, 0.5)	<0.001
	NCO	0.1 (0.1, 0.4)	<0.001
	Officer	0.5 (0.2, 1.8)	0.26
Deprivation	<1 SD	Baseline	
	± 1 SD	1.0 (0.6, 1.7)	0.87
	>1 SD	0.7 (0.3, 1.7)	0.45
	Outside State	0.6 (0.2, 1.9)	0.39
Education ¹⁹	Some secondary	Baseline	
	Completed secondary	4.5 (2.3, 9.0)	<0.001
	Some college	3.6 (1.8, 7.3)	<0.001
	Honours degree or Masters	2.9 (1.2, 6.9)	0.01
Last dental visit ²⁰	Within 12 months	Baseline	
	12 to 24 months	1.0 (0.5, 2.1)	0.92
	Over 24 months	1.6 (0.8, 3.4)	0.19
Age		0.95 (0.92, 0.97)	<0.001
Gender		1.4 (0.4, 4.5)	0.52

¹⁹ 29 missing cases

²⁰ 1 missing case

4.4 Dental caries

Dental caries, and its sequelae, are the primary cause of dental emergency appointments on deployment (Chaffin and Moss, 2008) and the Army expends considerable time and resources in the management of caries to minimize this problem. In 1990 the epidemiology suggested that soldiers had higher numbers of decayed teeth than civilian peers (Hayden, 1995). In the interim decay rates have decreased in the civilian population in Ireland, at least for those groups available for inspection (Whelton, 2007, Harding, 2016, Naseer, 2020), and Dental Officers have reported a decrease in the decay experience of serving soldiers. However, Dental Officers reported a significant proportion of recruits had caries on entry and surveys of Irish children living with deprivation continue to report higher decay prevalence than their peers (Harding, 2016). For some recruits, caries remains a problem and the data reported below will allow the service to determine the effectiveness of dental caries treatment programmes and to plan for the delivery of care.

4.4.1 Prevalence of decayed teeth

4.4.1.1 Summary statistics

The prevalence of untreated decayed teeth in the weighted sample was 16% and in the unweighted sample was 22%. In the sample, 75.9% of the caries in the weighted sample was primary caries and 24.1% was secondary decay and in the unweighted sample the percentages were 81% and 19%, respectively. The relative frequency distribution of decayed scores in the weighted Army sample is displayed in Figure 4-8. In the weighted sample 83.9% had no decayed teeth, 10.7% had one decayed tooth, 1.6% had two decayed teeth and 3.8% had three or more decayed teeth.

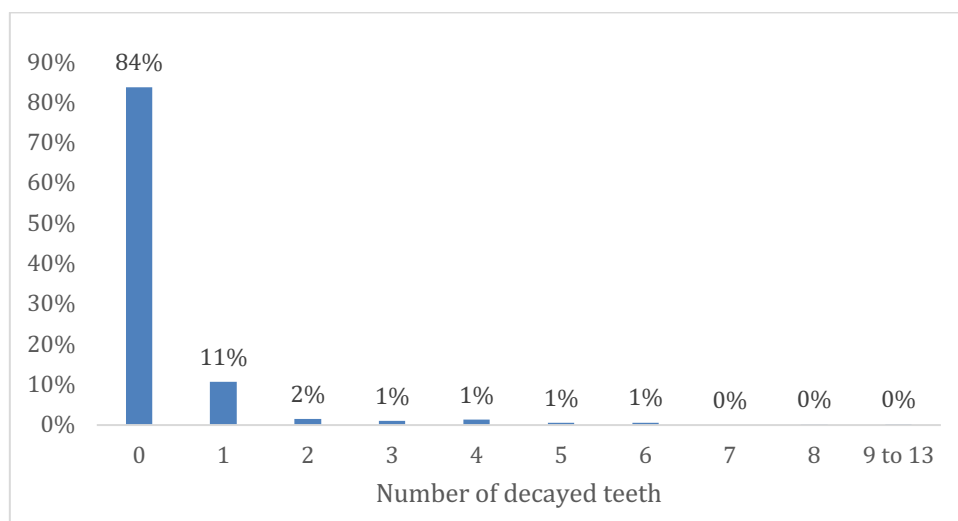


Figure 4-8: Relative frequency distribution of DT in weighted Army sample (n=364)

4.4.1.2 Comparison with previous surveys

Limited national data exists that may be used to compare with the Army results and is confined to reporting by selected age groups from studies conducted over 30 and 20 years ago, so comparisons to Irish national must be made with caution (O'Mullane and Whelton, 1992, Whelton, 2007). The prevalence of untreated decayed teeth compared favourably with international civilian surveys, as displayed in Figure 4-9. International evidence suggests that decay experience has peaks in the teenage years and in older age (Peres et al., 2019), which might suggest that a population group such as the Army with a higher proportion who are very young would have a higher prevalence of untreated decay. Instead, the results showed that the decay experience was lower in the Army than in international surveys, which showed that the Army system of care was effective in managing disease activity, at least by comparison with international civilian populations in high-income countries.

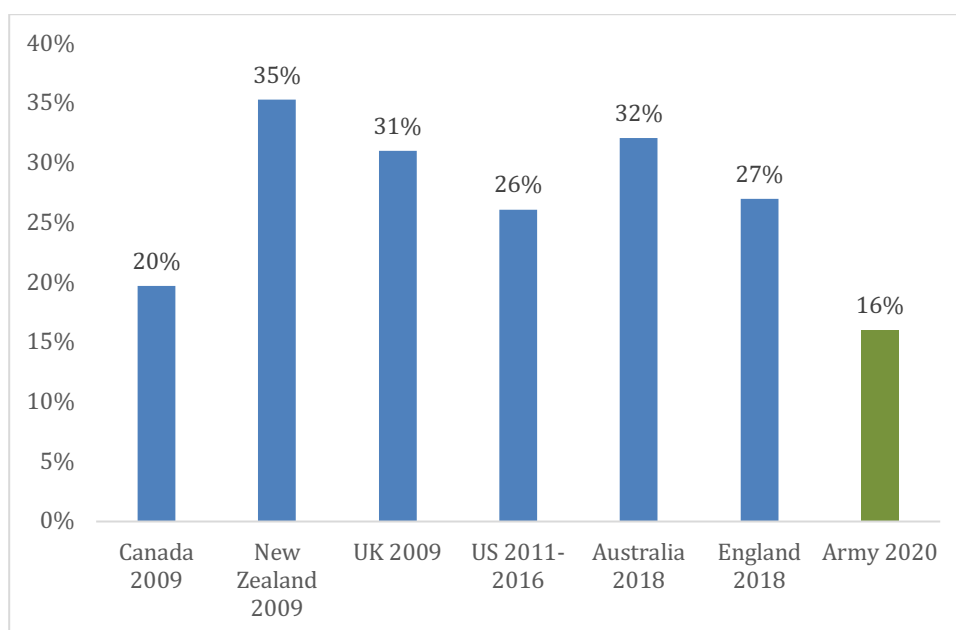


Figure 4-9: Prevalence of DT in international studies and Army 2020 (Cooney, 2010, Ministry of Health, 2010, White et al., 2011, CDC, 2019, Public Health England., 2020, Jamieson et al., 2021)

4.4.1.3 Comparison between new entrants and the trained strength

The prevalence of decayed teeth in the trained strength and new entrants is displayed in Table 4-20. There was a statistically significant difference in the prevalence ($\chi^2=57.6$, $df=1$, $n=777$, $p<0.001$) which showed that while a large proportion of new recruits and cadets were caries free, those with caries experience had had their decay largely untreated prior to entry to the army. For a proportion of the trained strength (14.8%), dental caries persisted despite regular access to dental care.

Table 4-20: Prevalence of DT in the weighted Army, trained strength and new entrants

Group	n	DT >0
Weighted Army	364	16.1%
Trained strength	553	14.8%
New entrants	224	39.7%

4.4.1.4 Prevalence of DT by demographic variables and intermediate determinants of oral health

The prevalence of decayed teeth by demographic and intermediate determinants of oral health is displayed in Table 4-21. There were statistically significant differences in the distribution between the New Entrants and other ranks ($\chi^2=62.6$, $df=3$, $n=777$, $p<0.001$), which reflected the large number of untreated new entrants. By age, the differences between the 18 to 24 years age group and other groups ($\chi^2=36.1$, $df=4$, $n=777$, $p<0.001$) may be understood by the inclusion of many new entrants in the youngest age group. A social gradient was evident in the education category with a higher caries experience in the “some secondary” category ($\chi^2=16.1$, $df=3$, $n=777$, $p<0.001$) and the “Outside State” deprivation category ($\chi^2=13.9$, $df=3$, $n=777$, $p=0.003$). The results accorded with international findings of associations between markers of deprivations and the prevalence of caries (Cooney, 2010, Ministry of Health, 2010, White et al., 2011, Peres et al., 2020). Patients with phobia also had a greater prevalence of decayed teeth, as has been reported elsewhere (Hallstrom and Halling, 1984, Heidari et al., 2017). An important finding was the high prevalence of untreated decayed teeth in respondents who hadn’t attended in over 12 months ($\chi^2=39.1$, $df=2$, $n=776$, $p<0.001$). These findings have important implications for dental fitness and attendance in the Army in light of deployment requirements.

Table 4-21: Prevalence of decayed teeth by demographic and intermediate determinants of oral health, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	33.4%	16.7%	14.3%	14%	5.6%	<0.001
Gender	Male (n=749)		Female (n=28)		0.08	
	21.5%		35.7%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	<0.001	
	39.7%	18.9%	10.9%	11.5%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	<0.003	
	41%	27%	20.5%	13.9%		
Education categories ²¹	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	0.002	
	36.5%	24.6%	15.6%	18.1%		
Last dental visit ²²	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)	<0.001		
	16.4%	36%	38.5%			
Phobia ²²	No phobia (n=728)		Phobia (n=47)		0.02	
	21.2%		36.2%			

4.4.1.5 Binary logistic regression DT>0

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of decayed teeth and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=87.8$, $df=13$, $p<0.001$), explained 17% of the variance in DT>0 and correctly classified 77.8% of the cases. The results are displayed in Table 4-22 and show that rank, education and dental visiting were statistically significant. All the rank categories were statistically significantly lower when compared with new entrants, as would be expected following exposure to the Army system of care. Social gradients were evident in the education categories, although the odds ratios were lower in all the groups relative to the “some secondary” group, only the “completed secondary” group was statistically significant. In the dental visiting category, respondents who hadn’t attended in over 12 months were about twice as likely to have decayed teeth and support the findings of the descriptive data. Since dental recall is set by risk, these finding

²¹ 29 missing cases

²² 1 missing case

suggest that a standard recall of greater than 12 months is not adequate to maintain soldiers at readiness for deployment.

Table 4-22: Binary logistic regression of DT>0, unweighted Army (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.4 (0.3, 0.8)	0.003
	NCO	0.3 (0.1, 0.6)	0.001
	Officer	0.2 (0.1, 0.6)	0.004
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.5, 1.2)	0.28
	>1 SD	0.5 (0.2, 1.0)	0.06
	Outside State	1.1 (0.5, 2.6)	0.81
Education ²³	Some secondary	Baseline	
	Completed secondary	0.5 (0.3, 0.9)	0.01
	Some college	0.6 (0.3, 1.2)	0.14
	Honours degree or Masters	0.7 (0.3, 1.0)	0.29
Last dental visit ²⁴	Within 12 months	Baseline	
	12 to 24 months	2.1 (1.3, 3.5)	0.004
	Over 24 months	2.5 (1.6, 4.1)	0.001
Age		0.99 (0.96, 1.0)	0.71
Gender		0.70 (0.29, 1.6)	0.40

The prevalence of decayed teeth was greater in patients with phobia than in patients without phobia and the differences were statistically significant. Phobia was added to the above model, which remained statistically significant ($\chi^2=89.2$, df=14, $p<0.001$). The presence of phobia was associated with an increased risk of decayed teeth ($p<0.001$), with an odds ratio of 2.5 95% CI [1.5, 4.0]. As such the results were in agreement with international findings and show the need for enhanced prevention in this group (Hallstrom and Halling, 1984, Heidari et al., 2017).

²³ 29 missing cases

²⁴ 1 missing case

4.4.2 Mean number of decayed teeth

4.4.2.1 Summary statistics

The summary statistics for the number of decayed teeth in the Army is displayed in Table 4-23. The mean values in the weighted and unweighted samples were 0.3 95% CI [0.2, 0.4] and 0.6 95% CI [0.5, 0.7] respectively and show the very low level of active decay in the Army. In both cases the samples were not normally distributed, with Kolmogorov-Smirnov test p-values less than 0.05. The median value was 0 IQR 0 in both the weighted and unweighted samples. The minimum number of decayed teeth in the sample was zero and the maximum value was thirteen, showing the wide range of values present.

Table 4-23: Summary statistics, decayed score, weighted and unweighted Army samples

Data set	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	5.11×10^{-226}	364	0.3	0.2, 0.4	0	0	0	13
Unweighted	5.52×10^{-25}	777	0.6	0.5, 0.7	0	0	0	13

4.4.2.2 Comparison with previous surveys

As was the case for the prevalence data, national data do not exist that can be used to compare with these results as such data was reported by age groups over 20 years ago (O'Mullane and Whelton, 1992, Whelton, 2007). The mean number of untreated decayed teeth compared favourably with international civilian surveys, as displayed in Figure 4-10. These results may be seen within the context of an Army system that compelled soldiers to be free of caries and fit for duty, particularly deployment, at points in their career.

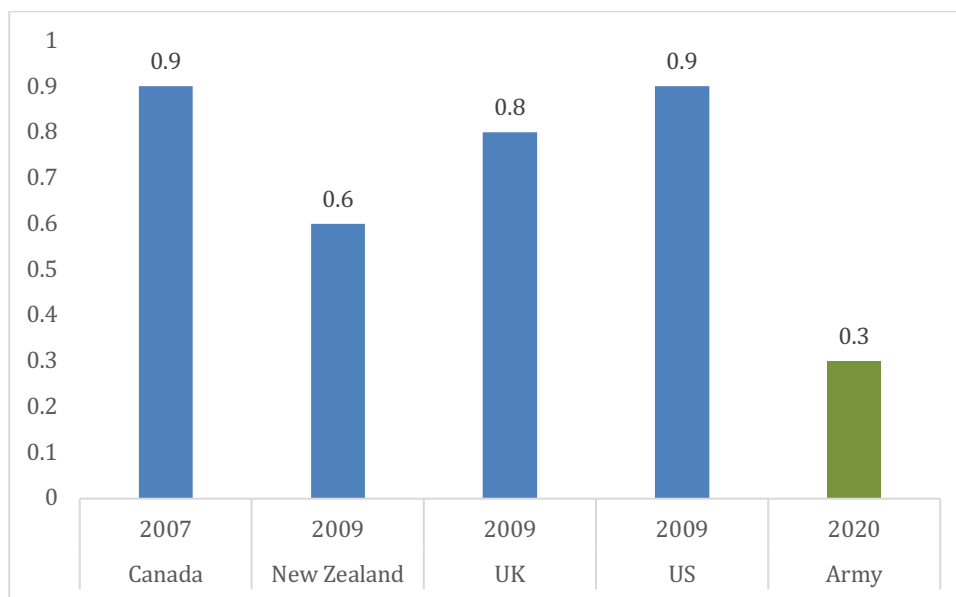


Figure 4-10: Mean DT scores in international studies and Army 2020 survey (Cooney, 2010, Ministry of Health, 2010, White et al., 2011) (CDC, 2019)

4.4.2.3 Comparison between new entrants and the trained strength

The mean number of DT in the trained strength and the recruits is displayed in Table 4-24.

The results show the higher mean number of decayed teeth in new entrants when compared to serving personnel (Mann-Whitney, $p < 0.001$), which reflected the untreated status of many of this group.

Table 4-24: Mean number of DT and prevalence of DT>0 in Army, trained strength and recruits

Group	n	Mean [95% CI] no DT
Weighted Army	364	0.3 [0.2, 0.4]
Trained strength	553	0.3 [0.2, 0.3]
Recruits and cadets	224	1.4 [1.1, 1.7]

Figure 4-11 displays the mean values in the trained strength of the Irish Army, the results from the deployed battalion in 1991 and results from military publications in high-income countries for comparison. The most important comparison was between the Irish deployed battalion from 1991 and the survey in 2020 which showed the large decrease that occurred in the intervening decades, which might be attributable to lifetime community water fluoridation for many soldiers or changing dietary patterns. However, the fact that 14.8% of the trained strength continue to experience tooth decay, suggests greater efforts on prevention and targeting moderate and high-risk groups are required within the Army dental service. Within the context of these reports, the number of untreated decayed teeth in the Irish Army was lower in the trained strength than most international military surveys, which indicated that the system was relatively successful in achieving its goal of treating disease.

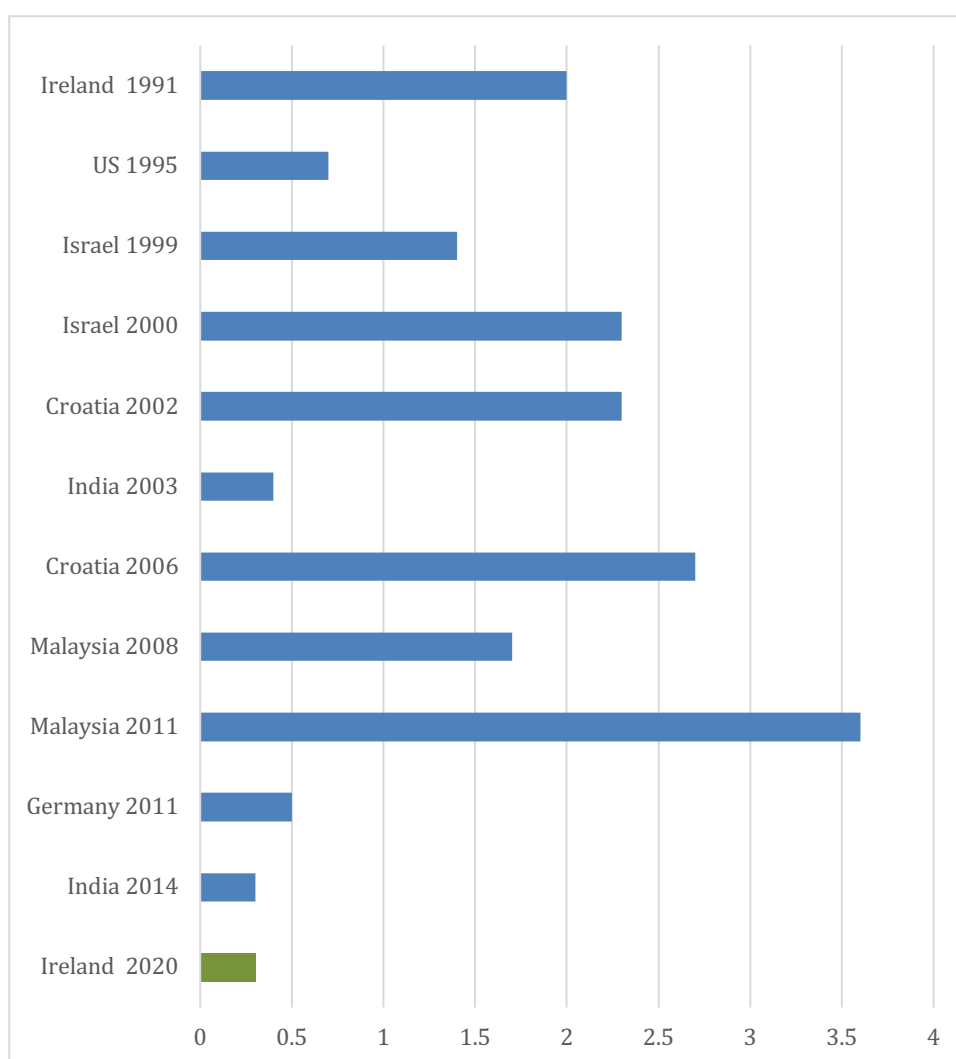


Figure 4-11: Mean number of decayed teeth, trained strength, international military surveys and Irish Army 2020 (York et al., 1995, Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000, Skec et al., 2002, Ahuja and Darekar, 2003, Jasmin and Jaafar, 2011, Ziebolz et al., 2011, Patankar, 2014, Wahid et al., 2014)

The mean number of decayed teeth is displayed in Figure 4-12 from 16 HIC and LMIC reporting on recruit oral health. The mean number of untreated decayed teeth in the recruits showed a wide variation with no particular pattern in the international reports reflecting differing trends in dental disease in HIC and LMIC internationally. The results in the Irish Army were similar to that reported in HIC including the Finnish Army (Tanner et al., 2013), but lower than that reported in the UK (Elmer et al., 2011) and about twice as high as reports from Switzerland (Röthlisberger et al., 2007) and New Zealand (Naysmith et al., 2023). Limited risk factor data published with these reports makes effective comparison impossible and further research is required on this topic.

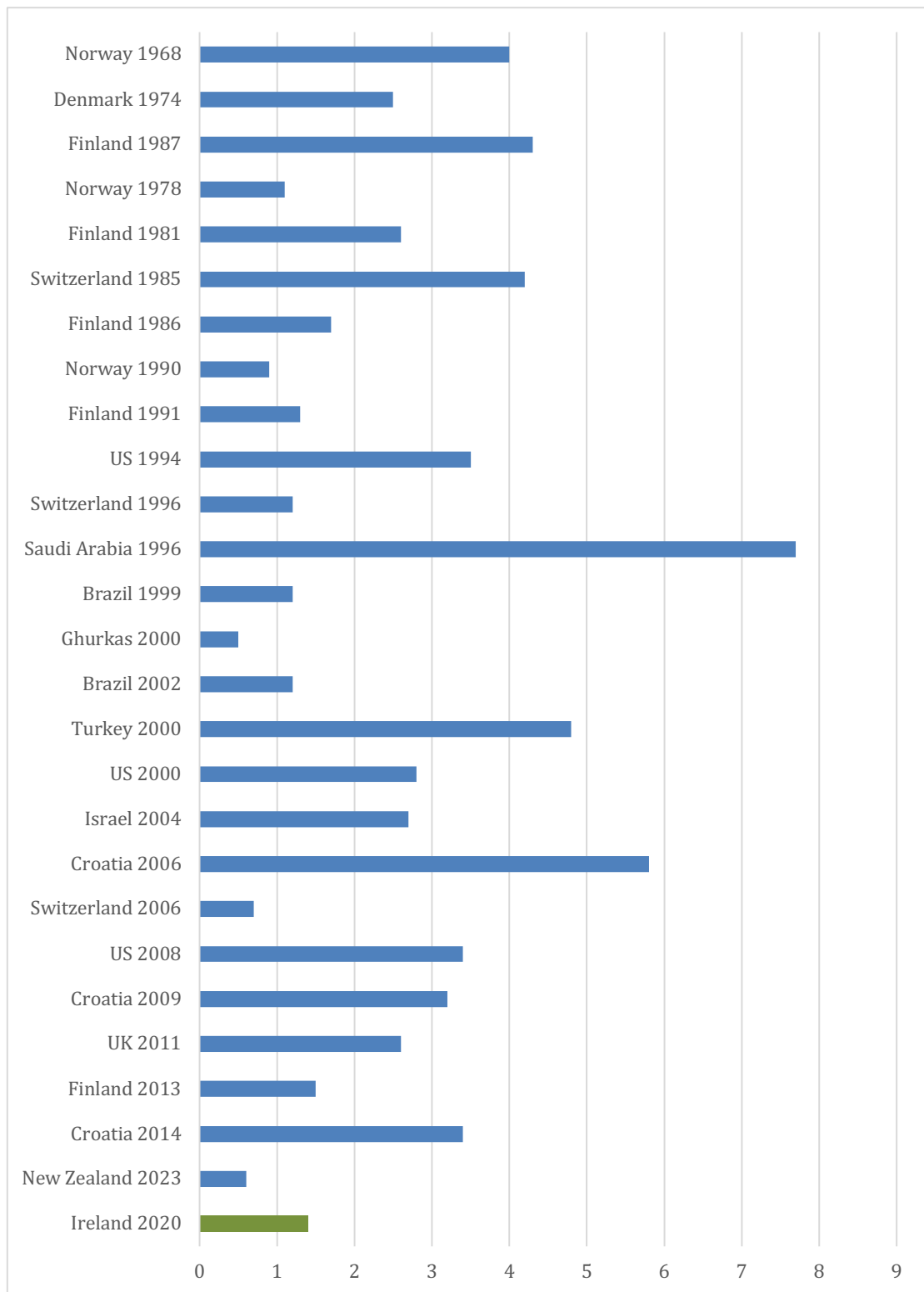


Figure 4-12: Mean number of decayed teeth, recruits, international military studies and Ireland 2020 (Antoft et al., 1974, Asmyhr et al., 1994, Johansson et al., 1996, Lewsey et al., 2000, Ceylan et al., 2004, Levin and Shenkman, 2004, Bastos et al., 2007, Röthlisberger et al., 2007, Badel et al., 2009, Elmer et al., 2011, Tanner et al., 2013, Spalj et al., 2014, Naysmith et al., 2023)

4.4.2.4 Decayed teeth presented by demographic variables and intermediate determinants of oral health

The mean number of decayed teeth in the demographic and intermediate determinants are displayed in Table 4-25. The new entrants had more decayed teeth (Kruskal-Wallis, $p < 0.001$) than other groups and was statistically different from the other groups in pair-wise analysis. In the deprivation groups, soldiers from outside the Republic of Ireland had more carious teeth than those living within 1 SD of the mean (Kruskal-Wallis, $p < 0.009$) and those living >1 SD above the mean (Kruskal-Wallis, $p < 0.003$). These soldiers with home addresses outside Ireland include many living in Northern Ireland where local dental services are not funded by the Army. These and other factors, such as a lack of community water fluoridation, may hamper efforts to reduce decay experience in this group.

Table 4-25: Mean number of decayed teeth by demographic and intermediate determinants of oral health, unweighted Army ($n=777$)

Age groups	18 to 24 years ($n=287$)	25 to 34 years ($n=282$)	35 to 44 years ($n=133$)	45 to 54 years ($n=57$)	>55 years ($n=18$)	p value
	1.1 (0.9, 1.4)	0.3 (0.2, 0.4)	0.3 (0.1, 0.4)	0.2 (0.0, 0.4)	0.1 (0.0, 0.2)	<0.001
Gender	Male ($n=749$)		Female ($n=28$)		>0.05	
	0.6 (0.5, 0.7)		1.1 (0.4, 1.9)			
Rank groups	New entrant ($n=224$)	Private ($n=264$)	NCO ($n=202$)	Officer ($n=87$)	<0.001	
	1.4 (1.1, 1.7)	0.4 (0.2, 0.5)	0.2 (0.1, 0.3)	0.2 (0.0, 0.3)		
Deprivation categories	Outside State ($n=39$)	<1 SD below mean ($n=137$)	± 1 SD of mean ($n=522$)	>1 SD above mean ($n=79$)	0.001	
	1.4 (0.5, 2.2)	0.9 (0.6, 1.2)	0.5 (0.4, 0.6)	0.5 (0.1, 0.8)		
Education categories ²⁵	Some secondary ($n=74$)	Completed secondary ($n=338$)	Some College ($n=192$)	Honours degree/ Masters ($n=144$)	<0.001	
	1.2 (0.6, 1.8)	0.7 (0.6, 0.9)	0.3 (0.2, 0.4)	0.4 (0.2, 0.6)		
Last dental visit ²⁶	<12 months ($n=567$)	12 to 24 months ($n=100$)		>24 months ($n=109$)	<0.001	
	0.4 (0.3, 0.5)	1.0 (0.6, 1.4)		1.2 (0.8, 1.7)		
Phobia ²⁶	No phobia ($n=728$)		Phobia ($n=47$)		0.01	
	0.6 (0.4, 0.7)		1.2 (0.5, 1.8)			

²⁵ 29 missing cases

²⁶ 1 missing case

Gradients by education were present as soldiers with “some secondary” education had more decayed teeth than the “some college” (Kruskal-Wallis, $p<0.001$) and “Honours degree or Masters” (Kruskal-Wallis, $p<0.005$), groups. Generally, the results concurred with the conclusions of national (O'Mullane and Whelton, 1992, Whelton, 2007) and international reports (Cooney, 2010, Ministry of Health, 2010, White et al., 2011, Peres et al., 2020) of greater disease experience of those living with disadvantage. The results of the mean number of teeth by dental visit mimicked the results of the prevalence data with a lower mean number in recent attenders and was suggestive of the need for regular recall in the military setting.

4.4.3 Teeth missing as a result of caries

4.4.3.1 Summary statistics

Teeth missing as a result of caries represents the intersection of the carious destructive process and treatment options available to patients at the time of diagnosis. In particular, funded endodontic therapy in molar teeth was not available for the bulk of personnel and the effect on tooth retention of this policy was unknown. The results of the mean number of teeth present reported above indicate that this value was likely to be small in the Army and the effect on subgroups will be discussed in the chapter on determinants of oral health.

In this survey attempts were made by examiners to exclude teeth extracted as a result of orthodontic therapy or as a result of trauma, made considerably easier by the reduction in extractions in orthodontic therapy in recent years (Bradley, 2013, Elias et al., 2024). It was also necessary to consider how to exclude teeth missing as a result of periodontal disease. The young age of most participants reduced the likelihood of error in this part of the assessment. The overall low number of teeth lost means that the number of missing teeth reported in this survey is likely to approximate the number of missing teeth as a result of caries.

The summary statistics for teeth missing due to caries in the weighted and unweighted Army sample are displayed in Table 4-26. The mean number of missing teeth was 1.4 95% CI [1.1, 1.6] in the weighted sample and the median value was 0 IQR 2, indicating that the majority of personnel had not lost teeth as a result of caries. These results were a vast improvement on the results of the last national surveys with mean tooth loss of 1.6 teeth in 16 to 24 year old and 5.7 teeth in 35 to 44 year old respondents in 2000 (Whelton, 2007). The minimum values in the Army sample were zero and the maximum value was twenty-eight teeth but no personnel had complete tooth loss whereas 0.9% of 35- to 44-year-old respondents were edentulous in 2000 and the proportion increased with age to 40.9% of the 65 years or older age group.

Table 4-26: Summary statistics, missing teeth, weighted and unweighted Army sample

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	2.78×10^{-78}	364	1.4	1.1, 1.6	0	2	0	28
Unweighted	9.03×10^{-216}	777	1.1	0.9, 1.2	0	2	0	28

The frequency distribution of number of missing teeth in the weighted Army sample is displayed in Figure 4-12. In the weighted sample 51.6% did not have a tooth extracted as a result of caries, which shows the remarkable reduction in the impact of caries since the last civilian survey was carried out in 2000. The data were strongly skewed and in the weighted

sample, 90.6% had three or fewer missing teeth and 99% had eight or fewer missing teeth, with severe tooth loss confined to a very small number of people in the sample (eight of 777 respondents had nine or more missing teeth).

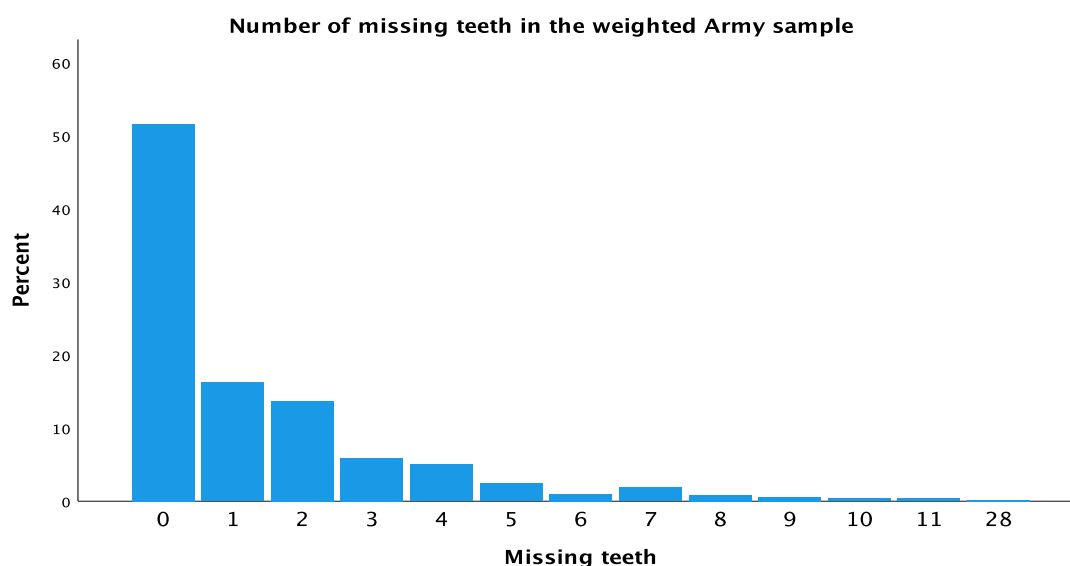


Figure 4-9: Relative frequency distribution of missing teeth in the weighted Army sample (n=364)

4.4.3.2 Comparison between new entrants and the trained strength

The mean number and prevalence of missing teeth as a result of caries is displayed in Table 4-27 for new entrants and the trained strength. There was a statistically significant difference between the two groups in both mean (Mann-Whitney, $p < 0.001$) and prevalence ($\chi^2 = 100.1$, $df = 1$, $p < 0.001$), which indicated that for the majority, tooth loss predominantly happened during military service. This may have reflected a change in access to dental care on joining the Army and the result of dental treatment. Decisions to extract teeth are multifactorial reflecting disease related issues of advanced decay and the end stage of the restorative cycle, prosthodontic related factors and patient factors including dental phobia, preference for extractions over root canal treatment and the means and willingness to pay (Richards et al., 2005, Broers et al., 2010, Broers et al., 2022). The data provide baseline data that can be used to assess whether strategies to reduce tooth loss have been effective in the Army, bearing in mind the complexity underpinning tooth loss as described above.

Table 4-27: Mean number of missing teeth, Army, trained strength and recruits

Group	n	Mean [95% CI] no MT	MT>0 (p<0.001)
Weighted Army	364	1.4 [1.1, 1.6]	48.4%
Trained strength	553	1.4 [1.2, 1.6]	49.7%
New entrants	224	0.2 [0.1, 0.3]	11.2%

The mean number of missing teeth in the Irish Army deployed battalion in 1991, the present study (Irish Army 2020) and international surveys are displayed in Figure 4-13. The Army data in 2020 was considerably lower than that reported in 1991 and suggestive of overall improvements in oral health in Ireland and in the Army in the interim. Ireland has had mandatory fluoridation of the public water supplies since 1964 (O’Sullivan, 2015). It has been suggested that this, plus access to fluoridated toothpastes provides a large explanation for the trends in decline of decayed teeth and associated dental extractions in the Irish population (O’Sullivan, 2015). The mean values in the trained strength were also lower than those reported in international civilian studies (Cooney, 2010, Ministry of Health, 2010, CDC, 2019). Considering the relatively high prevalence of caries recorded in some recruits, these data are testament to the power of free basic dental care in retaining teeth in a population.

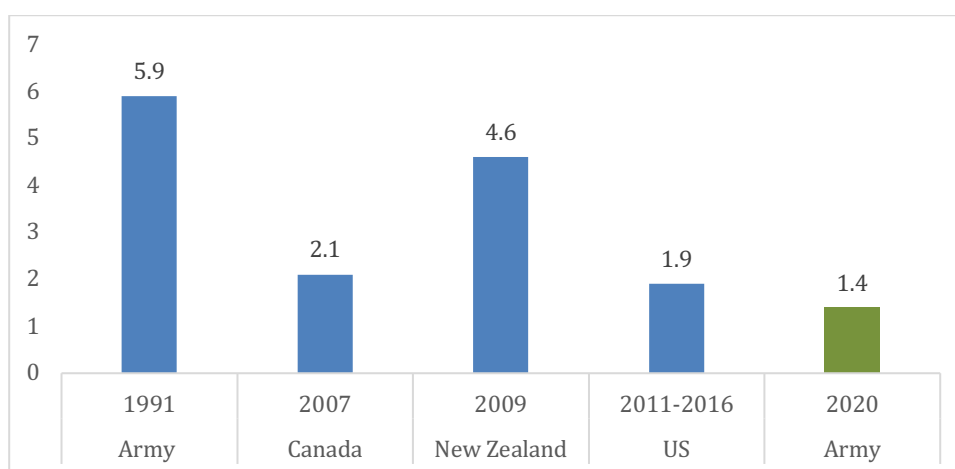


Figure 4-13: Mean number of missing teeth, Army 1991, international surveys and Army 2020 (Cooney, 2010, Ministry of Health, 2010, CDC, 2019)

The mean number of teeth in the trained strength of the international military compared to the Irish army data is displayed in Figure 4-14. With the exception of India (Ahuja and Darekar, 2003, Patankar, 2014), those countries that displayed a lower mean number of missing teeth than in the Irish Army in 2020 had a higher mean number of decayed teeth, indicating untreated populations. Given the time span, age and other differences the data trends should to be interpreted with caution.

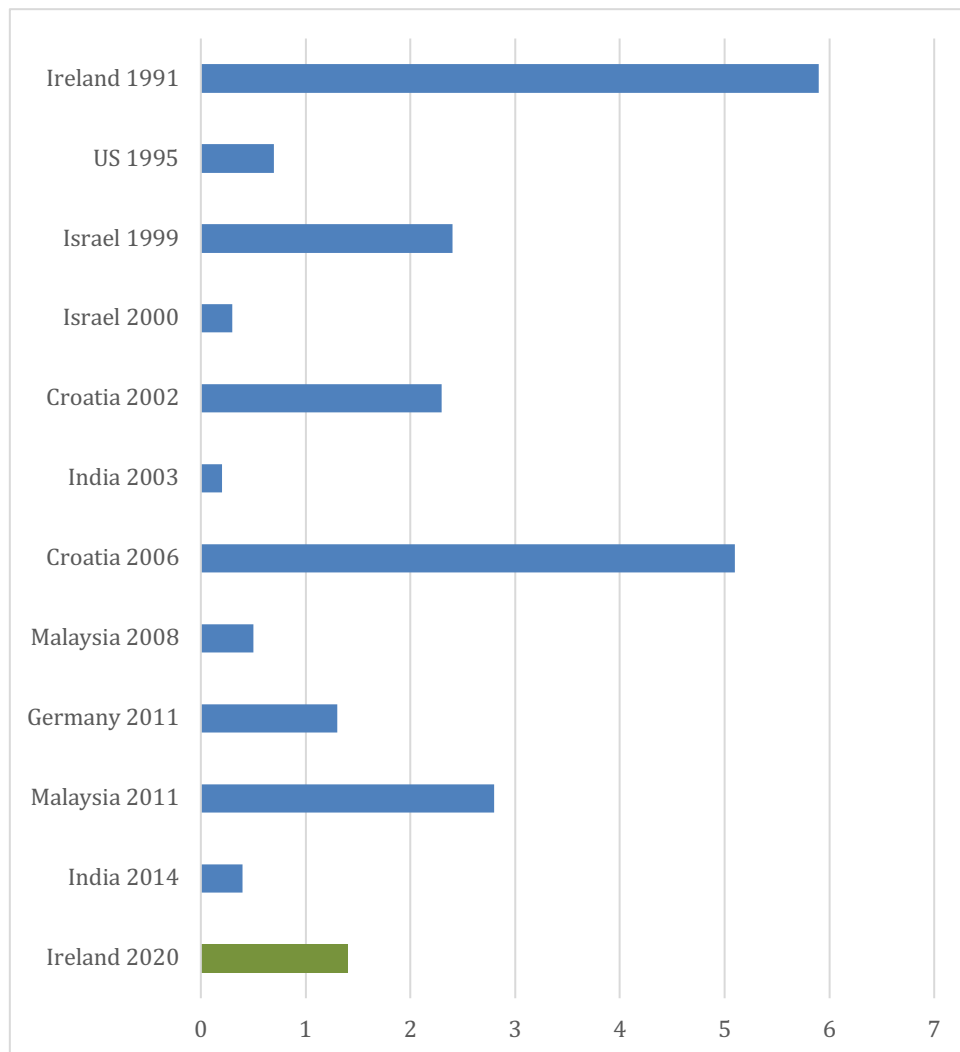


Figure 4-14: Mean number of missing teeth as a result of caries, trained strength, international military and Irish Army 2020 (York et al., 1995, Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000, Skec et al., 2002, Ahuja and Darekar, 2003, Jasmin and Jaafar, 2011, Ziebolz et al., 2011, Patankar, 2014, Wahid et al., 2014)

The mean number of missing teeth as a result of caries in new entrants in the Irish Army and international military recruits is displayed in Figure 4-15. Many of these countries showed a decrease in the number of missing teeth over time but with a plateauing of effect when the number fell below 0.5 missing teeth in countries including Switzerland (Röthlisberger et al., 2007) and Finland (Tanner et al., 2013) that may indicate an irreducible minimum. The mean number of missing teeth was low in Ireland in 2020 by comparison with most other countries but it must be borne in mind that the prevalence of decay in Irish recruits may partly have been a result of the large untreated component. Nonetheless, the overall low mean number demonstrates that the loss of teeth as a result of caries was an uncommon finding in recruits in Ireland and other high-income countries in recent years.

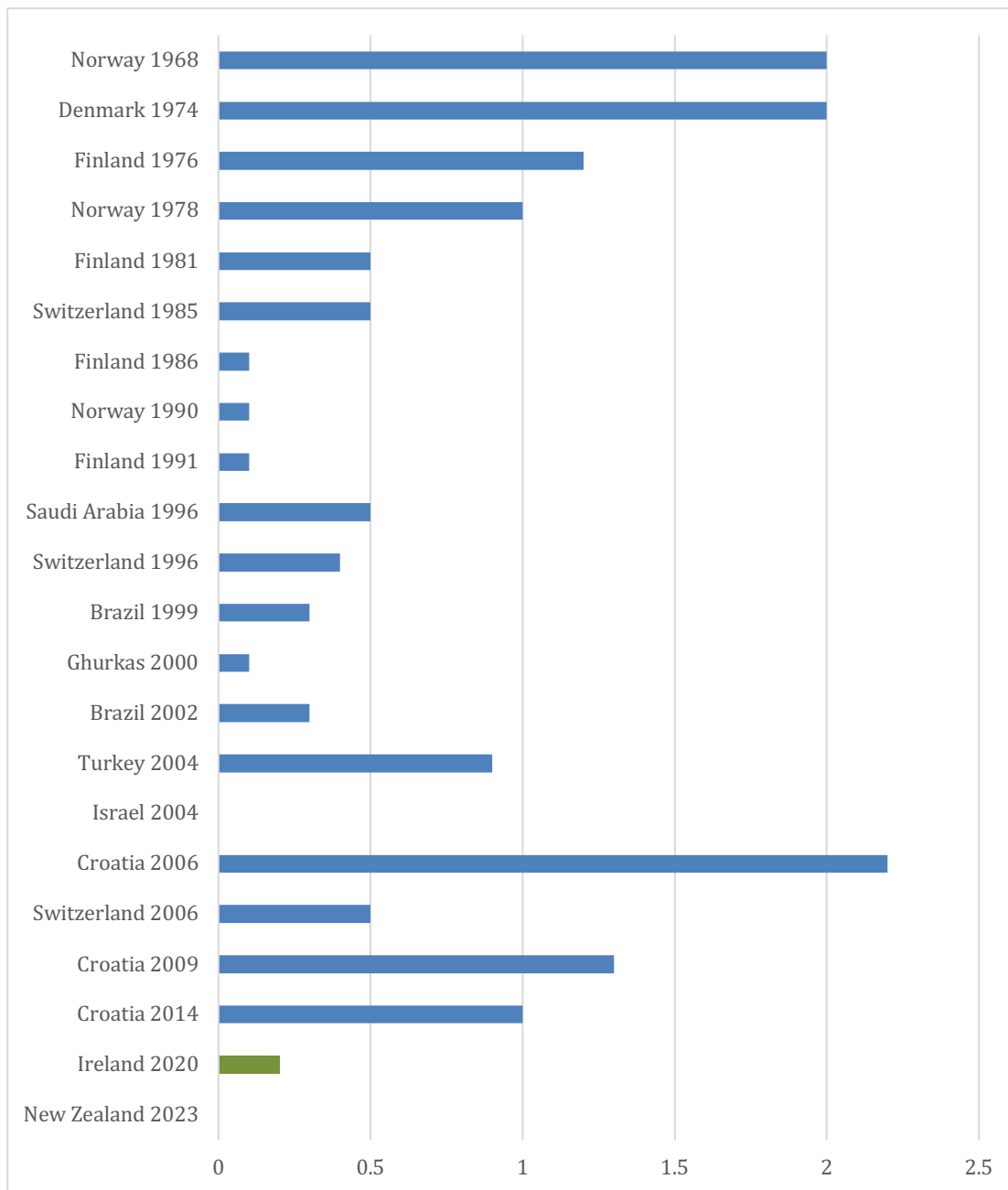


Figure 4-15: Mean number of missing teeth as a result of caries, recruits in international military and Irish Army 2020 (Antoft et al., 1974, Asmyhr et al., 1994, Johansson et al., 1996, Lewsey et al., 2000, Ceylan et al., 2004, Levin and Shenkman, 2004, Bastos et al., 2007, Röthlisberger et al., 2007, Badel et al., 2009, Elmer et al., 2011, Tanner et al., 2013, Spalj et al., 2014, Naysmith et al., 2023)

4.4.3.3 Missing teeth reported by demographic variables and intermediate determinants of oral health

The mean and prevalence of missing teeth as a result of caries is displayed in Table 4-28 and Table 4-29 by demographic and intermediate determinants of oral health. The mean and prevalence increased with age and each age group was statistically different from the others, with the exception of the 45 to 54 and the 55 years or older age groups.

Table 4-28: Mean number of missing teeth by demographic and intermediate determinants, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	0.4 (0.2, 0.5)	0.9 (0.7, 1.0)	1.7 (1.3, 2.1)	3.3 (2.2, 4.4)	4.0 (2.8, 5.2)	0.001
Gender	Male (n=749)		Female (n=28)			0.17
	1.1 (0.9, 1.2)		0.9 (0.1, 1.7)			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		<0.001
	0.2 (0.1, 0.3)	1.2 (0.9, 1.4)	2.1 (1.7, 2.4)	0.7 (0.5, 1.0)		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.06
	0.4 (0.1, 0.8)	1.2 (0.7, 1.7)	1.1 (0.9, 1.2)	1.1 (0.6, 1.6)		
Education categories ²⁷	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		<0.001
	2.2 (1.3, 3.1)	0.7 (0.5, 0.8)	1.5 (1.2, 1.9)	0.8 (0.6, 1.0)		
Last dental visit ²⁸	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)		0.002 Within and others
	1.1 (1.0, 1.3)	0.7 (0.4, 0.9)		1.0 (0.4, 1.6)		
Phobia ²⁸	No phobia (n=728)		Phobia (n=47)			0.001
	1.0 (0.9, 1.1)		2.4 (1.1, 3.7)			

Social gradients were evident in the number of missing teeth. The mean and prevalence increased from new entrant to NCO ranks, with each statistically significant to the other

²⁷ 29 missing cases

²⁸ 1 missing case

groups. However, the values for the officer ranks were not different to the private ranks, despite the fact that officers were older and age-matched with NCO ranks. Lifetime access by officers to molar and other complex endodontics on demand may partially explain these differences. In the deprivation categories, the prevalence values were lower in those with home addresses outside the State, but many of these were untreated new entrants. In the education categories, the “completed secondary” and ‘Honours degree or Masters” groups had fewer missing teeth than the “some secondary” and “some college” groups. Many of the “completed secondary” group were young soldiers and the advantage may have been a result of age. The greater number of missing teeth in the “some secondary” group was indicative of a pattern in the results of higher risk in this group. A greater number of missing teeth were present in the “within 12 months” dental visiting group, as might be expected from a treated group with a lower untreated decay experience, reported above (Sheiham et al., 1985).

Table 4-29: Prevalence of missing teeth by demographic and intermediate determinants, unweighted Army (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	17.8%	39%	57.1%	80.7%	94.4%	0.001
Gender	Male (n=749)		Female (n=28)			0.13
	39.1%		25%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	<0.001	
	11.1%	43.6%	62.4%	39.1%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.03	
	17.9%	42.3%	39.8%	34.2%		
Education categories ²⁹	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	<0.001	
	56.8%	28.1%	50.5%	36.1%		
Last dental visit ³⁰	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)	0.02		
	42.3%	28%	29.4%			
Phobia ³⁰	No phobia (n=728)		Phobia (n=47)			0.01
	35.7%		56.3%			

²⁹ 29 missing cases

³⁰ 1 missing case

4.4.3.4 Binary logistic regression MT>0

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of missing teeth as a result of caries and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=200.5$, $df=13$, $p<0.001$), explained 32% of the variance in MT>0 and correctly classified 72.1% of the cases. The results are displayed in Table 4-30 and show that rank, education and age were statistically significant when adjusted for age and gender. All the rank categories were statistically significantly greater when compared with new entrants, except for officers, which was indicative of the advantage held by their rank. In the education categories, all the groups had fewer missing teeth than the “some secondary” group. There was an OR 1.1 95% CI [1.1, 1.1] increase in missing teeth for every unit year of age increase. However, there was no effect by deprivation category which indicated that the Army system had to some degree offset this risk, possibly by equal access to care through civilian practices.

Table 4-30: Binary logistic regression of MT>0, unweighted Army (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	2.7 (1.5, 4.8)	<0.001
	NCO	3.1 (1.4, 6.4)	0.004
	Officer	2.1 (0.9, 5.4)	0.09
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.5, 1.3)	0.43
	>1 SD	0.7 (0.4, 1.4)	0.34
	Outside State	0.6 (0.2, 1.6)	0.30
Education ³¹	Some secondary	Baseline	
	Completed secondary	0.4 (0.2, 0.8)	0.01
	Some college	0.4 (0.2, 0.7)	0.005
	Honours degree or Masters	0.3 (0.1, 0.6)	0.002
Last dental visit ³²	<12 months	Baseline	
	12 to 24 months	0.9 (0.5, 1.5)	0.59
	>24 months	0.8 (0.5, 1.4)	0.47
Age		1.1 (1.1, 1.1)	<0.001
Gender		1.0 (0.38, 2.7)	0.98

³¹ 29 missing cases

³² 1 missing case

The prevalence results showed that patients with phobia had a higher prevalence of missing teeth. When phobia was added, the model remained statistically significant and patients with phobia ($p < 0.001$) had an increased risk of missing teeth (OR 3.7 95% CI [1.8, 7.4]), as has been reported elsewhere (Hallstrom and Halling, 1984, Heidari et al., 2017). The results indicate that patients with phobia are a target for early preventative interventions as a means of preventing tooth loss.

4.4.4 Filled teeth

4.4.4.1 Summary statistics

The summary statistics for the number of filled teeth in the weighted and unweighted Army sample is displayed in Table 4-31. Neither sample was normally distributed with Kolmogorov-Smirnov test p-values less than 0.05. The mean values were 6.7 95% CI [6.2, 7.2] and 5.5 95% CI [5.1, 5.8] in the weighted and unweighted samples respectively. The median value in the weighted sample was 6 IQR 7 and in the unweighted sample was 4 IQR 8. The minimum value in both samples was zero and the maximum value was twenty-three, showing the wide distribution of number of filled teeth in the sample.

Table 4-31: Summary statistics, filled teeth, weighted and unweighted Army sample

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	4.00×10^{-6}	364	6.7	6.2, 7.2	6	7	0	23
Unweighted	1.19×10^{-31}	777	5.5	5.1, 5.8	4	8	0	23

The relative frequency distribution of filled teeth in the Army is displayed in Figure 4-16. There was a relatively even distribution between zero and ten filled teeth in the sample (between 5.9% and 9.2% in each category), with a decrease in occurrence in the percentage of personnel with eleven or more filled teeth.

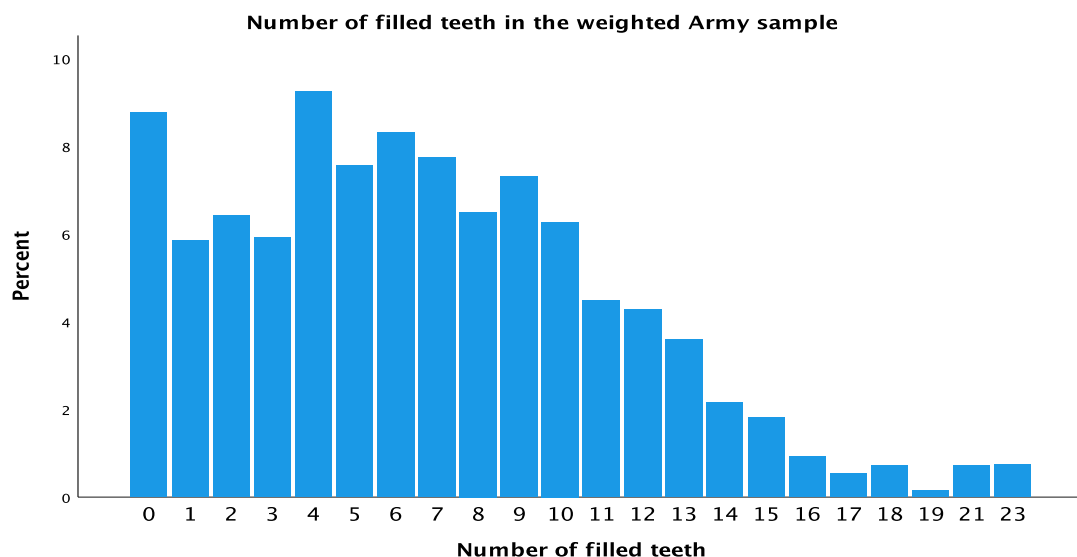


Figure 4-16: Relative frequency distribution of filled teeth in the weighted Army sample (n=364)

4.4.4.2 Comparison between new entrants and the trained strength

There was a statistically significant differences in the mean number of filled teeth (Mann-Whitney, $p < 0.001$) between the new entrants and the trained strength, as displayed in Table 4-32, that shows that, taken in conjunction with the decay data, the recruits were largely an untreated group.

Table 4-32: Mean number of FT in the Army, trained strength and recruits

Group	n	Mean [95% CI] no FT
Weighted Army	364	6.7 [6.2, 7.2]
Trained strength	553	6.9 [6.5, 7.3]
New entrants	224	2.0 [1.6, 2.3]

4.4.4.3 Comparison with previous surveys

Figure 4-17 shows the mean number of filled teeth in the Irish Army deployed battalion in 1991, international civilian surveys and the Irish Army in 2020. The mean number of filled teeth did not differ much between the Army in 1991 and 2020, which indicates that similar volumes of operative services were provided but against a background of higher disease rates in 1991. The mean number of filled teeth was only a little less than most international surveys, and higher than the mean in the US (Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011b, CDC, 2019, Public Health England., 2020). It may have been expected that the mean scores would be lower in the Army, given the relatively young age of soldiers but reflects the high disease burden on entry and the presentation as a treated group (Sheiham et al., 1985).

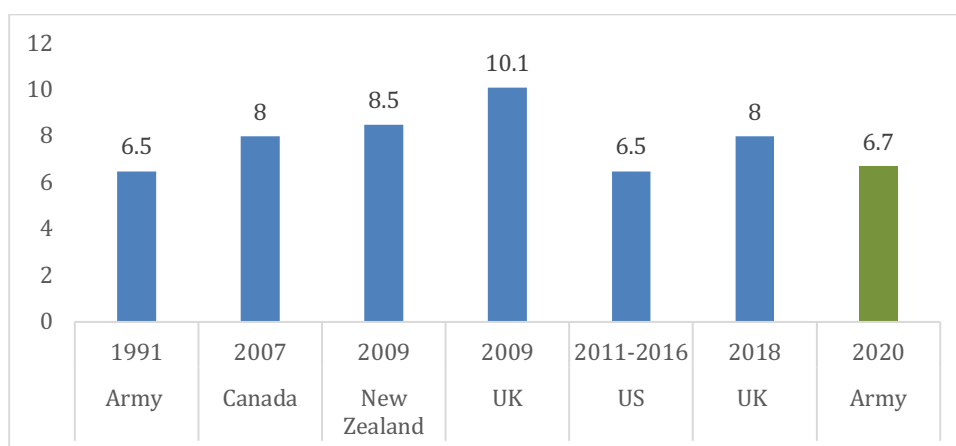


Figure 4-17: Mean number of filled teeth, Army 1991, international studies and Army 2020 (Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011b, CDC, 2019, Public Health England., 2020)³³

³³ Data from UK in 2009 was derived from the reported prevalence data and mean number of restorations in respondents with restorations

The mean number of filled teeth in the Irish Army in 2020 and the trained strength of international armies is displayed in Figure 4-18. The lower scores in the Indian Army were in a population with very little decay experience (Ahuja and Darekar, 2003, Patankar, 2014); in Croatia (Skec et al., 2002), Israel (Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000) and Malaysia (Jasmin and Jaafar, 2011, Wahid et al., 2014) there was a large burden of untreated disease. Overall, there was no particular trend in the data that would make future comparison reliable.

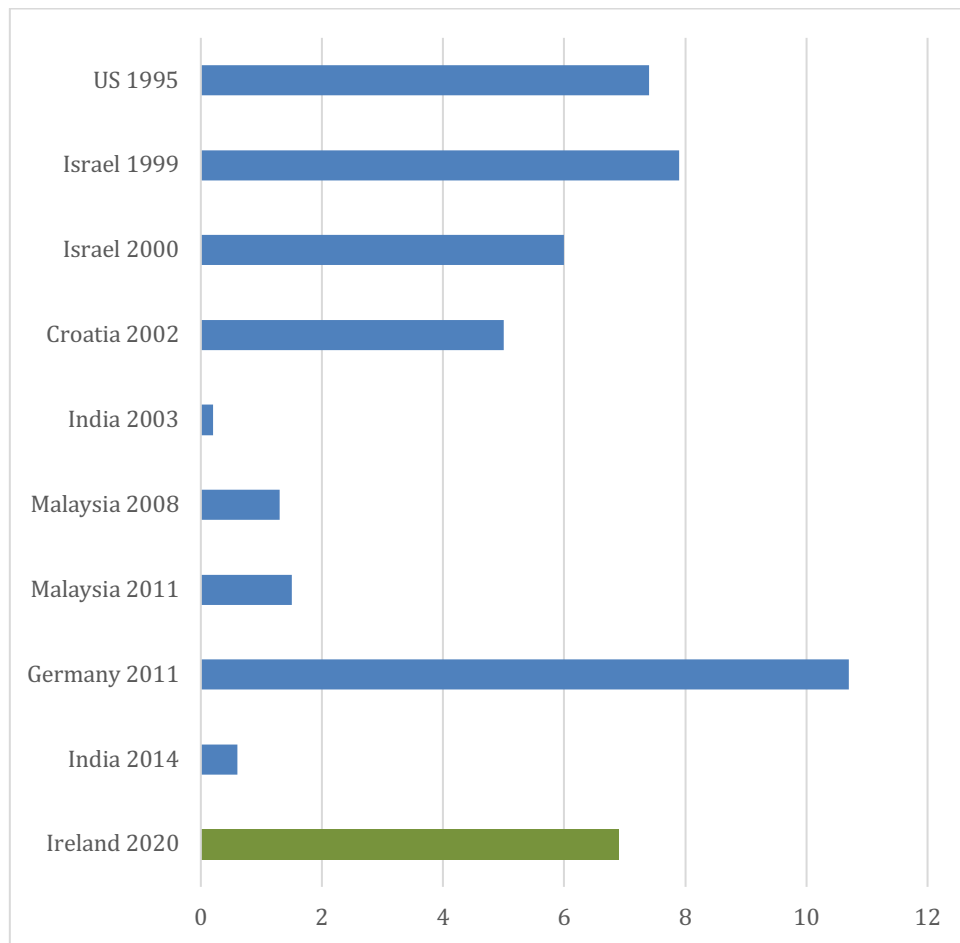


Figure 4-18: Mean number of filled teeth, trained strength Irish Army 2020 and international military studies (York et al., 1995, Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000, Skec et al., 2002, Ahuja and Darekar, 2003, Jasmin and Jaafar, 2011, Ziebolz et al., 2011, Patankar, 2014, Wahid et al., 2014)

The mean number of filled teeth in new entrants in the Irish Army in 2020 and the international military is displayed in Figure 4-19. There was a trend of decreasing numbers of filled teeth in recruits over time but direct comparison is similarly difficult due to varying underlying disease rates in the community and access to care.

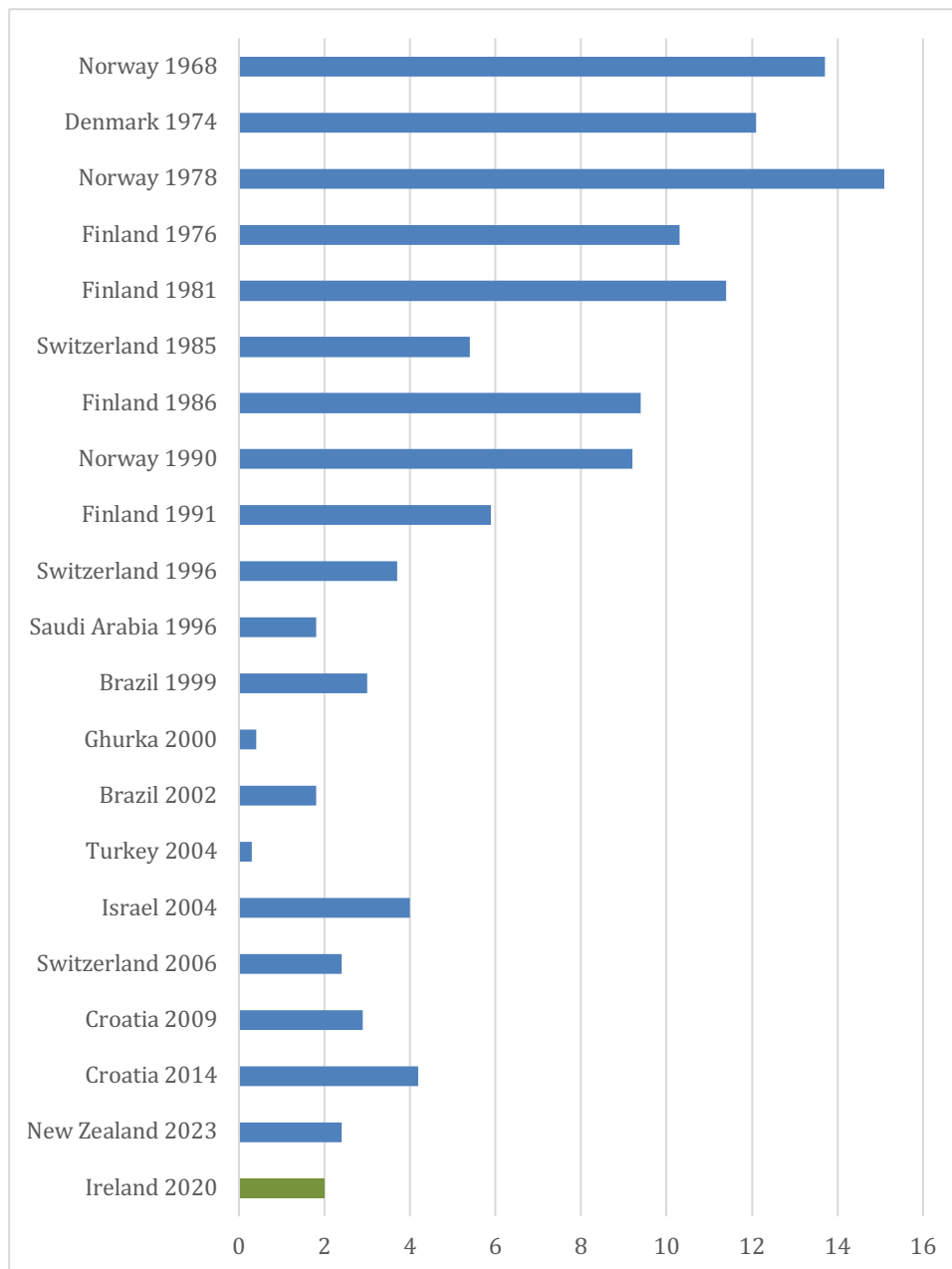


Figure 4-19: Mean number of filled teeth, recruits in the Irish Army 2020 and international military (Antoft et al., 1974, Asmyhr et al., 1994, Johansson et al., 1996, Lewsey et al., 2000, Ceylan et al., 2004, Levin and Shenkman, 2004, Bastos et al., 2007, Röthlisberger et al., 2007, Badel et al., 2009, Elmer et al., 2011, Tanner et al., 2013, Spalj et al., 2014, Naysmith et al., 2023)

4.4.4.4 Filled teeth displayed by demographic variables and intermediate determinants of oral health

The mean number of filled teeth in the Army shown by demographic variables and intermediate determinants is displayed in Table 4-33. The two most important drivers of differences were the increase with age and the differences by dental visiting group.

Table 4-33: Mean number of filled teeth by demographic and intermediate determinants, unweighted Army (n=364)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	2.7 (2.4, 3.1)	6.1 (5.5, 6.6)	8.3 (7.5, 9.1)	8.8 (7.7, 9.9)	8.6 (7.7, 9.9)	<0.001
Gender	Male (n=749)		Female (n=28)		0.01	
	5.5 (5.2, 5.9)		3.4 (1.9, 5.0)			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	<0.001	
	2.0 (1.6, 2.3)	6.3 (5.8, 6.9)	7.9 (7.3, 8.6)	6.2 (5.2, 7.2)		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.16	
	4.3 (3.0, 5.6)	5.2 (4.5, 5.9)	5.7 (5.3, 6.1)	5.3 (3.9, 6.6)		
Education categories ³⁴	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	<0.001	
	6.7 (5.6, 7.9)	4.2 (3.7, 4.6)	6.8 (6.1, 7.5)	5.8 (5.1, 6.6)		
Last dental visit ³⁵	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)	<0.001	
	6.1 (5.8, 6.5)	3.9 (3.0, 4.7)		3.4 (2.7, 4.1)		

By age, the number of filled teeth increased from the 18 to 24 years to 35 to 44 years and then plateaued and most of the statistically significant interactions were between the youngest age group and the older age groups. Men had more filled teeth but may be understood to be a consequence of the high proportion of new entrants in the female sample. In the ranks the untreated new entrants had fewer filled teeth (Kruskal-Wallis, $p<0.001$) than the other ranks. The NCO ranks had more filled teeth than officers (Kruskal-Wallis, $p=0.02$) and private soldiers (Kruskal-Wallis, $p=0.001$) despite the fact that NCOs and officers were age-matched

³⁴ 29 missing cases

³⁵ 1 missing case

groups and suggested advantage accruing to officer rank. The “completed secondary” rank had fewer fillings than the other education groups but this group was largely composed of new entrants and young soldiers who may have been untreated. A greater number of filled teeth were in the “<12 months” category, as might be expected in a treated group (Sheiham et al., 1985). In summary, the data showed the increase in number of filled teeth with age, as has been reported in national (O'Mullane and Whelton, 1992, Whelton, 2007) and international reports (Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011b) but also showed that social gradients existed with advantage experienced by rank and education.

4.4.4.5 Binary logistic regression FT>0

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of filled teeth and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=136.2$, $df=13$, $p<0.001$), explained 28% of the variance in FT>0 and correctly classified 84.2% of the cases. The results are displayed in Table 4-34 and show that rank, dental visits and age were statistically significant.

Table 4-34: Binary logistic regression of FT>0, unweighted Army (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	2.8 (1.4, 5.4)	0.002
	NCO	3.2 (1.0, 10.0)	0.04
	Officer	0.7 (0.2, 2.0)	0.48
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.4, 1.4)	0.44
	>1 SD	0.8 (0.3, 1.9)	0.61
	Outside State	1.1 (0.4, 3.1)	0.87
Education ³⁶	Some secondary	Baseline	
	Completed secondary	0.5 (0.2, 1.1)	0.09
	Some college	0.3 (0.1, 1.0)	0.06
	Honours degree or Masters	1.0 (0.3, 3.3)	0.98
Last dental visit ³⁷	<12 months	Baseline	
	12 to 24 months	0.6 (0.4, 1.1)	0.09
	>24 months	0.5 (0.3, 0.8)	0.008
Age		1.1 (1.0, 1.2)	<0.001
Gender		1.6 (0.6, 3.9)	0.33

³⁶ 29 missing cases

³⁷ 1 missing case

Every unit increase in age was associated with an OR 1.1 95% CI [1.0, 1.2] increase in the prevalence of filled teeth. The NCO and private ranks had statistically significant increases in the prevalence of filled teeth by comparison with the untreated new entrants. However, the officer rank was not statistically different from new entrants, adjusted for age, and showed that officers had better oral health than age-matched NCOs. As might be expected from a treated population (Sheiham et al., 1985), soldiers who had attended within 12 months had a greater prevalence of filled teeth than less recent attenders. In addition, individuals with lower risk may be assigned less frequent recall that may partially explain the results (NICE, 2004).

4.4.5 Mean DMFT

4.4.5.1 Summary statistics

The summary statistics for the DMFT scores in the weighted and unweighted Army sample are displayed in Table 4-35. In both cases the samples were not normally distributed, with Kolmogorov-Smirnov test p-values less than 0.05. The mean values were 8.4 95% CI [7.8, 9.0] and 7.1 95% CI [6.7, 7.5] in the weighted and unweighted samples respectively. The median values were 8 IQR 8 in the weighted sample and 6 IQR 9 in the unweighted sample. In both samples, the minimum value was zero and the maximum was 28 showing the wide range of values present in the population.

Table 4-35: Summary statistics, DMFT scores, weighted and unweighted Army sample

Data set	p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	2.00×10^{-6}	364	8.4	7.8, 9.0	8	8	0	28
Unweighted	1.61×10^{-23}	777	7.1	6.7, 7.5	6	9	0	28

4.4.5.2 Comparison with previous surveys

National population data were not available that might be compared with these results but they may be compared with the results of the deployed Irish battalion in 1991 and civilian studies from a number of HIC, as displayed in Figure 4-20.

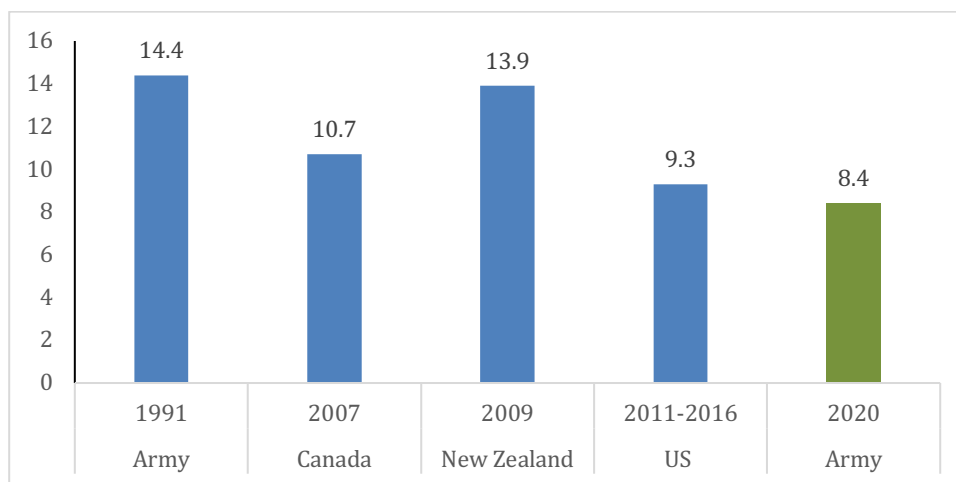


Figure 4-20: Mean DMFT scores, Army 1991, international surveys and Army 2020 (Cooney, 2010, Ministry of Health, 2010, CDC, 2019)

The mean scores in the Army in 1991 were about 70% higher than in 2020. The battalion in 1991 had not been treated to completion with an identified treatment need of 86.7% and a mean DT score of 2.1 95% CI [1.8, 2.4], which, if treated, would have likely increased the DMFT score even further. These results show the vast improvements in oral health in the Army in the intervening decades and the greater effectiveness of the service in meeting

treatment needs. The mean DMFT score in the Army was lower than in international surveys, as might be expected given the young age profile of the Army population.

4.4.5.3 Comparison between new entrants and the trained strength

The mean DMFT score was lower in the new entrants than the trained strength (Mann-Whitney, $p < 0.001$), as displayed in Table 4-36. Since recruits were younger than the trained strength, and DMFT scores have been reported to increase with age (O'Mullane and Whelton, 1992, Whelton, 2007), these results were unsurprising.

Table 4-36: Mean DMFT score in weighted Army, trained strength and recruits

Group	n	Mean [95% CI] DMFT
Weighted Army	364	8.4 [7.8, 9.0]
Trained strength	553	8.6 [6.5, 7.3]
New entrants	224	3.5 [3.0, 4.0]

The mean DMFT score in the trained strength of the Irish Army and international military studies is displayed in Figure 4-21 and shows that the mean approximated that of many of the high-income countries which aim to treat personnel to completion before deployment (York et al., 1995, Sgan-Cohen et al., 2000, Ziebolz et al., 2011) but without any useful trend that could be utilized.

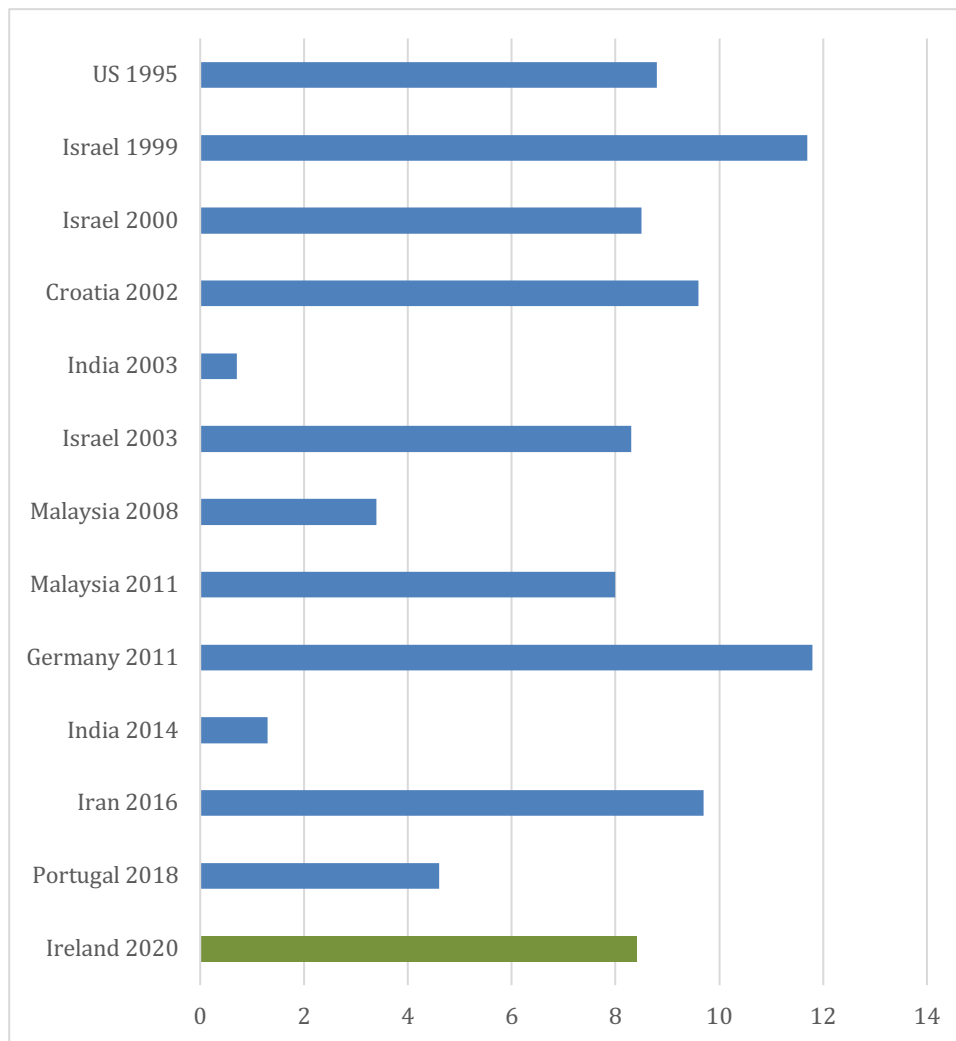


Figure 4-21: Mean DMFT in the trained strength, Army 2020 and international military studies (York et al., 1995, Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000, Skec et al., 2002, Ahuja and Darekar, 2003, Jasmin and Jaafar, 2011, Ziebolz et al., 2011, Patankar, 2014, Wahid et al., 2014, Khalilazar and Khoshdel, 2016, Azevedo et al., 2018)

Figure 4-22 displays the mean DMFT score in recruits in the Irish Army in 2020 and in military studies and followed the pattern of lower scores than in the trained strength. As was the case for the trained strength, these scores varied by the year of collection and local factors such as access to fluoride or dietary patterns. In general, there was a trend of decreasing DMFT scores with time but with outliers such as Croatia showing that predictions based on the experience in other countries is very difficult. It was interesting to note that recruits in Ireland had among the lowest mean DMFT scores, despite the large number who were untreated, which suggests that the benefits of water fluoridation had extended to even the most marginalized groups in Irish society.

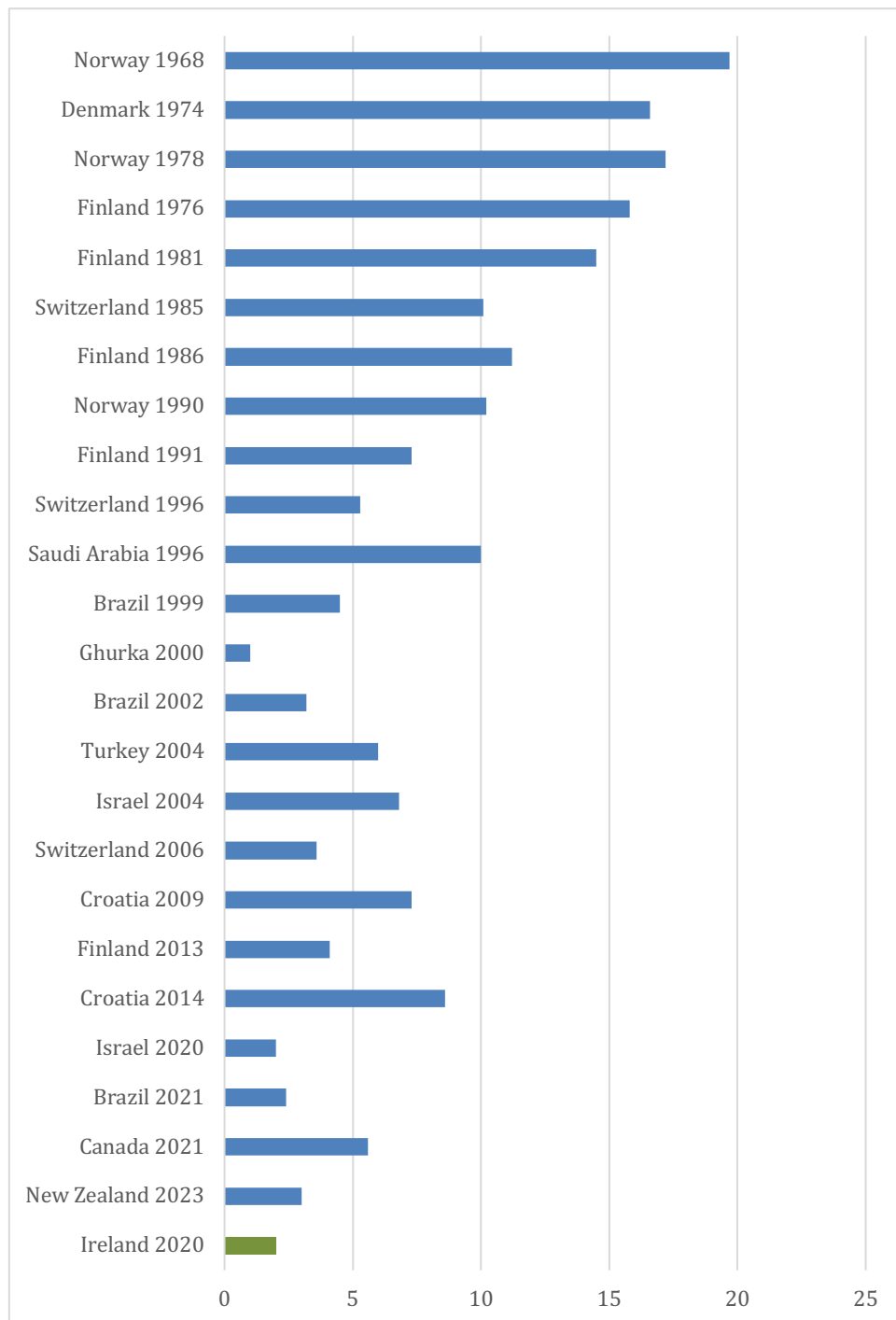


Figure 4-22: Mean DMFT score in recruits in the Irish Army in 2020 and military studies (Antoft et al., 1974, Asmyhr et al., 1994, Johansson et al., 1996, Lewsey et al., 2000, Ceylan et al., 2004, Levin and Shenkman, 2004, Röthlisberger et al., 2007, Bastos et al., 2007, Badel et al., 2009, Elmer et al., 2011, Tanner et al., 2013, Spalj et al., 2014, Naysmith et al., 2023)

4.4.5.4 Mean DMFT displayed by demographic variables and intermediate determinants of oral health

The mean DMFT by demographic and intermediate determinants is displayed in Table 4-37. DMFT scores increased with age, as has been reported in national (O'Mullane and Whelton, 1992, Whelton, 2007) and international reports (Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011b). The scores plateaued from 45 to 54 years to the 55 years and older age group and in pair-wise interactions, all but the pairs of the top two age groups were statistically significant. The differences between men and women reflected the large number of new entrants in the female sample.

Table 4-37: Mean DMFT by demographic and intermediate determinants, unweighted (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	4.2 (3.7, 4.7)	7.2 (6.6, 7.9)	10.2 (9.2, 11.2)	12.3 (10.8, 13.7)	12.7 (10.0, 15.3)	<0.001
Gender	Male (n=749)		Female (n=28)			
	7.2 (6.8, 7.6)		5.4 (3.1, 7.8)			0.04
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		
	3.5 (3.0, 4.0)	7.8 (7.2, 8.5)	10.2 (9.4, 11.0)	7.1 (5.9, 8.2)		<0.001
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		
	6.1 (4.4, 7.8)	7.3 (6.4, 8.2)	7.2 (6.7, 7.7)	6.8 (5.2, 8.4)		0.23
Education categories ³⁸	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		
	10.1 (8.6, 11.6)	5.5 (5.0, 6.1)	8.7 (7.8, 9.5)	7.0 (6.1, 7.9)		0.001
Last dental visit ³⁹	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)			
	7.7 (7.2, 8.2)	5.5 (4.5, 6.6)	5.6 (4.6, 6.7)			<0.001
Phobia ³⁹	No phobia (n=728)		Phobia (n=47)			
	7.0 (6.6, 7.4)		8.5 (6.5, 10.6)			0.71

³⁸ 29 missing cases

³⁹ 1 missing case

In the rank groups, there was an increase in DMFT scores from new entrants to the NCO ranks, but the officers had better scores than NCOs and were not statistically different from private soldiers, despite their older age. The “completed secondary” education group were statistically different from all other groups, which may be understood as a consequence of the young age of this group. There were also statistically significant differences between the “Honours or Masters’ degree” and “some secondary” categories, which showed the social gradients present in the Army. As was reported in the filled, missing and decay data above, the mean DMFT scores were greater in the “<12 months” dental visiting category, who were a broadly treated group (Sheiham et al., 1985).

4.4.6 Proportion attributable to DT, MT and FT

Figure 4-23 shows the proportion attributable to DT, MT and FT in the weighted Army sample, the trained strength and the new entrants in 2020. The data shows that in trained strength 80% was attributable to filled teeth but in recruits the figure was only 56%. Decayed teeth accounted for 39% of the total DMFT score in recruits but only 3% of the trained strength and shows the difference between the treated and untreated population that occurred following the transition to military service.

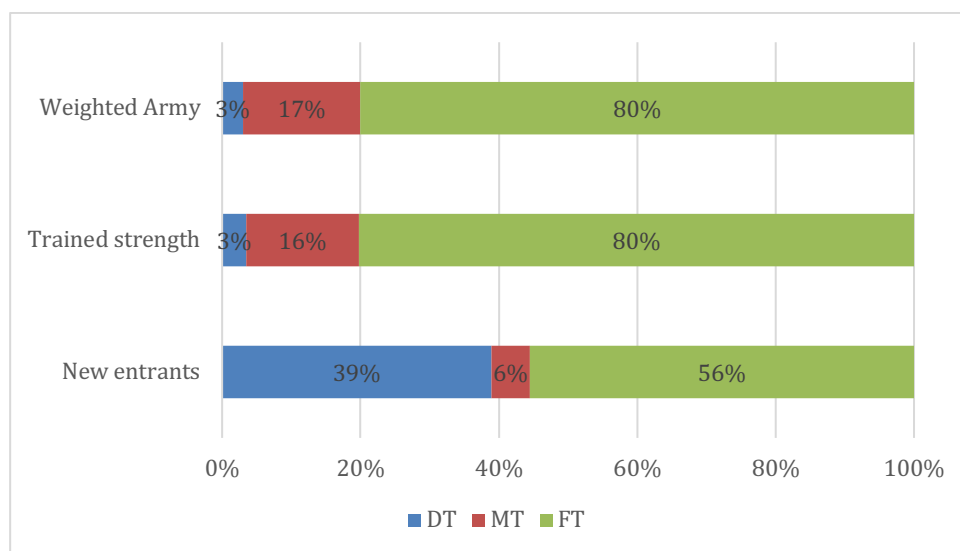


Figure 4-23: Percentage attributable to DT, MT and FT in the weighted sample (n=777), trained strength (n=523) and new entrants (n=224)

The percentage attributable to DT, MT and FT in the Army in 1991 and international civilian surveys in HICs is displayed in Figure 4-24. By comparison with the Irish Army battalion in 1991, the Army in 2020 had a lower proportion of decayed and missing teeth. The Army in 2020 had the lowest proportion with decayed teeth and missing teeth and the highest proportion with filled teeth than any of the civilian surveys.

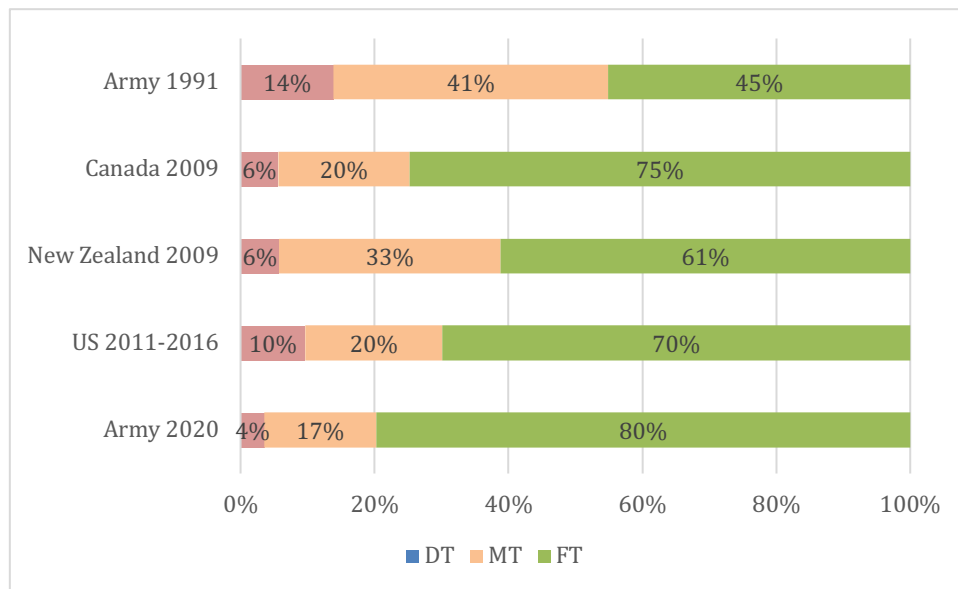


Figure 4-24: Percentage attributable to DT, MT and FT in the Army in 1991 and 2020 and international surveys (Cooney, 2010, Ministry of Health, 2010, CDC, 2019)

Figure 4-25 and Figure 4-26 display the proportion attributable to DT, MT and FT in the trained strength and recruits in the Irish Army in 2020 and international military surveys. In the trained strength, the proportion attributable to decayed teeth was the lowest of any international survey. The distribution of DT, MT and FT scores followed a similar pattern in the results from Ireland 2020, Germany 2011 and the US in 1995, which would be expected in countries attempting to follow STANAG 2466 and make personnel dentally fit before deployment. By contrast, in the recruits, about 40% of the DMFT score was attributable to decayed teeth, with a range of 6% (Asmyhr et al., 1994) to 80% (Ceylan et al., 2004) in the international studies.

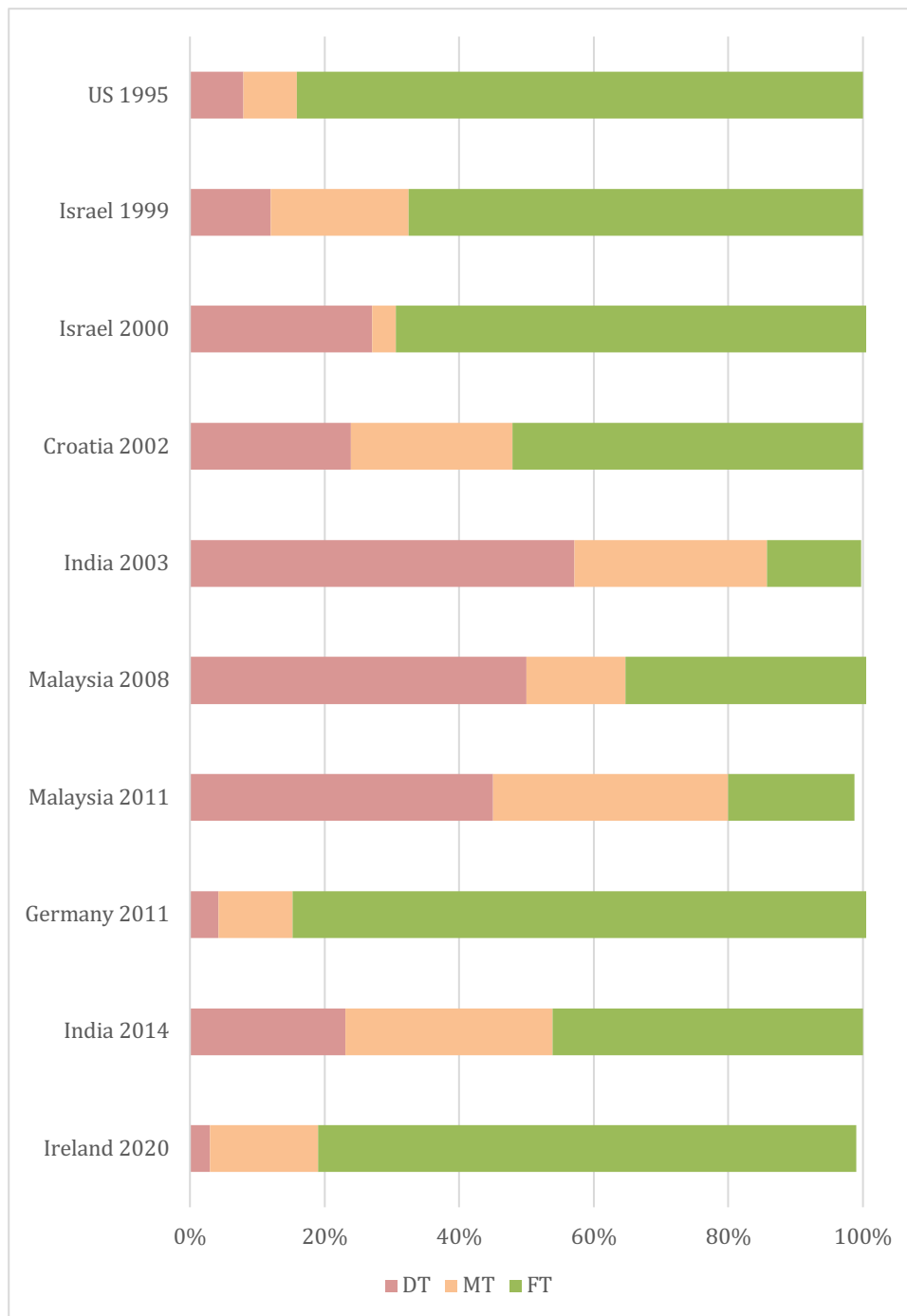


Figure 4-25: Percentage attributable to DT, MT and FT in the trained strength of the Irish Army in 2020 and international reports (York et al., 1995, Sgan-Cohen et al., 1999, Sgan-Cohen et al., 2000, Skec et al., 2002, Ahuja and Darekar, 2003, Jasmin and Jaafar, 2011, Ziebolz et al., 2011, Patankar, 2014, Wahid et al., 2014, Azevedo et al., 2018)

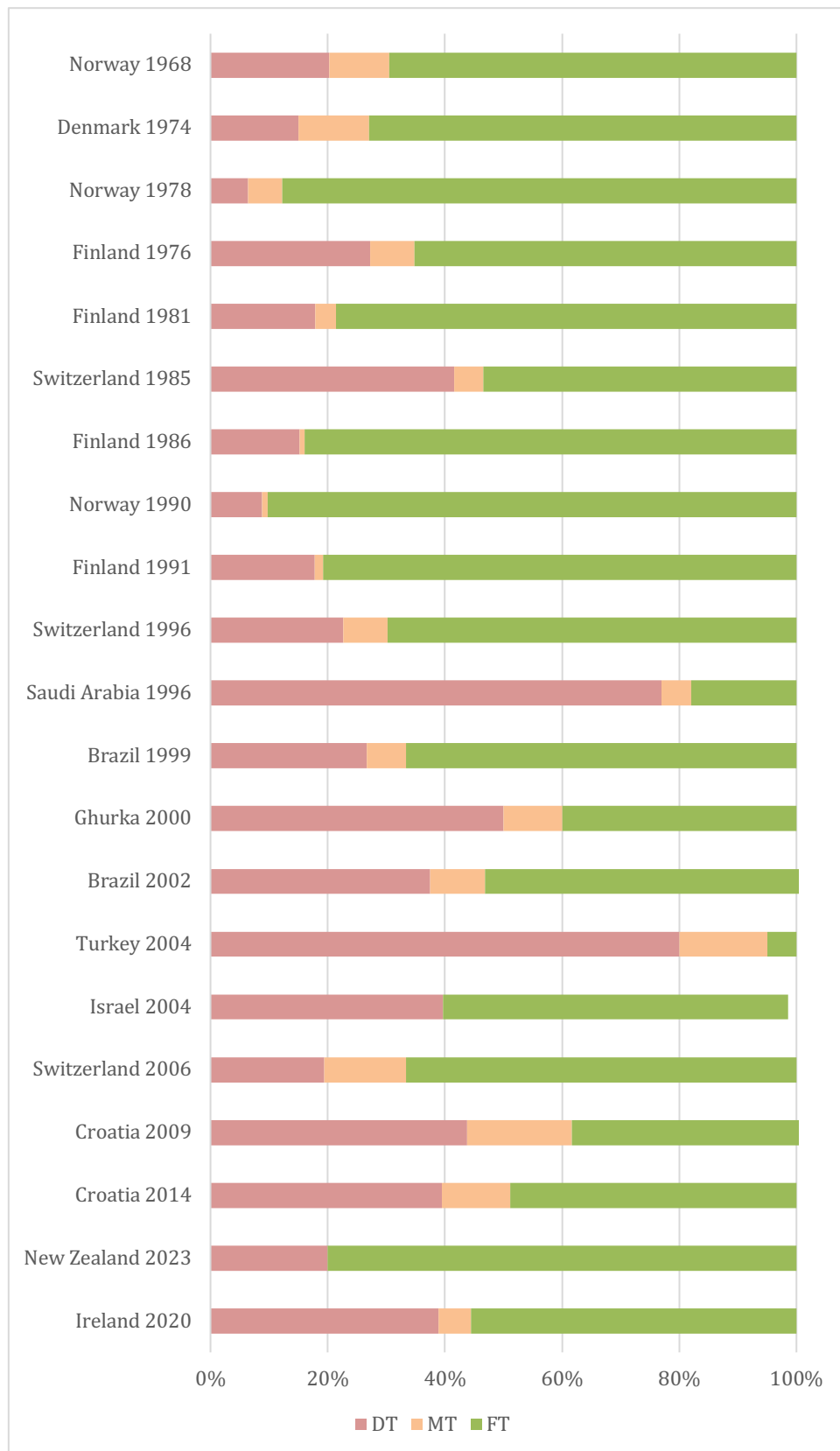


Figure 4-26: percentage attributable to DT, MT and FT in recruits in the Irish Army in 2020 and international surveys (Antoft et al., 1974, Asmyhr et al., 1994, Johansson et al., 1996, Lewsey et al., 2000, Ceylan et al., 2004, Levin and Shenkman, 2004, Bastos et al., 2007, Röthlisberger et al., 2007, Badel et al., 2009, Elmer et al., 2011, Tanner et al., 2013, Spalj et al., 2014, Naysmith et al., 2023)

4.4.7 Caries free subjects: DMFT=0

4.4.7.1 Summary statistics

In the weighted Army 7.1% had a DMFT score of zero, amounting to an estimated approximately 507 individuals in the Army. This was an important indicator to capture as this group cannot be identified using traditional dental forensic charting. Limited data exists that reports the proportion of populations that were free of caries. Canada reported 4.1% with a DMFT score of zero (Cooney, 2010) and in the US the prevalence was 8.4% (CDC, 2019). However, these surveys contained a wider range of age groups and comparison must be guarded.

4.4.7.2 Comparison between new entrants and the trained strength

There was a large difference in the prevalence in new entrants and the trained strength ($\chi^2=58.4$, $df=1$, $n=777$, $p<0.001$), as displayed in Table 4-38. It is not possible to wholly explain the sharp decrease in the prevalence of personnel with a DMFT scores of zero but changes in dietary practices, reduced exposure to fluoride when deployed, use of radiographs to detect decay, interventionist approaches to caries rather than a minimally invasive approach and over-treatment may be involved.

Table 4-38: Percentage with DMFT=0 in the weighted Army sample, trained strength and recruits

Group	n	% DMFT=0
Weighted Army	364	7.1%
Trained strength	553	6.5%
New entrants	224	26.3%

4.4.7.3 Comparison with previous surveys

In New Zealand the prevalence was reported for civilians in the national survey between 18 and 24 years as 22.7% (Ministry of Health, 2010) and in recruits to the Army in 2023 was reported as 31.2% (Naysmith et al., 2023). In the Australian Army, the prevalence in recruits was reported as 26.2% (Hopcraft and Morgan, 2005) and in Finland in recruits was reported as 21.3% (Tanner et al., 2013). The data shows that a significant subsection of young people in high-income countries is now free of caries, at least at the level of therapeutic intervention. The prevalence of personnel with a DMFT score of zero in the Irish Army was similar to the limited international data available.

4.4.7.4 Prevalence of DMFT=0 presented by demographic variables and intermediate determinants of oral health

The prevalence of respondents with DMFT=0 by demographic and the intermediate determinants of health is displayed in Table 4-39. The main difference in the rank groups was between new entrants and the other ranks, which could explain many of the findings. By age the percentage with DMFT=0 was greatest in the 18 to 24 years age groups and by gender the percentage was greater in women than men and these groups were characterized by having a high proportion of new entrants. Similarly, the “completed secondary” group had a higher prevalence than other education groups but contained many new entrants. The “<12 months” dental visiting category had the lowest proportion with DMFT=0. The reasons why such soldiers acquire restorations or other treatment can only be speculated but may include outmoded treatment approaches.

Table 4-39: Percentage with DMFT=0 by demographics and intermediate determinants of health, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	24.4%	6.4%	5.3%	0%	0%	<0.001
Gender	Male (n=749)		Female (n=28)			0.04
	11.7%		25%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		<0.001
	26.3%	7.2%	10.9%	11.5%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.53
	10.3%	8.8%	13%	13.9%		
Education categories ⁴⁰	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		<0.001
	4.1%	19.2%	7.8%	7.6%		
Last dental visit ⁴¹	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)		<0.001
	9.2%	23%		18.3%		
Phobia ⁴¹	No phobia (n=728)		Phobia (n=47)			0.19
	12.6%		6.3%			

⁴⁰ 29 missing cases

⁴¹ 1 missing case

4.4.7.5 Binary logistic regression DMFT=0

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of DMFT=0 and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($X^2=106.7$, $df=13$, $p<0.001$), explained 25% of the variance in DMFT=0 and correctly classified 87.4% of the cases. The results are displayed in Table 4-40 and show that rank, education and age were statistically significant. Every unit increase in age was associated with an OR 0.9 95% CI [0.8, 0.9] decrease in the prevalence of DMFT=0. Social gradients were evident in the data as officers had OR 3.6 95% CI [1.0, 12.2] and those with “some college” education had OR 5.1 95% CI [1.2, 20.6] greater likelihood of having DMFT=0 than the new entrants.

Table 4-40: Binary logistic regression of DMFT=0, unweighted sample (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.5 (0.2, 1.0)	>0.05
	NCO	0.5 (0.2, 1.9)	0.34
	Officer	3.6 (1.0, 12.2)	0.04
Deprivation	<1 SD	Baseline	
	±1 SD	1.7 (0.9, 3.5)	0.13
	>1 SD	1.9 (0.7, 4.9)	0.25
	Outside State	1.0 (0.3, 3.5)	0.83
Education ⁴²	Some secondary	Baseline	
	Completed secondary	3.5 (1.0, 12.1)	>0.05
	Some college	5.1 (1.2, 20.6)	0.02
	Honours degree or Masters	1.3 (0.3, 6.1)	0.76
Last dental visit ⁴³	<12 months	Baseline	
	12 to 24 months	2.0 (1.1, 3.6)	0.03
	>24 months	1.6 (0.9, 3.0)	0.15
Age		0.9 (0.8, 0.9)	<0.001
Gender		0.7 (0.2, 1.7)	0.39

⁴² 29 missing cases

⁴³ 1 missing case

4.5 Dental health in the Army in 1990/ 1992 and 2020

The results by rank in the Irish Army in 1990/ 1992 (Hayden, 1995) and 2020 are displayed in Figure 4-27 and displayed the decrease in prevalence of caries in the intervening years. In addition to the marked decrease in overall prevalence, there was a difference in the social gradients present. In 1990/ 1992 the officer ranks were a treated group, with few decayed teeth but more filled teeth and a higher DMFT score, whereas the enlisted personnel had the appearance of an untreated group, with more decayed teeth, fewer filled teeth and with more missing teeth in NCOs. It is notable that in 1990 the Army attempted to provide most basic dental care in-house and the better results in officers is suggestive of improved access as a result of power and social dynamics. In 2020, all ranks in the trained strength appeared to have been treated and had low numbers of decayed teeth in an environment where primary care was provided by civilian contractors who are effectively “rank blind”. However, the continuing advantage accruing to officers was evident in their lower DMFT scores and fewer lost teeth than the other ranks of the trained strength.

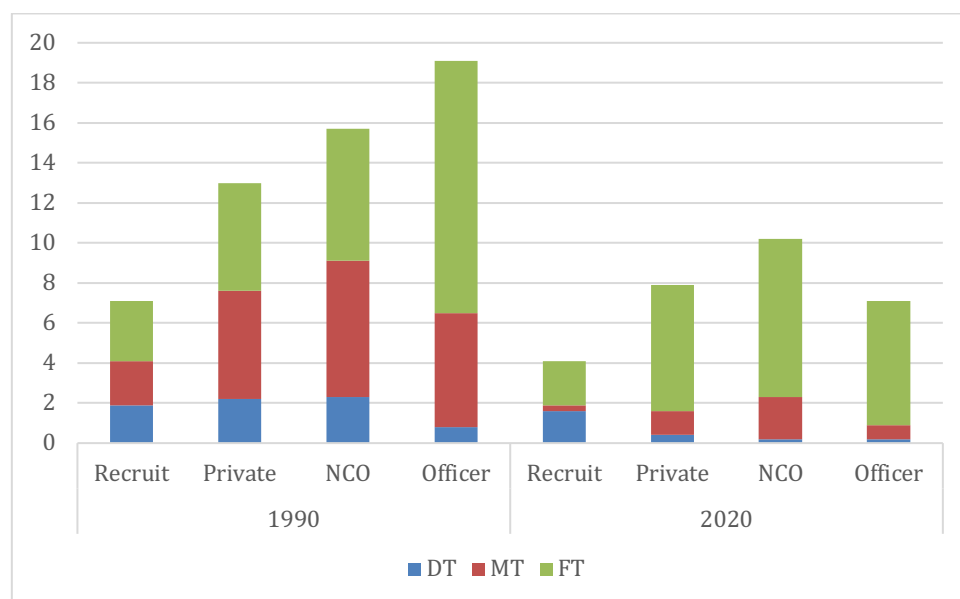


Figure 4-27: Irish Army data by ranks in 1990 and 2020.

Overall, the results showed vast improvements in dental health in soldiers since 1990 but showed that the improvements were not equally distributed. Few reports exist comparing clinical indicators by rank. In the Dutch Army higher median DMFT scores were reported in much older Officers and NCOs than younger private soldiers (van Klink, 2023). In the Indonesian and Israeli Armies, officers had lower DT and MT scores and higher FT scores, indicating a treated population, but the age of the groups was not reported (Horev et al., 2003). In the Indonesian Army officers had lower DMFT, DT and MT scores and higher FT

scores than age-matched enlisted personnel, which the authors indicated might be related to the better education of the officer group (Gaare et al., 1989).

4.6 Unrestorable teeth and PUFA

Unrestorable teeth and teeth with PUFA symptoms are important metrics as patients with these conditions might be expected to be at a high risk of experiencing a dental emergency either at home where dental services are freely available or on deployment where access to services is severely restricted. Little evidence of the prevalence of these conditions exists in the military setting. British Army recruits with a PUFA lesion were more likely to lose sleep (OR 5.6 95% CI [2.4, 12.9]) and to have difficulty completing daily tasks (OR 3.7, 95% CI [1.4, 9.9]) but interestingly not to report absence from work (OR 1.6, 95% CI [0.5, 5.4]) (Edwards et al., 2022). The data reported here will add to the national data and will contribute to discussions about these matters.

4.6.1 Unrestorable teeth

The summary statistics for unrestorable teeth in the weighted and unweighted Army sample are displayed in Table 4-41. Neither the weighted nor the unweighted samples were normally distributed with Kolmogorov-Smirnov test statistics p values less than 0.05. The mean values in the weighted and unweighted samples were 0.02 95% CI [0.00, 0.03] and 0.03 95% CI [0.01, 0.04] respectively and show the low number of unrestorable teeth in the overall sample. The median value was 0 IQR 0 in both the weighted and unweighted samples. In both cases the minimum value was zero and the maximum value was three.

Table 4-41: Summary statistics, unrestorable teeth, weighted and unweighted Army sample

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	1.19×10^{-300}	364	0.02	0.00, 0.03	0	0	0	3
Unweighted	6.18×10^{-51}	777	0.03	0.01, 0.04	0	0	0	3

The frequency distribution of the number of unrestorable teeth in the unweighted Army sample is displayed in Figure 4-28. In the unweighted sample, a total of fifteen personnel were recorded with twenty-one unrestorable teeth. Of these, eleven personnel had one unrestorable tooth, two personnel had two unrestorable teeth and two personnel had three unrestorable teeth.

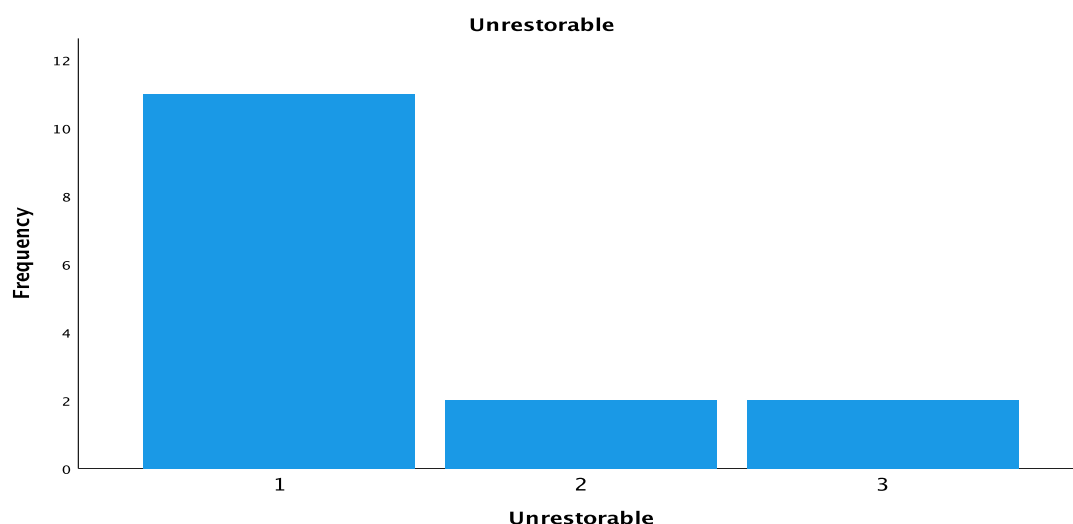


Figure 4-28: Frequency distribution, number of unrestorable teeth, unweighted Army sample (n=777)

There was a statistically significant difference in the mean (Mann-Whitney, $p=0.03$) and prevalence of unrestorable teeth ($\chi^2=4.5$, $df=1$, $n=777$, $p=0.03$) between the trained soldiers and recruits in the sample with a tendency for recruits to be more likely to present with unrestorable teeth compared to the trained strength. The results aligned with the observations by Dental Officers that recruits on entry were an untreated group, and included personnel with teeth that required extraction. A very small number of personnel in the trained strength had unrestorable teeth and about half were 35 to 44 years of age. Since the vast majority of personnel deploy overseas it is very difficult to imagine that these were carious teeth carried through years of military service and were more likely to be the end stage of heavily restored teeth, fractured teeth or other consequences of the treatment of caries. As such, the prevalence probably represented an irreducible minimum of unrestorable teeth in the Army.

Table 4-42: Mean number and prevalence of unrestorable teeth in the Army, trained strength and recruits

Group	n	Mean [95% CI] Unrestorable	Prevalence
Weighted Army	364	0.02 [0, 0.03]	1.4%
Trained strength	553	0.01 [0, 0.02]	1.3%
Recruits and cadets	224	0.06 [0.01, 0.11]	3.6%

Little has been published in national studies in HICs about the prevalence of unrestorable teeth. In the national studies the mean number of unrestorable teeth was similar in 1990 and 2000 (0.1 teeth) in the 16 to 24 years age group to that of the cadets and recruits in the Army in 2020 (O'Mullane and Whelton, 1992, Whelton, 2007). However, in the 1990 and 2000 surveys, the mean number of unrestorable teeth increased with age whereas in the Army the mean number was lower in the older trained strength than in the recruits as treatment was offered and mandated in service. The prevalence in the Army was lower than that reported in

the UK national survey of 8% (Steele et al., 2011a) or in military studies in Denmark (8.5%) (Marker et al., 1997) and showed the benefit of compulsion to meet dental fitness standards in a military setting. In the recruit group, the mean number of unrestorable teeth was lower than that reported in the UK Infantry (9.3%) (Edwards et al., 2022) but similar to that reported in the Finnish army in 1991 (3.7%) (Ankkuriniemi and Ainamo, 1997) and the non-infantry recruits in the British Army (Edwards et al., 2022). This may suggest a specific recruitment pattern in the UK Infantry that makes direct comparison with Irish Army recruits problematic.

4.6.2 Pulpal exposure, ulceration, fistula or abscess as a result of severe caries (PUFA)

The summary statistics for the PUFA scores in the weighted and unweighted Army sample are displayed in Table 4-43. Neither sample was normally distributed with Kolmogorov-Smirnov test p-values less than 0.05. The mean PUFA score was 0.01 95% [0.00, 0.03] in the weighted sample and 0.01 95% [0.01, 0.02] in the unweighted sample. The median value in both weighted and unweighted samples was 0 IQR 0. The minimum value was zero and the maximum value was one in both the weighted and unweighted samples. Only eleven personnel in the whole sample had a tooth with PUFA involvement – a remarkable testament to the management of severe caries. The summary results indicate that the management of severely decayed teeth (and their sequelae) was not a widespread problem in the Army and that dental care is provided in a timely fashion.

Table 4-43: Summary statistics, PUFA, weighted and unweighted Army

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	2.05×10^{-303}	364	0.01	0.00, 0.03	0	0	0	1
Unweighted	4.12×10^{-53}	776	0.01	0.01, 0.02	0	0	0	1

Neither the mean number (Mann-Whitney, $p=0.91$) nor the prevalence ($\chi^2=0.01$, $df=1$, $n=777$, $p=0.91$) of PUFA involved teeth differed between the trained strength and recruits, as displayed in Table 4-44. The data indicates that the severe consequences of caries were uncommon findings in recruits on entry, even though the prevalence of unrestorable teeth was higher and differed from that of trained personnel. These data suggest that along with a reduction in the number of teeth affected by caries, the number affected by severe caries has also reduced in the population, and aligned with the reduction in tooth loss.

Table 4-44: Mean number and prevalence of PUFA in the Army, trained strength and recruits

Group	n	Mean [95% CI] PUFA	Prevalence
Weighted Army	364	0.02 [0, 0.03]	1.5%
Trained strength	553	0.01 [0, 0.02]	1.4%
Recruits and cadets	224	0.01 [0.0, 0.03]	1.3%

Previous Irish national surveys have not reported the prevalence of PUFA lesions as they pre-date the development of the index. The low prevalence was in marked contrast to that reported in the UK national survey of 7% (Steele et al., 2011a) or the survey in England that reported a prevalence of 5.2% (Public Health England., 2020). In the British Army the prevalence in recruits was 17.5% and was associated with severe difficulties completing daily tasks (Edwards et al., 2022). The data suggests an overall lower prevalence in Ireland than the

UK and that severe caries should not be a significant cause of lost workdays in the Irish Army.

4.7 Complex prosthodontics

The Army had provided soldiers with dentures as a result of the historically high levels of tooth loss and need for replacement to undertake normal oral function (Hayden, 1995).

Anecdotally Dental Officers have observed a sharp decrease in the number of dentures being provided and information about prevalence will guide decisions that the Chief Dental Officer may make in relation to training of technicians, maintenance of a dental laboratory and outsourcing. Dentures also present a special risk to the oral health of patients (Preshaw et al., 2011) and identification of this group will allow planning for interventions to minimize risk.

Crowns, bridges, implants and other complex prosthodontic devices are not provided by the Army, except where the need followed documented trauma at work. However, these devices may require tailored maintenance programmes and may increase the risk of a dental emergency on deployment. The prevalence in the Army was unknown and the data will demonstrate the extent to which specialized maintenance or replacement programmes are required.

4.7.1 Denture wearing

A very small proportion of the Army had a denture with 1.6% of the weighted sample and 1.4% of the unweighted sample reporting denture wearing. The Healthy Ireland survey carried out in 2018 interviewed a representative sample of the Irish population in their own homes and included questions about denture wearing. In the sample, 18% reported wearing any denture, including 12% who reported wearing partial dentures and 6% who reported wearing full dentures (Dept. of Health, 2018). A similar prevalence was reported in a recent practice-based survey in the UK that reported a 15% prevalence of denture wearing (Public Health England., 2020) and in the Northern Ireland component of the 2009 ADH survey, which reported a prevalence of 20% (Chenery, 2011). The lower prevalence in the Army was most likely a reflection of the young age profile but may also have reflected the requirement to have a minimum number of teeth on entry. In addition, although soldiers are required to meet mandatory minimum oral health standards, it is clear that the treatment solution was not extraction and the provision of dentures.

As displayed in Table 4-45, there was little difference ($\chi^2=0.62$, $df=1$, $n=777$, $p=0.43$) in the prevalence of dentures in the recruits and trained strength. This indicates that the link between age and denture wearing reported in previous national surveys had been broken in the Army.

Table 4-45: Prevalence of denture wearing, weighted Army, trained strength and recruits

Group	n	Prevalence
Weighted Army	364	1.6%
Trained strength	553	1.6%
Recruits and cadets	224	0.9%

The prevalence of dentures in the demographic and intermediate determinants is displayed in Table 4-46. Dentures were most prevalent in the 45 to 54 years age group and in the NCO ranks. It was notable that none of the officers or personnel with an Honours degree or Masters' degree had a denture, which might suggest advantage in these groups relative to others. Denture wearing was greater in respondents with phobia ($\chi^2=1.7$, $df=1$, $p=0.003$), which might be expected from avoidant behaviour leading to more severe disease, tooth loss and dentures (Hallstrom and Halling, 1984). However, when entered into regression analysis and adjusted for the effect of age and gender, statistically significant associations with either of the demographic variables (age and gender) or any of the intermediate determinants (rank, deprivation, education, dental visiting and phobia) were not present.

The overall prevalence was low in all groups and although there was little difference in the prevalence in the 18 to 24 years age group by comparison with previous national surveys (O'Mullane and Whelton, 1992, Hayden, 1995, Whelton, 2007), there was markedly lower prevalence in the older age groups. For example, in 1990 about a third of soldiers and civilians had a denture whereas the prevalence in soldiers in 2020 was only 3%. It was also interesting to compare the prevalence in soldiers in 2020 in the 50 to 64 years age group (6.1%) with age-matched civilians in the TILDA study (31.2%) (Naseer, 2020), which is suggestive of a protective effect in the Army that may be a result of mandatory inspections, free treatment or access to complex dentistry in the deployed environment.

Table 4-46: Prevalence of dentures in the demographic and intermediate determinants, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	1.0%	0.4%	3%	5.3%	0%	0.02
Gender	Male (n=749)		Female (n=28)			0.33
	1.3%		3.6%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.04
	0.9%	0.8%	3.5%	0%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.76
	0%	2.2%	1.3%	1.3%		
Education categories ⁴⁴	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.09
	2.7%	0.9%	3.1%	0%		
Last dental visit ⁴⁵	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		0.06
	1.2%		0%	3.7%		
Phobia	No phobia (n=728)		Phobia (n=47)			0.003
	1.1%		6.4%			

4.7.2 Crowns, bridges and implants

Table 4-47 displays the prevalence of advanced prosthodontic devices, the mean units in the Army and the mean and median units in personnel with the selected prosthodontic devices. Crowns were the most prevalent device at 8.4% and only a small proportion of the Army had an implant. The median number of crowns in respondents with crowns was 1 IQR 2 crowns, showing that the individual restorative burden from crowns in the Army was small for most personnel. However, the maximum number of crowns was eight, and 23% of personnel with crowns also had bridges that had between two and eleven units, showing that a subset of the sample had a very high restorative burden with long-term implications for maintenance.

Only 5% of personnel in the weighted sample had a bridge and the median number of units suggests that this was mainly for replacement of a single missing tooth. Similarly, only 1.5% of the weighted Army had an implant in 2020 and 80% had a single crown. Although implants were relatively uncommon in the sample, they require specific maintenance

⁴⁴ 29 missing cases

⁴⁵ 1 missing case

pathways (Herrera et al., 2023) and the data indicates that the Dental Service in the future will require policies and procedures to identify and manage these devices.

Table 4-47: Prevalence of crowns, bridges, dentures and implants, weighted sample (n=364)

	Crowns	Bridges	Implants
Prevalence (%)	8.4%	5%	1.5%
Mean units	0.1 [0.1, 0.2]	0.1 [0.1, 0.2]	0.01 [0, 0.02]
Mean in personnel with device	2.0 [1.6, 2.5]	3.3 [2.5, 4.1]	1.0 [0.7, 1.3]
Median in personnel with device	1 IQR 2	3 IQR 2	1 IQR 0

Little has been written about the population prevalence of crowns in national surveys. In Ireland the mean number was reported by gender and age group but not the population mean or prevalence (O'Mullane and Whelton, 1992, Whelton, 2007). In the UK population prevalence was reported as 37% in 2009 (Steele et al., 2011b) and in England was 46.5% in 2018 (Public Health England., 2020). The high prevalence in these populations may have been aided by free or subsidised crowns available on the NHS system of care and as such was not directly comparable with the Army data. The prevalence of bridges was reported as 7% in the UK (Steele et al., 2011b) similar to the prevalence in the Army. The prevalence of the combined bridges and implants in England in 2018 was reported as 9.9% (Public Health England., 2020), about 50% greater than the Army combined data, but the England data contained a greater proportion of older respondents who might be expected to have more replacements for missing teeth. The prevalence of implants was 1.5% in the Army sample, similar to the reported 0.8% prevalence reported in Canada in 2007 (Cooney, 2010) and 1% reported in the UK in 2007 (Steele et al., 2011b). Analysis of the US NHANES data showed an increasing prevalence of implants from 0.9% in 1999 to 5.7% in 2015 (Elani et al., 2018) and although this sample contained many respondents over the age of 65 years, showed a trend that may become apparent in the Irish Army as implants become further incorporated into routine practice.

There were statistically significant differences in the prevalence of crowns ($\chi^2=14.8$, $df=1$, $n=777$, $p<0.001$) and bridges ($\chi^2=6.5$, $df=1$, $n=777$, $p=0.01$) between the new entrants and trained strength, as displayed in Table 4-48, but not in the prevalence of implants ($\chi^2=1.8$, $df=1$, $n=777$, $p=0.19$). The data shows that soldiers in the trained strength acquire complex prosthodontic devices, mainly crowns. These require maintenance and replacement and present a challenge for the Dental Service in the provision of a pool of clinicians with the capacity to provide a supportive service.

Table 4-48: Prevalence of crowns, bridges and implants in the trained strength and recruits

	Crowns	Bridges	Implants
Weighted Army (n=364)	8.4%	5%	1.5%
Trained strength (n=553)	9.0%	5.4%	1.6%
New entrants (n=224)	1.3%	1.3%	0.4%

4.7.3 Prevalence of any complex prosthodontic device

4.7.3.1 Summary statistics and prevalence in new entrants and the trained strength

In the weighted Army sample, 12.5% had a denture, crown, bridge or implant, as displayed in Table 4-49. There were statistically significant differences in the prevalence of complex prosthodontic devices between the trained strength and new entrants ($\chi^2=16.3$, $df=1$, $n=777$, $p<0.001$). This transition reflected the degradation of oral health following entry for about one in ten of the trained strength. These personnel represent one part of a high-risk group that should be targeted for special measures including shorter recall intervals.

Table 4-49: Prevalence of a denture, crown, bridge or implant in the Army, trained strength and recruits

	Any complex prosthodontic device
Weighted Army (n=364)	12.5%
Trained strength (n=553)	13.4%
New entrants (n=224)	3.6%

4.7.3.2 Prevalence by demographic and intermediate determinants of oral health

Table 4-50 displays the prevalence of complex prosthodontics by demographic and intermediate determinates of oral health in the unweighted Army sample. The prevalence was lowest in the 18 to 35 years age groups and was highest in the 45 to 54 years age group ($\chi^2=125.9$, $df=4$, $n=777$, $p<0.001$) and showed the accumulation of interventions with age. The prevalence was lower in the completed secondary group than other groups ($\chi^2=28.8$, $df=3$, $n=777$, $p<0.001$), which might be explained by the young age of this group. The prevalence increased from new entrants to the NCO group ($\chi^2=50.1$, $df=3$, $n=777$, $p<0.001$) and confirmed anecdotal observations by dental teams of the higher prevalence in the NCO group.

Table 4-50: Prevalence of complex prosthodontics in the demographic and intermediate determinants, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	3.5%	3.5%	17.3%	56.1%	38.9%	<0.001
Gender	Male (n=749)		Female (n=28)			0.22
	10.8%		3.6%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	<0.001	
	3.6%	6.1%	22.8%	13.8%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.53	
	5.1%	10.9%	10.3%	13.9%		
Education categories ⁴⁶	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	<0.001	
	18.9%	4.1%	14.6%	16.7%		
Last dental visit ⁴⁷	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)	0.65	
	10.8%	12%		8.3%		
Phobia ⁴⁷	No phobia (n=728)		Phobia (n=47)			0.97
	10.6%		10.4%			

4.7.3.3 Binary logistic regression complex prosthodontics

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of complex prosthodontics and was adjusted for the effect of age and gender. The model was statistically significant ($\chi^2=136.7$, $df=13$, $p<0.001$), explained 34% of the variance in presence of complex prosthodontics and correctly classified 90.4% of the cases. The results are displayed in Table 4-51 and shows that rank and age were statistically significant. Every unit increase in age was associated with an OR 1.2 95% CI [1.1, 1.2] increase in the prevalence of complex prosthodontics. Only the officer ranks were statistically different from the new entrants and had an OR 0.3 95% CI [0.1, 0.9] decrease in the prevalence of complex prosthodontics, which is underlined by lower total caries burden.

⁴⁶ 29 missing cases

⁴⁷ 1 missing case

Table 4-51: Binary logistic regression of presence of complex prosthodontics, unweighted sample (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.4 (0.1, 1.1)	0.07
	NCO	0.5 (0.1, 1.5)	0.21
	Officer	0.3 (0.1, 0.9)	0.04
Deprivation	<1 SD	Baseline	
	±1 SD	0.7 (0.4, 1.5)	0.41
	>1 SD	0.8 (0.3, 2.3)	0.74
	Outside State	0.5 (0.1, 3.0)	0.45
Education ⁴⁸	Some secondary	Baseline	
	Completed secondary	0.5 (0.2, 1.2)	0.10
	Some college	0.8 (0.3, 1.9)	0.57
	Honours degree or Masters	1.2 (0.4, 3.4)	0.73
Last dental visit ⁴⁹	<12 months	Baseline	
	12 to 24 months	1.7 (0.8, 3.8)	0.17
	>24 months	0.9 (0.4, 3.8)	0.87
Age		1.2 (1.1, 1.2)	<0.001
Gender		1.4 (0.2, 11.0)	0.70

⁴⁸ 29 missing cases

⁴⁹ 1 missing case

4.8 Prevalence of periodontitis

In a review of the deployment of 6316 US troops Bosnia Chaffin reported periodontal pain as a cause stated by 5.4% of the 480 personnel who attended for a dental emergency appointment (Chaffin and Moss, 2008). A similar rate of 4% was reported for French troops in Afghanistan (Gunepin et al., 2011). Thus, although the vast majority of dental complaints on deployment are as a result of caries and its sequelae or as a result of pericoronitis, periodontal pathology presents a small but important cause of dental emergency. In addition, the high prevalence of periodontitis in populations (Whelton, 2007, Eke et al., 2020) means that cases are inevitably identified when routine dental examinations occur and there is a moral imperative to manage these cases that extends beyond the occupational requirements. Current prevalence rates in Ireland and the Army were unknown and these data will contribute to the planning of the delivery of care.

Known difficulties that have arisen in the definition of a periodontal case (Tonetti et al., 2005, Eke et al., 2012) were managed by defining periodontal cases using the Periodontal Screening and Recording methodology in use in the Army at that time (Landry and Jean, 2002). Within the context of the workflow of the dental service in the Army, patients with a PSR score of 3 or 4 were referred for comprehensive periodontal care, which started with full mouth periodontal charting. In brief, the PSR methodology mimics the CPITN methodology but sets the threshold for code 3 at 4mm and the threshold for code 4 at 6mm and allows useful comparison with national surveys reporting using CPITN (O'Mullane and Whelton, 1992, Whelton, 2007). The data were reported as a maximum measure with the single worst sextant used as classification as a periodontal case as was the case in the national surveys.

A limitation of the PSR methodology is that it does not account for over-estimation of disease that may occur in oedematous tissues. In older adults the apical migration of the attachment apparatus in disease means that the outcome may be an over-estimation of the severity of disease. However, in younger patients without apical migration of the attachment apparatus pseudo-pocketing may occur, leading to an over-estimation of the prevalence of periodontitis. In the Army these young patients present with oedema, bleeding tissues and sub-gingival calculus and require hygienist appointments for debridement using anaesthetic to resolve inflammation and as such are “treatment cases”. However, in the data collection for epidemiological purposes these cases provided data that were confusing, difficult to interpret and likely to have over-estimated the prevalence of periodontitis. No immediate solution is

apparent other than to undertake full mouth charting – a significant obstacle given the time and specialist expertise required.

4.8.1 Prevalence of periodontal health and conditions measured by PSR

The proportion of personnel by maximum PSR score in the weighted and unweighted sample of the Army is displayed in Table 4-52. In the weighted samples, only 6.1% of personnel had a PSR score of zero, which was surprising as the survey was composed of mainly young men and women. One of the limitations of the reporting in this study was that the PSR record was reported as a maximum measure and a single bleeding site would have classified a respondent in at least the PSR 1 category. It is known that bleeding may occur in health as a result of probe angulation, force or trauma from repeated probing (Hefti, 1997) and it is possible that these factors were involved. An additional 22.9% of the weighted sample had a score of one, indicating a group with gingival inflammation that required oral hygiene instructions but without the need for professional intervention. Since periodontitis is preceded by gingivitis and repeated bleeding is a risk factor for progression of disease (Claffey et al., 1990), these patients should be provided with tailored preventative programmes. A PSR score of two was recorded in 43.8% of the sample and showed the high degree of ineffective oral hygiene practices and requirement for professional intervention. Using the thresholds of a single site with 4mm or 6mm pocketing, in total, 27.2% of the sample had periodontitis, comprising 21.7% with pocketing of 4 or 5mm and 5.5% severe cases with pocketing of 6mm or greater.

Table 4-52: Maximum PSR score in the Army, weighted and unweighted sample

	n	PSR 0 (%)	PSR 1 (%)	PSR 2 (%)	PSR 3 (%)	PSR 4 (%)
Weighted	361	6.1	22.9	43.8	21.7	5.5
Unweighted	772	4.9	19.3	42.1	28.6	5.1

Direct comparison with international studies is difficult as they contained younger and much older participants than the Army sample, as well as more women and people with diverse ethnic and racial characteristics. In Australia, the population estimates were 28.8% at the threshold of pocketing of 4mm or more, which was comparable to the Army estimate of 21.7% (Ha et al., 2020) but might have been expected to be higher in Australia since it contained respondents of older age. In Canada, the survey recorded a prevalence of pocketing greater than 4mm as 20.1%, which was the lowest of any national survey and was probably affected by the use of eight molar and two incisor index teeth (Cooney, 2010). By contrast in both the UK and the US the population estimates were far greater than the estimated prevalence in the Irish Army. In the UK, using CPITN, the population estimate was 45%

including 8% with severe disease with pocketing of 6mm or more (White et al., 2011) and in the US the population estimate using the CDC definition for adults over the age of 30 years was 42.2%, including 7.8% severe cases. It is difficult to reconcile these differences without the capacity to undertake detailed analysis of the results in younger men that would allow more ready comparison.

4.8.2 Comparison between new entrants and the trained strength

The maximum PSR scores in the trained strength and new entrants is displayed in Table 4-53 and the differences in the distributions were statistically significant ($\chi^2=80.0$, $df=4$, $n=777$, $p<0.001$). The main difference was in the recording of at least one 4mm pocket in about half of recruits resulting in a PSR score of 3. This was likely to have been as a result of oedematous tissue and highlights one of the deficiencies of using the PSR measure in young populations. Nonetheless, the data showed that over half of the recruit group had inflammation to such an extent that referral for hygienist intervention was warranted and shows that a different approach to the management of recruits might be required.

Table 4-53: Maximum PSR score in the weighted Army, trained strength and recruits

	n	PSR 0 (%)	PSR 1 (%)	PSR 2 (%)	PSR 3 (%)	PSR 4 (%)
Weighted	364	6.1	22.9	43.8	21.7	5.5
Trained strength	553	6.5%	23.5	44.1	20.3	5.6
Recruits and cadets	224	0.9	8.9	37.1	49.1	4.0

A number of military studies are available for comparison with the recruits (Figure 4-29) and the trained strength (Figure 4-30). As was the case for the international civilian surveys, these results had huge variation that might be ascribed to the particulars of each population under observation including age range, gender proportion, ethnicity, smoking prevalence and socio-economic distribution. An advantage of comparison of data in relation to the recruits reported in international military studies is that similar ages to the Irish sample were present. The Finnish and Swiss recruit studies did not report patients with severe disease (Ankkuriniemi and Ainamo, 1997, Röthlisberger et al., 2007), whereas the prevalence in the US recruit studies was between 0.9% and 4.7% (Moss, 2011) and international reviews have reported a prevalence between 0.1% and 2.6% (Jenkins and Papapanou, 2001, Albandar and Tinoco, 2002), making direct comparison difficult. The results of the presence of moderate disease in the Irish Army recruits was considerably higher than other military reports, probably because of the over-reporting of disease in the Irish Army study, described above. These studies

highlight the need for more secure definitions of periodontitis and the need for more detailed periodontal examinations in this age group.

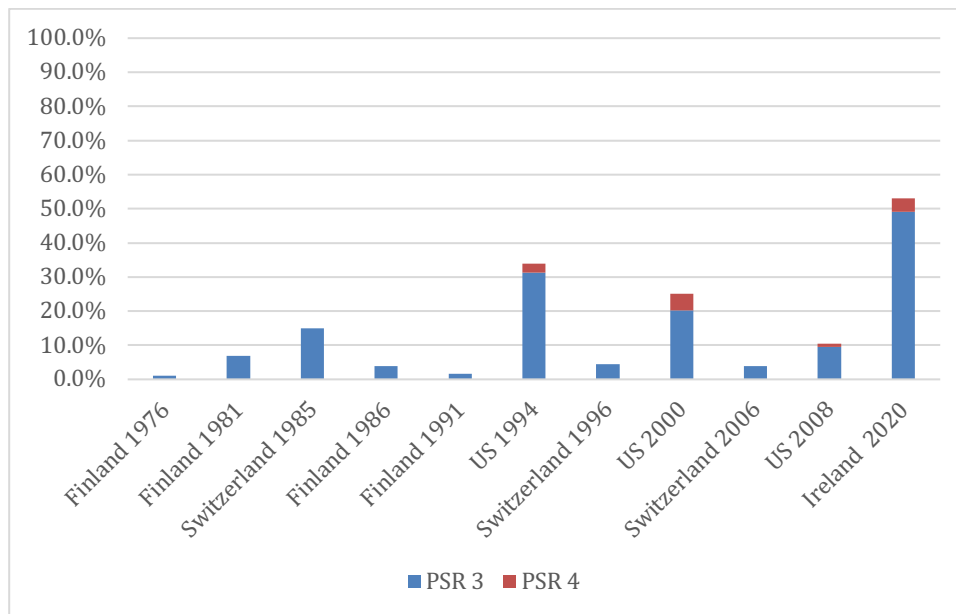


Figure 4-29: Prevalence of periodontitis as measured using PSR or CPITN in recruits in the Irish Army 2020 and recruits in the international military (Ankkuriniemi and Ainamo, 1997, Röthlisberger et al., 2007, Moss, 2011)

The reported prevalence in the trained strength of a number of armies is displayed in Figure 4-30 and shows the wide range of reported prevalence from 0.3% total periodontitis in Indian soldiers (Patankar, 2014) to 95.9% in Spanish soldiers (García et al., 2020), with over and under-reporting of prevalence equally likely. Notwithstanding the differences as a result of age and smoking status, these results reinforce the problems using these indices as reporting tools in epidemiological studies.

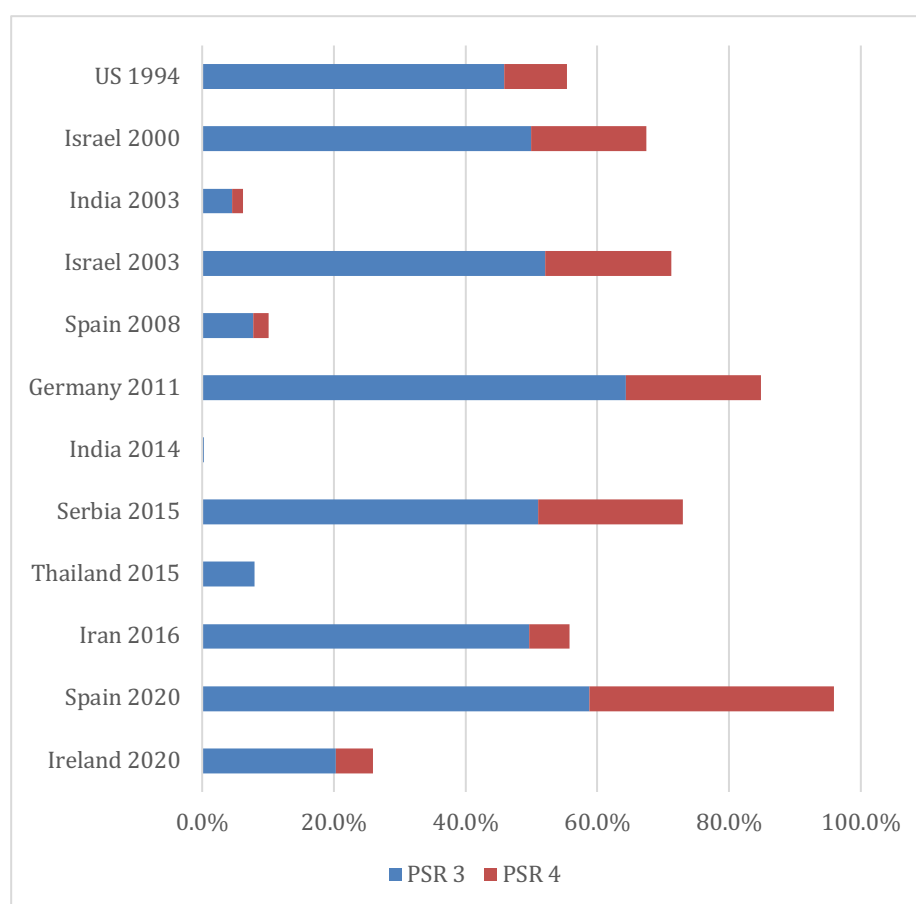


Figure 4-30: Prevalence of periodontitis as measured using PSR or CPITN in the trained strength of the Irish Army 2020 and military studies (York et al., 1995, Katz et al., 2000, Ahuja and Darekar, 2003, Vered and Sgan-Cohen, 2003, Mombiedro Sandoval and Llana Puy, 2008, Ziebolz et al., 2011, Patankar, 2014, Kovačević et al., 2015, Thankappan et al., 2015, García et al., 2020)

4.8.3 Prevalence of PSR by demographic variables and intermediate determinants of oral health

The prevalence of PSR 3 or 4 by demographic variables and intermediate determinants of oral health are displayed in Table 4-54. The differences by rank were between the new entrants and the other rank groups ($\chi^2=58.1$, $df=3$, $n=777$, $p<0.001$), which was a result of the high prevalence of inflammatory disease detected in the new entrants.

There was a statistically significant difference in the prevalence of PSR 3 or 4 between the 18 to 24 and the 25 to 34 years age group ($\chi^2=19.6$, $df=4$, $n=777$, $p<0.001$) which was a result of the high prevalence of new entrants in this age group. However, there was no particular pattern by age, unlike those reported in international surveys (Cooney, 2010, Ministry of Health, 2010, White et al., 2011, Ha et al., 2020) which tended to show an increase with age, albeit with plateaus or decreases in extreme old age. Comparisons with national surveys in relation to the prevalence of periodontitis showed the difficulties in case definition across a range of settings using the CPITN/ PSR methodology. The range of total periodontitis was so great in most of the age groups that meaningful interpretation is

impossible. In the analysis of severe periodontitis, it is scarcely believable that there were no personnel in the 16 to 24 years age group in the military or civilian surveys in 1990 that had severe disease. Similarly, in the 25 to 34 years age group in 1990 52% of soldiers were recorded with mild to moderate disease but again none were detected with severe disease, results that are suggestive of under-diagnosis. International data suggests a prevalence of severe periodontitis of about 10 to 15% in adults over the age of 40 years (Eke et al., 2020) which roughly corresponded to the order of magnitude of severe disease in the Army in 2020. The prevalence in these age groups in the Army may also have been affected by selective discharge from service, the small numbers in some of the groups and or regionalized access to hygienist therapy.

The prevalence by last dental visit differed between the “<12 months” group and the “>24 months” group ($\chi^2=8.0$, $df=2$, $n=776$, $p=0.02$) and may indicate that soldiers with periodontal disease who access services are identified and appropriately treated.

Table 4-54: Prevalence of PSR 3 or 4 by demographic variables and intermediate determinants of oral health, unweighted sample ($n=777$)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	41.1%	26.9%	33.8%	22.8%	55.6%	<0.001
Gender	Male (n=749)		Female (n=28)			0.53
	33.5%		39.3%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	<0.001	
	53.1%	25%	30.7%	17.2%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.19	
	46.2%	38%	30.7%	40.5%		
Education categories ⁵⁰	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	0.08	
	48.6%	34.9%	29.7%	26.4%		
Last dental visit ⁵¹	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)	0.02		
	31.2%	36%	45%			
Phobia ⁵¹	No phobia (n=728)		Phobia (n=47)		0.22	
	33.1%		41.7%			

⁵⁰ 29 missing cases

⁵¹ 1 missing case

4.8.4 Binary logistic regression PSR>2

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of periodontitis and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=79.9$, $df=13$, $p<0.001$), explained 14% of the variance in presence of complex prosthodontics and correctly classified 68.9% of the cases. The results are displayed in Table 4-55 and shows that rank and age were statistically significant. Every unit increase in age was associated with an OR 1.04 95% CI [1.01, 1.07] increase in the prevalence of periodontitis. Adjusted for age, all the rank groups were statistically lower than the new entrants, which reflected the high detected prevalence of inflammatory disease in the new entrants.

Table 4-55: Binary logistic regression of presence of PSR 3 or 4, unweighted sample (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.2 (0.1, 0.3)	<0.001
	NCO	0.2 (0.1, 0.4)	<0.001
	Officer	0.1 (0.1, 0.3)	<0.001
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.5, 1.2)	0.25
	>1 SD	1.1 (0.6, 2.1)	0.73
	Outside State	0.8 (0.4, 1.7)	0.54
Education ⁵²	Some secondary	Baseline	
	Completed secondary	0.6 (0.4, 1.1)	0.10
	Some college	0.7 (0.4, 1.3)	0.28
	Honours degree or Masters	0.6 (0.3, 1.2)	0.11
Last dental visit ⁵³	<12 months	Baseline	
	12 to 24 months	0.8 (0.5, 1.4)	0.46
	>24 months	1.3 (0.8, 2.0)	0.35
Age		1.04 (1.01, 1.07)	0.002
Gender		1.0 (0.4, 2.1)	0.92

⁵² 29 missing cases

⁵³ 1 missing case

4.9 Tooth surface loss

4.9.1 Prevalence estimates

The prevalence of TSL at the threshold of a single sextant with at least a score of two, was 22.1% in the weighted Army sample and 17.4% in the unweighted Army sample. The prevalence was very low by comparison with the national studies (reported by age groups) in Ireland (O'Mullane and Whelton, 1992, Whelton, 2007) or international studies in the UK (Kelly et al., 2000, White et al., 2011) or Australia (Slade et al., 2004) but were higher than the estimates for the US population (Alwaheidi et al., 2021). It is difficult to fully understand the reasons for such differences but the younger age of the Army population, the use of index teeth and the use of different measures may explain the differences.

4.9.2 Comparison between new entrants and the trained strength

The prevalence in the weighted Army, trained strength and recruits is displayed in Table 4-56. There was a much lower prevalence in recruits than the trained soldiers ($\chi^2=31.6$, $df=1$, $n=777$, $p<0.001$), as might be expected given their younger age (Whelton, 2007, Alwaheidi et al., 2021, White et al., 2011).

Table 4-56: Prevalence of TSL in weighted Army, trained strength and recruits

	Prevalence TSL
Weighted Army	22.1%
Trained strength	22.2%
New entrants	5.4%

Few military studies have reported the prevalence of TSL. In the Army of Singapore, the prevalence in soldiers between the ages of 18 and 25 years reported by Lim *et al* at the threshold of a single sextant with at least a BEWE score of two was 21.8%, which was higher than the reported prevalence in similarly aged recruits in the Irish Army (Lim et al., 2022). The prevalence in a group of Saudi recruits using anterior teeth only was 28% (Johansson et al., 1996) but up to 66% in a high-risk group consuming up to 4.8L of carbonated drinks per week (Johansson et al., 1997). Overall, the data points to a much lower prevalence of TSL in recruits in the Irish Army. Whether this was due to the presence of national water fluoridation, which has been reported as a factor that reduces the prevalence of TSL (Lussi et al., 2019), or a decrease in the reported consumption of carbonated drinks by adolescents in Ireland requires further research (Chatelan et al., 2022).

4.9.3 Prevalence estimates by demographic variables and intermediate determinants of oral health

The prevalence of BEWE $\geq$ 2 in the unweighted sample is reported by demographic variables and intermediate determinants of oral health in Table 4-57. The prevalence of BEWE $\geq$ 2 was associated with age ($\chi^2=25.1$, $df=4$, $n=777$, $p<0.001$). There prevalence was lowest in the youngest age group but without any discernible pattern across the age groups, unlike reports from national (Whelton, 2007) and international surveys (White et al., 2011, Alwaheidi et al., 2021) that showed an increase with age. The results in the Army must be interpreted with caution due to the small size of the older age groups. The lowest prevalence by rank was in the new entrants, which may have been affected by age. However, the lowest prevalence in the education categories was in the “Honours degree or Masters” group, which was suggestive of a social gradient.

Table 4-57: BEWE $\geq$ 2 reported by demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	9.8%	25.5%	16.5%	15.8%	22.2%	<0.001
Gender	Male (n=749)		Female (n=28)			0.22
	17.6%		10.7%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		<0.001
	5.4%	25.8%	21.3%	13.8%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.30
	10.3%	16.1%	19%	12.7%		
Education categories ⁵⁴	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.008
	16.2%	16%	22.4%	11.1%		
Last dental visit ⁵⁵	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		0.05
	19.4%		11%	12.8%		
Phobia ⁵⁵	No phobia (n=728)		Phobia (n=47)			0.04
	18.1%		6.4%			

⁵⁴ 29 missing cases

⁵⁵ 1 missing case

4.9.4 Binary logistic regression model BEWE $\geq$ 2

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of BEWE $\geq$ 2 and was adjusted for the effect of age, gender and last dental visit. The model was statistically significant ($\chi^2=45.2$, $df=13$, $p<0.001$), explained 10% of the variance in presence of complex prosthodontics and correctly classified 83.3% of the cases. The difference in the prevalence of BEWE $\geq$ 2 was statistically significant between the phobia and non-phobia groups. However, when added to the model, and adjusted for age and gender, phobia was not statistically significant and was thereafter removed. The results are displayed in Table 4-58 and show that only rank was statistically significant, and showed a large increase in risk in all the rank groups by comparison with the new entrant rank groups. This may indicate specific risk accumulating from military service, which may include the increased use of carbonated drinks on deployment.

Table 4-58: Binary logistic regression of presence of BEWE $\geq$ 2, unweighted sample ($n=777$)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	5.7 (2.8, 11.8)	<0.001
	NCO	5.2 (2.1, 13.0)	<0.001
	Officer	5.2 (1.7, 16.6)	0.005
Deprivation	<1 SD	Baseline	
	$\pm$ 1 SD	1.4 (0.8, 2.4)	0.27
	>1 SD	0.9 (0.4, 2.4)	0.98
	Outside State	1.5 (0.4, 5.0)	0.53
Education ⁵⁶	Some secondary	Baseline	
	Completed secondary	0.9 (0.5, 2.0)	0.86
	Some college	1.0 (0.5, 2.1)	0.99
	Honours degree or Masters	0.5 (0.2, 1.4)	0.21
Last dental visit ⁵⁷	<12 months	Baseline	
	12 to 24 months	0.8 (0.4, 1.6)	0.55
	>24 months	0.8 (0.4, 1.6)	0.55
Age		1.0 (1.0, 1.0)	0.39
Gender		1.3 (0.4, 4.7)	0.67

⁵⁶ 29 missing cases

⁵⁷ 1 missing case

4.9.5 Prevalence estimates and risk categories

The percentage of the weighted Army sample (n=364) by BEWE risk category is displayed in Figure 4-31. In the weighted sample, 65.8% were in the no risk category, 27.6% were in the low-risk category and 6.6% were in the medium risk category. No personnel were in the high-risk category. These results indicate that management of TSL at a specialist level is not required on a routine basis in the Army.

In the national surveys the prevalence of moderate TSL was reported as being between 11 and 15% and an additional 1 to 3.3% was in the severe categories (Kelly et al., 2000, Slade et al., 2004, Whelton, 2007, White et al., 2011, Al-Zwaylif et al., 2018). The prevalence of moderate wear in the Army sample is about half of the range in the national studies and may be explained by the younger age of the Army sample. A very similar result to the Army was reported by Lim et al in a group of young soldiers who had a prevalence of 38.6% of low to moderate TSL reported by BEWE category (Lim et al., 2022). There were no personnel in the Army study in the severe risk category, which was a marked difference from previous national studies.

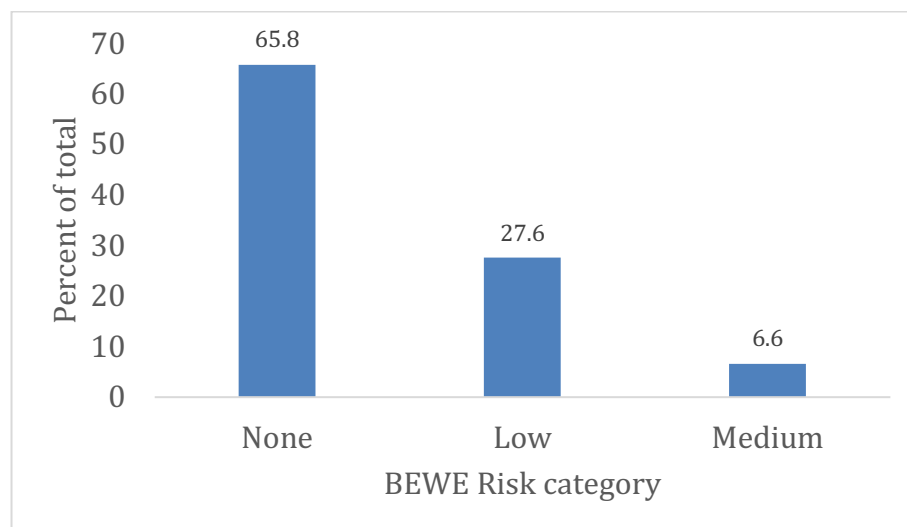


Figure 4-31: Percentage distribution of the weighted Army sample by BEWE categories (n=364)

The summed sextant BEWE scores may be used to determine risk categories that formulate treatment plans that are provided on a patient level and includes oral hygiene, dietary advice and fluoride advice (Bartlett et al., 2008). However, this approach would seem to be at odds with the severity of TSL recorded in every sextant as the summed score may under-estimate the severity of TSL in low-prevalence populations. For instance, a patient with up to 50% TSL in the anterior maxilla could be categorized as none or low risk, depending on the severity of TSL in other sextants. Difficulties in categorization may be compounded by the

known difficulties in identifying incipient lesions and differentiating from physiologic processes (Mulic, 2010).

In order to assess the efficacy of risk categorization using BEWE, the prevalence of risk categories and the prevalence of any sextant at the threshold of BEWE score 2 in these categories was determined, as displayed in Table 4-59. In the ‘None’ category there were twelve personnel, corresponding to 2.2% of the total of this group, who had at least one sextant with moderate wear and in the low-risk category, about half had at least one sextant with moderate TSL. These differences would suggest that the risk categories are not as useful for treatment planning purposes in a population with a low prevalence of medium and high-risk TSL.

Table 4-59: Frequency distribution of personnel by BEWE risk category and sextants with moderate TSL, unweighted sample (n=777)

BEWE risk category	Summed score	At least one sextant with ≥ 2	
		Yes	No
None	0 to 3	12 (2.2%)	545 (97.8%)
Low risk	4 to 8	83 (46.1%)	97 (53.9%)
Medium risk	9 to 13	40 (100%)	0 (0%)
High risk	≥ 14	0 (0%)	0 (0%)

The percentage of personnel in the weighted Army sample by single maximum score is displayed in Figure 4-32. This displays the risk at a patient level utilizing the single maximum site, as is used in periodontal screening. The results show a reduction in the number categorized as no risk and an associated increase in the number at low and moderate risk. Since most of the management, especially in the none and low risk categories is applied at the patient level rather than a site level (Bartlett et al., 2008), categorization by single worst sextant would appear to be a more logical choice for the Army population and is simpler to use.

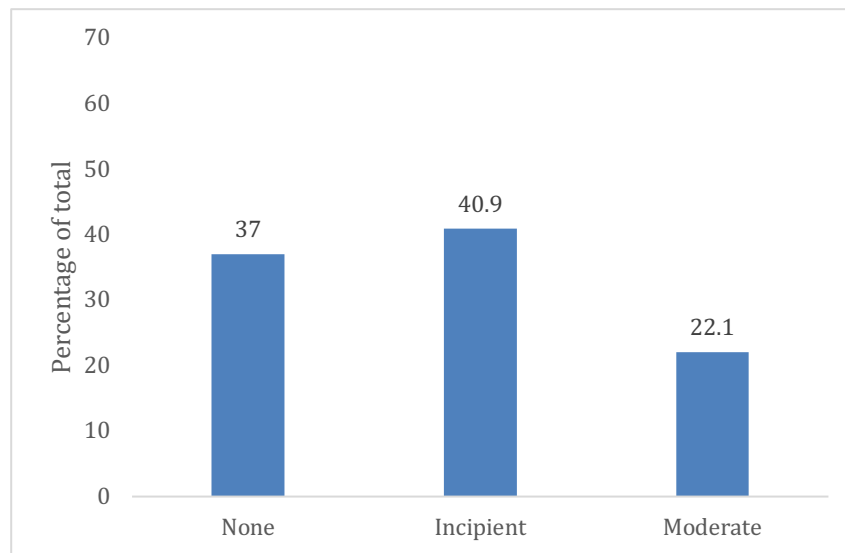


Figure 4-32: Percentage distribution of the weighted Army sample by maximum score in any sextant (n=364)

4.9.6 Distribution of TSL by tooth surface

The percentage of the BEWE score attributable to tooth surface loss in maxillary posterior teeth, maxillary anterior teeth, mandibular posterior teeth and mandibular anterior teeth in the unweighted Army sample, is displayed in Figure 4-33. The vast majority was attributable to TSL in the anterior teeth but whether this represents preferential loss in the anterior part of the mouth or the known difficulties assessing the posterior part of the mouth (Johansson et al., 1996) is unknown.

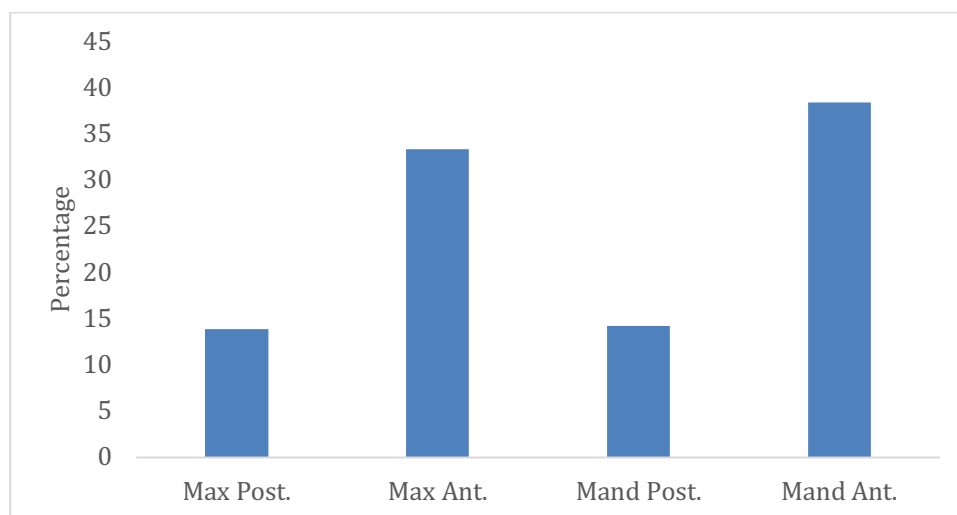


Figure 4-33: Percentage of BEWE score attributable to tooth surface loss in maxillary posterior teeth, maxillary anterior teeth, mandibular posterior teeth and mandibular anterior teeth, unweighted Army sample (n=417)

Further analysis of the sample indicates that of the 417 personnel with a summed score greater than zero, 98.3% had incisor TSL. Only 1.7% of the reported sample solely had TSL in the posterior sextants without having TSL in the anterior sextants. This indicates that for

the vast majority of personnel, an examination of the anterior teeth is sensitive enough to detect the presence of TSL. This also indicates that valid comparisons may be made with national studies that only report the TSL characteristics of anterior teeth.

4.10 Conclusion

These results have provided valuable data that can be used in the planning for services within the Army. The wider applicability includes providing information about a group of mainly young, healthy men of whom little is currently known about their oral health in Ireland.

A number of high-level results emerged from the data. The mean number of teeth in the Army was 28.2 95% CI [27.9, 28.5], with little difference between recruits and the trained strength indicating retention of teeth into older age and a marked difference with the results of previous national surveys. No personnel in the survey were edentulous and 99.1% had at least 21 teeth, with a concomitant reduction in the prevalence of dentures to 1.4%. These combined results show the improvements in oral health that have occurred that might be ascribed to lifetime fluoridation and changing treatment approaches to aid the retention of teeth.

In addition to retaining teeth, personnel had more sound teeth with a mean SUNT 21.2 95% CI [20.6, 21.7] in the Army. On entry 26.3% of recruits and cadets had a DMFT score of zero but both the number of SUNT and the proportion with DMFT equal to zero reduced with service and highlighted the need for strategies to preserve oral health that might include minimally invasive approaches to managing dental disease and a change in the way dentists are paid for the management of these cases.

Only 16% of the Army had decayed teeth, a testament to the success of the treatment programme, particularly in light of the fact that 39.7% of recruits and cadets on entry presented with decayed teeth. Few personnel had the sequelae associated with severe caries as measured by PUFA and unrestorable teeth. In terms of treatment, only 6% of total DMFT scores were a result of extraction, by comparison with 14% in deployed soldiers in 1991, and over half of soldiers in 2020 had no missing teeth as a result of caries.

The overall prevalence of periodontitis was 27.2%, as measured by the presence of a single pocket depth of at least 4mm in depth. The population estimate was lower than that reported internationally (Eke et al., 2015) but understandable in relation to the young age of the Army. Over-estimation of disease in the recruit and cadet group showed the difficulty of managing oedematous states without detailed examinations. Within the sample no personnel were recorded with BEWE scores of three in any sextant, indicating that complex restorative rehabilitation is not required on a routine basis. Again, the young age of soldiers in the Army was a salient factor.

A series of binary regression analyses were conducted, which considered the effect of rank, education and deprivation on the main clinical indicators, adjusted by age, gender and last dental visit. The results are summarized in Table 4-60 and show the outstanding feature of the analyses that deprivation was not associated with oral health status in the Army. These results were at odds with those reported in Ireland by Medical Card status (Whelton, 2007), by small area deprivation in England (Public Health England., 2020), Australia (Peres et al., 2020) and New Zealand (Ministry of Health, 2010) and by income in Canada (Cooney, 2010). It is only possible to speculate about the rationale for these findings but it is possible that free basic healthcare and mandatory dental fitness before deployment reduced gradients by deprivation index. In this respect it was interesting to note that statistically significant differences were present in a wide range of clinical indicators in the new entrants, without access to the Army system of care. In the new entrants, those living in the poorest small areas had worse oral health including a lower number of SUNT, over half with decayed teeth, higher DMFT and FT scores and a greater proportion wearing dentures. Similar findings have been reported in soldiers in the British Army drawn from the two lowest deprivation quintiles (Elmer et al., 2011). These differences suggests that the military system had some impact on reducing the social gradients present, at least where measures of small area deprivation were concerned.

Table 4-60: Statistically significant independent variables (demographic indicators and intermediate determinants of oral health) associated with dependent variables (clinical indicators)

Indicator	Rank	Dep*	Education	Last dental visit	Phobia	Age	Gender
SUNT	✓		✓			✓	
DT	✓		✓	✓	✓		
MT	✓		✓		✓	✓	
FT	✓		✓	✓		✓	
DMFT=0	✓		✓	✓		✓	
Complex restorative	✓					✓	
PSR 3 or 4	✓					✓	
BEWE ≥ 2	✓						

*Dep = small area deprivation

By contrast, social gradients existed by rank across all of the clinical indicators (adjusted for age) and showed that a new social gradient existed with better oral health in officers than age-matched NCOs. These results were mirrored in the education categories with better oral health in soldiers with an Honours degree or Masters (mainly officers) and poorer oral health in soldiers with “some secondary” education. Recency of dental visiting affected the

prevalence of decayed teeth, number of filled teeth and proportion with DMFT=0 and patients with phobia had a greater risk of decayed teeth and missing teeth. These results show that optimal access could not solve all the barriers created by inequality and targeted measures at high-risk groups are required.

These important results will allow military management to form a baseline from which they may monitor the change in oral health of the Army. The data can also be used to analyse the success of changing strategies in service delivery, including the delivery of preventative programmes.

5 The proximal determinants of oral health in the Irish Army

5.1 Introduction

The previous chapter reported the prevalence of diseases and conditions in the Army. The results showed improvements in oral health in soldiers by comparison with the results of previous Army (Hayden, 1995) or national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) with an increase in tooth retention and a decrease in the prevalence of denture wearing. Provision of free dental treatments and the mandatory meeting of dental fitness standards before deployment were part of a system that resulted in a low prevalence of untreated caries of 16%, with a mean number of 0.3 95% CI [0.2, 0.4] untreated carious teeth. The prevalence of periodontitis and TSL was also low at 27.2% and 22.1%, respectively, possibly aided by the relatively young age of soldiers by comparison with national populations.

Army studies (Hayden, 1995), national civilian (O'Mullane and Whelton, 1992, Whelton, 2007) and international civilian (Cooney, 2010, White et al., 2011, CDC, 2019, Amarasena et al., 2021) surveys have highlighted that certain groups are at higher risk of disease, particularly those at risk of economic disadvantage. The previous chapter highlighted differences between the disease experience of new recruits and the trained strength, particularly in the prevalence and mean number of untreated carious teeth, demonstrating that the experience of disease was not evenly distributed. The chapter also showed that social gradients in disease experience existed by rank and education in the Army, with officers enjoying better oral health than would be expected based on their age, while soldiers with “some secondary” education had poorer oral health than other groups.

The dental service was aware that service delivery was overly focussed on the reflexive treatment of observed disease without the management of the proximal determinants of disease that underpinned outcomes but the prevalence of these determinants in the Army population was unknown. In light of these matters, the epidemiological survey undertook a detailed examination of the proximal determinants of oral diseases and conditions in the Irish Army. The results will be used to identify groups in need of additional supports and to develop an action plan for the reduction in harmful health behaviours.

5.2 Smoking

The association between smoking and oral diseases including oral cancer (Sadri and Mahjub, 2007), periodontitis (Genco and Borgnakke, 2013) and caries (Jiang et al., 2019) have been described in detail, along with impacts including tooth loss (Carson and Burns, 2016). In the national survey in 2000, smokers had a greater prevalence of pockets of at least 4mm, fewer teeth and a higher rate of edentulousness but in the interim national or Irish Army data linking smoking to oral health has not become available. Smoking also affects military fitness (Conway and Cronan, 1992, Reynolds et al., 1994) and overall health (Chang et al., 2021) and complete cessation is a target for health intervention.

In 1990 Hayden reported that over 40% of soldiers smoked (Hayden, 1995), in 2000 the national survey reported that about a third of respondents smoked (Whelton, 2007) and in 2019 the Healthy Ireland survey reported that 17% of the civilian population smoked (Dept. of Health, 2019) but data for the Army in recent years was not available. The international evidence suggested that soldiers smoked more than civilian peers (Feigelman, 1994, Machuca et al., 2000, Di Nicola et al., 2006, Fear et al., 2010) and that the ill health effects of smoking lasted long after military service (Bethmann and Cho, 2023).

A large body of smoking data was collected in the survey that is not of direct relevance to the outcomes of the research. In this thesis the estimation of the prevalence of smoking was reported to understand the systems that might be required to reduce the impact of smoking on health and oral health in the Army.

5.2.1 Prevalence of smoking

The prevalence of smoking in the Army compared to national data reported in the Healthy Ireland report of 2019 is displayed in Table 5-1 and shows that the prevalence of 20.7% in the Army was higher than in the national civilian population, as has been reported in the military internationally (Feigelman, 1994, Fear et al., 2010). There were about three times as many occasional smokers in the Army as in the Healthy Ireland survey (Dept. of Health, 2019). Occasional smokers have been reported to have a higher likelihood to become daily smokers but often do not draw the attention of healthcare professionals to the same extent as daily smokers (Robertson et al., 2016). There were more ex-smokers in the national survey than in the Army, as a result of the inclusion of older citizens in the national data.

Table 5-1: Prevalence of smoking in Ireland 2019 and weighted Army (n=364) 2019-2020

	Smoking category			Ex-smoker	Non-smoker
	All	Daily	Occasional		
Healthy Ireland 2019	17.0	14.0	3.0	28.0	55.0
Army	20.7	11.9	8.8	24.8	54.5

5.2.2 Comparison between new entrants and the trained strength

Table 5-2 displays the difference between the trained strength and new entrants and shows statistically significant differences in the smoking categories ($\chi^2=23.5$, $df=3$, $p<0.001$). These data show that about a quarter of Army new entrants smoked and suggests that new entrants were drawn from a subset of the population. The results also show that efforts to decrease smoking prevalence must begin on entry and be applied progressively throughout military service.

Table 5-2: Prevalence of smoking in the trained strength and new entrants, unweighted data

	Smoking category			Ex-smoker	Non-smoker
	All	Daily	Occasional		
Trained strength (n=553)	19.9%	11.4%	8.5%	25.5%	54.6%
New entrants (n=224)	25.4%	12.5%	12.9%	10.3%	64.3%

5.2.3 Prevalence displayed by demographic variables and intermediate determinants of oral health

The prevalence of current (daily or occasional) smoking in the unweighted sample is reported by demographic variables and intermediate determinants of oral health in Table 5-3. The prevalence was highest in the youngest age group and declined in older age ($\chi^2=10.9$, $df=4$, $n=777$, $p=0.03$). The pattern differed from the national population both in the prevalence and the peak in the youngest age group (Dept. of Health, 2019). A social gradient was present, with a lower prevalence in officers than new entrants and NCOs ($\chi^2=11.6$, $df=4$, $n=777$, $p=0.009$) and across the education categories ($\chi^2=19.6$, $df=3$, $n=777$, $p<0.001$), including a third of the “some secondary” category. Interestingly, the differences across the deprivation categories were not statistically significant, thus differing from the national reports (Dept. of Health, 2019). The prevalence in the most affluent group (17.7%) was higher than reported for the most affluent civilians (14%) (Dept. of Health, 2019) and suggests that the Army may recruit personnel from all social classes with higher risk than civilian peers.

Table 5-3: Prevalence of current smoking reported by demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

unweighted sample (n=777)						
Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	26.1%	19.9%	21.1%	14%	0%	0.03
Gender	Male (n=749)		Female (n=28)			0.34
	21.8%		14.3%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.009
	25.4%	24.6%	17.8%	10.3%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.09
	12.8%	28.5%	20.9%	17.7%		
Education categories ⁵⁸	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		<0.001
	31.1%	25.7%	16.7%	11.1%		
Last dental visit ⁵⁹	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)		0.26
	20.5%	21%		27.5%		

5.2.4 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of smoking and was adjusted for the effect of age and gender. The model was statistically significant ($\chi^2=28.6$, $df=11$, $p=0.003$), explained 6% of the variance in the prevalence of smoking and correctly classified 78.9% of the cases. The results are displayed in Table 5-4 and shows that only the education category was statistically significant, when adjusted for age and gender, and showed a large decrease in smoking in the “some college” and “Honours degree or Masters” groups by comparison with the “some secondary” group. These results are interesting as they suggest that smoking is a behaviour in the Army that transcends rank and social class and may indicate recruitment from a subsection of Irish society.

⁵⁸ 29 missing cases

⁵⁹ 1 missing case

Table 5-4: Binary logistic regression of presence of smoking, unweighted (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.9 (0.6, 1.5)	0.78
	NCO	1.0 (0.5, 2.0)	0.91
	Officer	0.8 (0.3, 2.1)	0.62
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.5, 1.3)	0.36
	>1 SD	0.7 (0.3, 1.5)	0.34
	Outside State	0.3 (0.1, 0.9)	0.30
Education ⁶⁰	Some secondary	Baseline	
	Completed secondary	0.6 (0.4, 1.2)	0.17
	Some college	0.4 (0.2, 0.9)	0.01
	Honours degree or Masters	0.3 (0.1, 0.7)	0.008
Last dental visit	<12 month	Baseline	
	12 to 24 months	0.9 (0.5, 1.6)	0.76
	>24 months	1.4 (0.8, 2.3)	0.24
Age		1.0 (1.0, 1.0)	0.40
Gender		1.7 (0.6, 5.2)	0.31

5.2.5 Summary of the main results of the smoking data

These results showed the high prevalence of smoking in the Army relative to the national civilian population (Dept. of Health, 2019) and show the pressing need for targeted health promotion. A quarter of new entrants smoked on joining which suggest recruitment from a subset of the Irish population. When adjusted for age and gender only education level was statistically significant but the outcome was partly a result of the relatively high prevalence of smoking in more affluent soldiers. The results should be communicated to military management to develop policies at a senior level that will tackle smoking cessation on an Army-wide basis.

⁶⁰ 29 missing cases

5.3 Alcohol consumption

Alcohol has been reported as a risk for the development of dental caries, TSL and periodontal disease, with impacts exacerbated by lifestyle habits such as brushing frequency (Park et al., 2014) and smoking (Bobo and Husten, 2000). In Ireland, surveys have reported that younger men are more likely to binge drink (Dept. of Health, 2018) and an excessive drinking culture has been reported in the military internationally (Fear et al., 2007, Marimoutou et al., 2010, Mattiko et al., 2011). These factors explain the rationale for the collection of data about alcohol consumption in the Irish Army. The priority was to identify the proportion of high-risk users, as defined by the HSE (HSE, 2024), to quantify the need for pathways of care from the dental service to medical colleagues specializing in this area.

5.3.1 Summary statistics

The summary statistics for the number of units of alcohol consumed by the respondents is displayed in Table 5-5. The mean number of units consumed was low, but with a huge range from zero units to 50 units. By comparison, the Healthy Ireland document reported a national average of 10.8L, corresponding to about 17 standard units per person per week (Dept. of Health, 2019). It is possible that soldiers are an outlier in the national consumption but the smoking data would suggest that alternative theories should be considered. The low number of units reported may have been a result of recall bias, a known problem in data collection in alcohol surveys as the volume reported in national surveys does not typically cover national sales (Rehm, 1998). Soldiers may also have been reluctant to divulge data to a member of an occupational team.

Table 5-5: Summary statistics, units of alcohol, weighted and unweighted samples

Sample	p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	0.17	364	5.5	5.0, 6.1	4	9	0	50
Unweighted	0.17	777	6.0	5.6, 6.5	4	9	0	50

In this survey, patients were classified as high-risk for alcohol misuse using the HSE guidelines of 11 units a week or more if female or 17 or more units a week if male (HSE, 2024). The percentage of abstainers, low-risk and high-risk consumers in the weighted Army, trained strength and new entrants are displayed in Table 5-6. A small proportion of the weighted Army sample consumed alcohol at high risk (4%), but it must be considered that this may include personnel who handle weapons, drive, fly, engage in robust training, handle secure data and a plethora of other tasks that require adequate concentration. There was also a

group with increased risk of harm including 0.6% who drank 30 units or more and 0.2% who drank 40 units or more a week, with the potential to incur immediate health damage.

The percentage of abstainers in the Army sample was 23% of the weighted sample, very similar to the proportion reported by the Healthy Ireland survey in 2018 at 24.8% (Dept. of Health, 2018). However, caution must be exercised when comparing the two datasets as the reported abstinence in the Healthy Ireland data was over the previous 12 months whereas in the Army sample personnel were asked to recall their consumption over a typical week. The data indicates that the abstinence rates were much higher in Irish soldiers than those reported in British and American soldiers (Fear et al., 2007, Mattiko et al., 2011). For example, in the British Army only 3% of men and 2% of women were abstainers (Fear et al., 2007).

5.3.2 Comparison between new entrants and the trained strength

The comparison between the trained strength and new entrants is displayed in Table 5-6, with the p-value for the results of the statistical tests for differences between the groups. New entrants had a higher mean number of units consumed, a lower proportion of abstainers and a higher proportion of high-risk drinkers than in the trained strength, which corresponded with the reported higher prevalence in younger civilians in Ireland (Dept. of Health, 2018).

Table 5-6: Units of alcohol per week and alcohol risk categories in the weighted Army, the trained strength and recruits and cadets

	Units per week	Abstainers	Low risk	High risk
Weighted Army (n=364)	5.5 (5.0, 6.1)	23.1%	72.9%	4%
Trained strength (n=553)	5.5 (5.0, 5.9)	23%	73.2%	3.8%
New entrants (n=224)	7.4 (6.4, 8.4)	15.6%	75%	9.4%
p value	<0.001	<0.001		

5.3.3 Prevalence by demographic and intermediate determinants of oral health

The prevalence of high-risk alcohol misuse in the unweighted sample is reported by demographic variables and intermediate determinants of oral health in Table 5-7. The prevalence was highest in the youngest age group ($\chi^2=9.9$, $df=4$, $n=777$, $p=0.04$) and in the new entrants ($\chi^2=9.9$, $df=3$, $n=777$, $p=0.02$) but with no difference by gender, deprivation or education. These results differed from the national data which, although using different metrics, reported higher prevalence in men and those living in more deprived communities (Dept. of Health, 2018). The prevalence was lowest in the group who had attended within 12

months ($\chi^2=9.7$, $df=2$, $n=776$, $p=0.008$) but may be a sign of salutogenic orientation in more recent attenders.

Table 5-7: Prevalence of alcohol misuse reported by demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	7.7%	3.2%	3%	10.5%	5.6%	0.04
Gender	Male (n=749)		Female (n=28)			
	5.3%		7.1%			0.68
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		
	9.4%	3.4%	4.5%	3.4%		0.02
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		
	12.8%	5.8%	4.8%	5.1%		0.20
Education categories ⁶¹	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		
	8.1%	6.5%	3.1%	4.9%		0.28
Last dental visit ⁶²	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)			0.008
	3.9%	10%	9.2%			

5.3.4 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on high-risk alcohol misuse and was adjusted for the effect of age and gender. The model was statistically significant ($\chi^2=15.4$, $df=11$, $p=0.17$), explained 6% of the variance in the prevalence of smoking and correctly classified 94.5% of the cases. However, when adjusted for age, none of the independent variables were found to have a statistically significant association with alcohol misuse. The results indicate that alcohol misuse is evenly distributed across the Army population and no assumptions should be made about classes of patients at risk.

5.3.5 Conclusions of the alcohol data

These data show that 4% of the Army consumed alcohol above the safe thresholds defined by the HSE and included a small proportion with hazardous drinking at immediate risk of harm to health. The prevalence was greatest in the new entrants and the youngest soldiers and the

⁶¹ 29 missing cases

⁶² 1 missing case

declared pattern of consumption did not follow the reported civilian pattern (Dept. of Health, 2018). Overall, the conclusion of these results is that the risks posed relate to future development of oral cancer and capacity and safety issues associated with military service.

5.4 Dietary patterns

It has long been known that diet affects the incidence and severity of dental caries (Gustafsson et al., 1954, Holloway et al., 1962) and recent reviews have reported small but weak associations between diet and TSL (Salas et al., 2015, Chan et al., 2020). In Ireland the national survey in 2000 reported that a quarter of 16 to 24 year old respondents ate sugary foods five or more times daily (Whelton, 2007) with a higher consumption in younger people and in the Healthy Ireland report in 2018 a third reported eating sugary foods daily (Dept. of Health, 2018). In the UK a half of respondents consumed cariogenic foods six or more times a day, with little difference by social class (Chadwick et al., 2011). Little is known about the dietary pattern of soldiers in the Irish Army. The results will be used to determine the prevalence of high-risk diet in the Army, to assess whether high-risk behaviour is associated with other proximal determinants and to assess the association with clinical indicators. The data will be used to formulate the delivery of preventative programmes and to identify high-risk groups in the Army.

5.4.1 Summary statistics and differences between new entrants and trained strength

Table 5-8 displays the proportion of respondents who had a high-risk diet in the weighted Army, trained strength and new entrants, the item frequency and the p-values for the results of the χ^2 test for differences in distribution between the new entrants and trained strength. About half of the Army consumed a high-risk diet, which approximated the results of the UK national survey, although the latter did not include sugar in hot drinks (Chadwick et al., 2011). About a third of the Army had sugar in hot drinks, which may present a specific risk in Army culture given the importance of morning coffee in all workplaces to allow informal meetings to facilitate problem solving. Each teaspoon of sugar constitutes approximately 10% of the maximum daily intake recommended by the WHO, which adds health risks outside of the oral cavity (World Health Organization, 2015). About a third of Irish civilians reported consuming a cariogenic diet at least daily and 9% drank sugar sweetened drinks (Dept. of Health, 2018). Although not directly comparable because of the methodology, the results suggested that soldiers had a higher consumption than the national population.

A higher proportion (58.5%) of new entrants consumed a high-risk diet, with the difference explained by a higher consumption of cakes, sweets and chocolate by the new entrants. Anecdotally, dental teams have reported sweets being used as a reward in recruit training and it is certainly the case that ration packs have a high carbohydrate content, including sweets

and other cariogenic foods. As a first point of entry into the Army this may form a culture of the consumption of cariogenic foods that may later be difficult to change.

Table 5-8: Consumption six or more times a week of cakes or other baked goods, sweets or chocolate and fizzy drinks or fruits juices; consumption of sugary tea or coffee and consumption of a high-risk diet. Data reported for the weighted Army, trained strength and recruits and cadets. The p values for the differences in distribution between the trained strength and recruits and cadets are displayed.

	Weighted (n=364)	Trained strength (n=553)	New entrants (n=224)	p value
High-risk diet	51.3%	50.5%	58.5%	0.04
Cakes and other baked goods	11.2%	11%	17.4%	0.02
Sweets or chocolate	12.6%	12.5%	21.9%	<0.001
Fizzy drinks or fruit juices	9.5%	9%	12.1%	0.20
Sugary tea or coffee	37%	37.1%	41.1%	0.28

5.4.2 Prevalence by demographic and intermediate determinants of oral health

The prevalence of current high-risk diet in the unweighted sample is reported by demographic variables and intermediate determinants of oral health in Table 5-9. The prevalence decreased with age ($\chi^2=14.5$, $df=4$, $n=777$, $p=0.006$) but differed little in the 18 to 44 years age groups who make up the bulk of the Army. In the Healthy Ireland report, although using different metrics, there was little difference by age (Dept. of Health, 2019) and in the UK although the 18 to 24 years age group had the highest prevalence, there was little difference in the remaining relevant age groups (Chadwick et al., 2011). These results might suggest a longer-term military effect mediated by annual requirements to achieve military fitness standards. In the 2000 national survey, the respondents who ate cariogenic foods less than three times a day had more teeth and lower DMFT scores than the other groups but with little difference in the 16 to 24 years age group and a widening effect in older age (Whelton, 2007), which might suggest that the effect of cariogenic diets might be masked somewhat in a young Army population. More pertinently, the large proportion with a cariogenic diet underpins the high prevalence of decayed teeth seen in those without access to treatment, including new entrants and those with less recent attendance.

Evidence of social gradients were present in the data, with gradients present by rank ($\chi^2=9.5$, $df=3$, $n=777$, $p=0.02$) and by education level ($\chi^2=14.5$, $df=3$, $n=748$, $p=0.003$) but not by deprivation ($\chi^2=0.5$, $df=4$, $n=777$, $p=0.91$). In the education categories, 68.9% of soldiers with “some secondary” education had a high-risk diet and provided rationale for the results seen in the clinical indicators. In the rank groups, there was a decrease from new entrant to NCO and officer that reflected the underlying age of these groups. The limited differences between

NCOs and officers, and those between the deprivation categories, indicate that diet was unaffected by social class, as has been reported in the UK (Chadwick et al., 2011).

Table 5-9: Prevalence of high-risk diet reported by demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	57.8%	51.8%	54.1%	38.6%	22.2%	0.006
Gender	Male (n=749)		Female (n=28)			
	53%		46.4%			0.49
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		
	58.5%	55.3%	47.5%	42.5%		0.02
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		
	56.4%	54%	51.9%	56.4%		0.91
Education categories ⁶³	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		
	68.9%	54.7%	47.9%	44.4%		<0.001
Last dental visit ⁶⁴	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)			
	53.1%	52%	52.3%			0.97

5.4.3 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of a high-risk diet and was adjusted for the effect of age and gender and is displayed in Table 5-10. The model was not statistically significant ($\chi^2=22.2$, $df=13$, $p>0.05$), only explained 4% of the variance in the prevalence of high-risk diet (Nagelkerke R^2) and correctly classified only 55.2% of the cases, thus being close to a random coin toss. Marginal improvements occurred when last dental visit was removed from the model ($\chi^2=21.8$, $df=11$, $p=0.03$). Higher education remained statistically significant by comparison with those with “some secondary” education but the results must be interpreted with caution due to the low predictability of the model. Other factors such as urban-rural or type of military unit (infantry versus technical) might be important but not available for interpretation within the model.

⁶³ 29 missing cases

⁶⁴ 1 missing case

Table 5-10: Binary logistic regression for presence of high-risk diet (n=748, unweighted data)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.9 (0.6, 1.5)	0.85
	NCO	1.0 (0.5, 1.8)	0.94
	Officer	0.9 (0.4, 1.8)	0.78
Deprivation	<1 SD	Baseline	
	±1 SD	1.1 (0.7, 1.6)	0.75
	>1 SD	1.2 (0.7, 2.2)	0.50
	Outside State	1.1 (0.5, 2.4)	0.7
Education ⁶⁵	Some secondary	Baseline	
	Completed secondary	0.5 (0.3, 0.8)	0.007
	Some college	0.4 (0.3, 0.8)	0.006
	Honours degree or Masters	0.4 (0.2, 0.7)	0.005
Last dental visit	<12 month	Baseline	
	12 to 24 months	1.0 (0.6, 1.5)	0.85
	>24 months	1.0 (1.0, 1.0)	0.92
Age		1.0 (1.0, 1.0)	0.07
Gender		1.5 (0.7, 3.2)	0.34

5.4.4 Conclusion of the diet data

The results showed a high prevalence of dietary behaviours that would adversely affect oral health. The data are of wider interest in the Army due to the common risks with other diseases that may affect health and military fitness. Carbohydrate rich ration packs and a culture of morning coffee may compound the risk in the Army. Comparisons with the national civilian population are difficult due to the paucity of data but the results from the Healthy Ireland survey are suggestive of a higher prevalence in soldiers (Dept. of Health, 2018). The higher prevalence in new entrants accords with the findings of the smoking data reported herein and suggests recruitment from a specific subgroup of the Irish population. No systematic approach to manage dietary behaviours existed in the Army dental service. The failure to tackle behaviour resulted in a treatment-oriented approach that needs to be transformed into a preventatively-oriented model of care.

⁶⁵ 29 missing cases

5.5 Preventative measures

The Army spends considerable time and money financing the treatment of personnel with oral disease as a means of reducing the risk of lost workdays caused by dental emergencies, particularly on deployment. Chairside preventative measures are an integral part of clinical practice whose aim is to reduce the burden of disease experience in a populations (Pitts, 2004). In the national survey in 2000, less frequent brushers and those without access to optimal fluoridation measures had fewer teeth, fewer SUNT and higher DMFT scores (O'Mullane and Whelton, 1992, Whelton, 2007). Deployments by Irish soldiers to non-fluoridated countries, increasing consumption of bottled water in Ireland (Geological Survey Ireland, 2023) may have exacerbated the risk. For these reasons information about preventative measures undertaken by soldiers were recorded in this survey.

5.5.1 Brushing frequency

5.5.1.1 Summary statistics

The reported brushing frequency in the Army is displayed in Table 5-11. Since the prevalence of brushing “less than once a day” was very small, this group was merged with the “once a day” group and the data dichotomized into high risk and low risk brushing. The results show that the vast majority of personnel declared brushing twice a day or more. The proportion brushing twice a day or more frequently in the Army was higher than reported by civilians in 2000, at around 70% for the 16 to 24 and 35 to 44 years age group (Whelton, 2007). The results were also better than reported in high-income countries including 69% in New Zealand (Ministry of Health, 2010), 73% in Canada (Cooney, 2010), 75% in the UK (Steele and O’ Sullivan, 2011) and 77% in England (OHID, 2024)

Table 5-11: Brushing frequency in the weighted and unweighted Army sample

	Twice a day or more	Once a day	Less than once a day
Weighted (n=364)	85.5% (311)	13.6% (49)	0.9% (3)
Unweighted (n=777)	83.5% (649)	15.6% (121)	0.9% (7)

5.5.1.2 Brushing frequency in the new entrants and the trained strength

Table 5-12 shows that new entrants brushed less frequently than the trained strength ($\chi^2=7.8$, $df=1$, $p=0.005$) and require supports on entry to the Army. A wide range has been reported in recruits in the international military, from 55% of Croatian recruits (Skec et al., 2006) to 93% of Swiss recruits (Menghini et al., 2010) which only serves to show that international comparisons are of limited utility.

Table 5-12: Brushing frequency in the trained strength and recruits and cadets

Group	≥ 2 per day	< 2 per day
Trained strength (n=553)	85.9% (475)	14.1% (78)
New entrants (n=224)	77.7% (174)	22.3% (50)
p value	0.005	

5.5.1.3 Prevalence by demographic and intermediate determinants of oral health

The prevalence of brushing at least twice a day in the Army and associated determinants of oral health is displayed in Table 5-13 and shows that the vast majority of soldiers in these groups brushed twice a day or more. There was no particular pattern by age, with statistically significant differences between the 18 to 24 and 25 to 34 years age group ($\chi^2=14.6$, $df=4$, $p=0.006$). The prevalence of brushing twice a day or more was lower in the new entrants than the trained strength ($\chi^2=8.4$, $df=3$, $p=0.04$) but there were no associations with measures of deprivation including education ($\chi^2=5.2$, $df=4$, $p=0.16$) and deprivation group ($\chi^2=3.2$, $df=3$, $p=0.36$). Fewer of the less frequent attenders brushed at least twice daily ($\chi^2=29.7$, $df=2$, $p<0.001$) which indicated that health messages routinely provided in practice were not accessed or acted upon. Similar differences have been reported by dental visiting pattern in Australia (Luzzi et al., 2020), Canada (Cooney, 2010) and the UK (Chadwick et al., 2011) and indicate an overall pattern of reduced brushing in less frequent attenders.

Table 5-13: Prevalence of brushing ≥ 2 per day in the demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	78%	89.7%	83.5%	82.5%	77.8%	0.006
Gender	Male (n=749)		Female (n=28)			0.18
	83.2%		92.9%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.04
	77.7%	85.6%	85.1%	88.5%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.36
	89.7%	86.9%	82%	84.8%		
Education categories ⁶⁶	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.16
	86.5%	80.2%	84.9%	87.5%		
Last dental visit ⁶⁷	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		<0.001
	87.1%		82%	66.1%		
Phobia ⁶⁷	Phobia (n=47)			No phobia (n=729)		0.61
	80.9%			83.7%		

5.5.1.4 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of a high-risk brushing and was adjusted for the effect of age, gender and dental visiting and is displayed in Table 5-14. The model was statistically significant ($\chi^2=36.4$, $df=13$, $p<0.001$), explained 8% of the variance in the prevalence of high-risk brushing and correctly classified 83.4% of the cases. In the outcomes, only dental attendance was statistically significant, with soldiers not attending in over two years having an OR 3.0 95% CI (1.8, 4.9) likelihood of brushing less than twice a day by comparison with attenders within 12 months and suggests that more recent attenders may have accessed appropriate preventative advice.

⁶⁶ 29 missing cases

⁶⁷ 1 missing case

Table 5-14: Binary logistic regression for presence of high-risk brushing (n=748, unweighted data)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.6 (0.3, 1.1)	0.08
	NCO	0.5 (0.2, 1.2)	0.11
	Officer	0.5 (0.2, 1.4)	0.19
Deprivation	<1 SD	Baseline	
	±1 SD	1.5 (0.9, 2.7)	0.15
	>1 SD	1.2 (0.5, 2.6)	0.80
	Outside State	0.6 (0.2, 2.2)	0.44
Education ⁶⁸	Some secondary	Baseline	
	Completed secondary	1.5 (0.7, 3.2)	0.33
	Some college	1.3 (0.6, 3.0)	0.57
	Honours degree or Masters	0.9 (0.4, 2.5)	0.87
Last dental visit ⁶⁹	Within 12 months	Baseline	
	12 to 24 months	1.3 (0.7, 2.3)	0.42
	>24 months	3.0 (1.8, 4.9)	<0.001
Age		1.0 (1.0, 1.0)	0.22
Gender		3.2 (0.7, 14.3)	0.12

The impact of low frequency brushing was that the prevalence of DT ($\chi^2=7.6$, df=1, p=0.006) was higher in less frequent brushers (31.3%) than in more frequent brushers (20.2%) and the prevalence of periodontitis ($\chi^2=10.1$, df=4, p=0.04) was higher in less frequent brushers (42%) than in more frequent brushers (32.2%) which accorded with the findings of national surveys (O'Mullane and Whelton, 1992, Whelton, 2007) and with reviews of the effect of fluoride (Kumar et al., 2016, Walsh et al., 2019).

⁶⁸ 29 missing cases

⁶⁹ 1 missing case

5.5.2 Use of floss or other interdental aids in the previous seven days

5.5.2.1 Summary statistics

The number of times that floss or another interdental device was used in the last seven days, is displayed in Table 5-15, with a low mean value and a wide range from zero to twenty-one times. The data indicates that interdental aids are typically used irregularly in the Army.

Table 5-15: Summary statistics, number of times in the last 7 days that floss or another device was used to clean between teeth in the weighted and unweighted Army samples

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	3.61×10^{-57}	363	2.2	1.9, 2.5	1	3	0	21
Unweighted	6.78×10^{-173}	776	1.8	1.6, 2.0	0	3	0	21

The relative frequency distribution is displayed in Figure 5-1 and shows that about half hadn't used any interdental device and 86% used devices six or fewer times a week, showing a large disconnect between activity and recommended use (Cepeda et al., 2017). However, the results were better than those in the national survey in 2000 as only 3.6% of the 16 to 14 years age group and 5% of the 35 to 44 years age group used interdental brushes regularly and a quarter of the 16 to 24 years old and a third of the 35 to 44 years old group regularly used floss (Whelton, 2007).

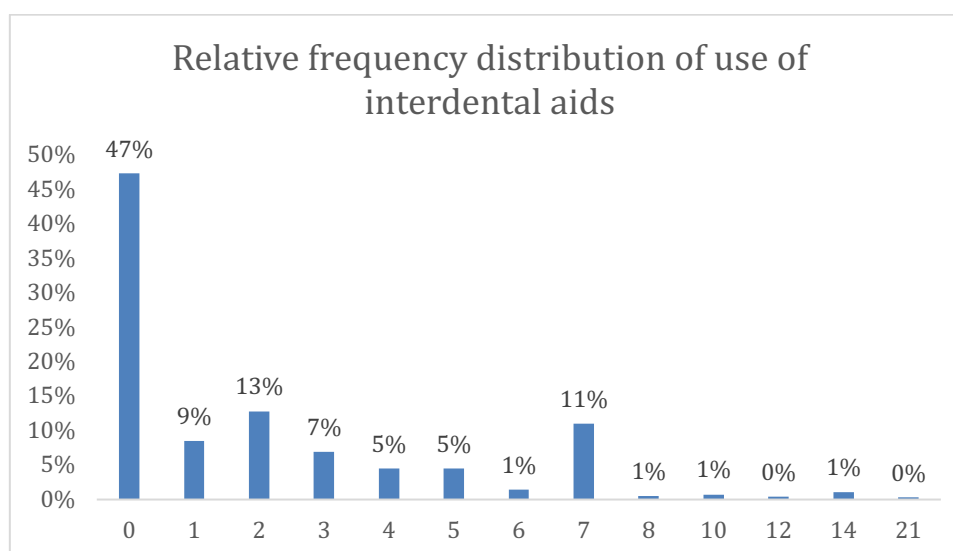


Figure 5-1: Relative frequency distribution of interdental aid use in the weighted Army sample

The results were, however, similar to those reported in other high-income countries. A Canadian national study reported that 28.3% flossed five times a week or more (Cooney, 2010) and in the Army the comparable figure was 20% for use of interdental aids five or more

times a week. In the US, NHANES data reported that 28% hadn't flossed in the previous week (Su et al., 2022) whereas the comparable figure in the Army was 47%. The Australian national survey reported a remarkably similar figure of 44.3% that hadn't used floss at least once per week (Luzzi et al., 2020).

5.5.2.2 Comparison between new entrants and the trained strength

The prevalence of use and the mean number of times used in the trained strength and the recruits are displayed in Table 5-16 and shows that recruits were far less likely to have used interdental aids than the trained strength. The prevalence of use at least once a week was very close to the 25.7% who used floss in the 16 to 24 years age group in 2000 in Ireland (Whelton, 2007). Evidence from high-income countries was in agreement with these findings and reported that interdental use was less in young adults than the older age groups (Cooney, 2010, Chadwick et al., 2011, Luzzi et al., 2020).

Table 5-16: Prevalence of personnel in trained strength and recruits who did not use floss or interdental aids in the previous week and the mean number used.

	Used in previous week	Mean number in previous week
Trained strength (n=553)	54.1%	2.3 (2.0, 2.5)
New entrants (n=224)	24.1%	0.8 (0.5, 1.1)
p value	<0.001	<0.001

5.5.2.3 Prevalence by demographic and intermediate determinants of oral health

Figure 5-2 displays the number of times floss or other interdental aids were used in the Army in the previous week by determinants of oral health. Use increased with age (Kruskal-Wallis, $p < 0.001$) and was statistically different between the 18 to 24 years age group and other groups (Kruskal-Wallis, $p < 0.001$). These results were in accord with international surveys that have reported increasing use with age. In Canada (Cooney, 2010) and in Australia the prevalence of use increased with age to a peak in the 55 to 74 years age group and then declined in extreme old age (Luzzi et al., 2020). In the UK the prevalence increased with age to a peak in the 45 to 54 years age group and then declined into older age (Chadwick et al., 2011).

Social gradients were not present in the deprivation category and in the ranks the differences were between new entrants and the other ranks. In the education category, the "completed secondary" and "some secondary" had less use than the "some college" and "Honours degree or Masters" groups (Kruskal-Wallis, $p < 0.001$).

Use was lower in patients with phobia, who were reported to have a higher prevalence of disease and conditions. Less frequent attenders also used floss less frequently, potentially by missing the opportunities for health advice. Clustering of risk behaviours was seen in the lower use of interdental aids in those who brushed less than twice a day (Mann-Whitney, $p<0.001$) or had a high-risk diet (Kruskal-Wallis, $p<0.001$). In the smoking categories, older ex-smokers used interdental aids more frequently than the occasional or non-smoker groups (Kruskal-Wallis, $p<0.001$).

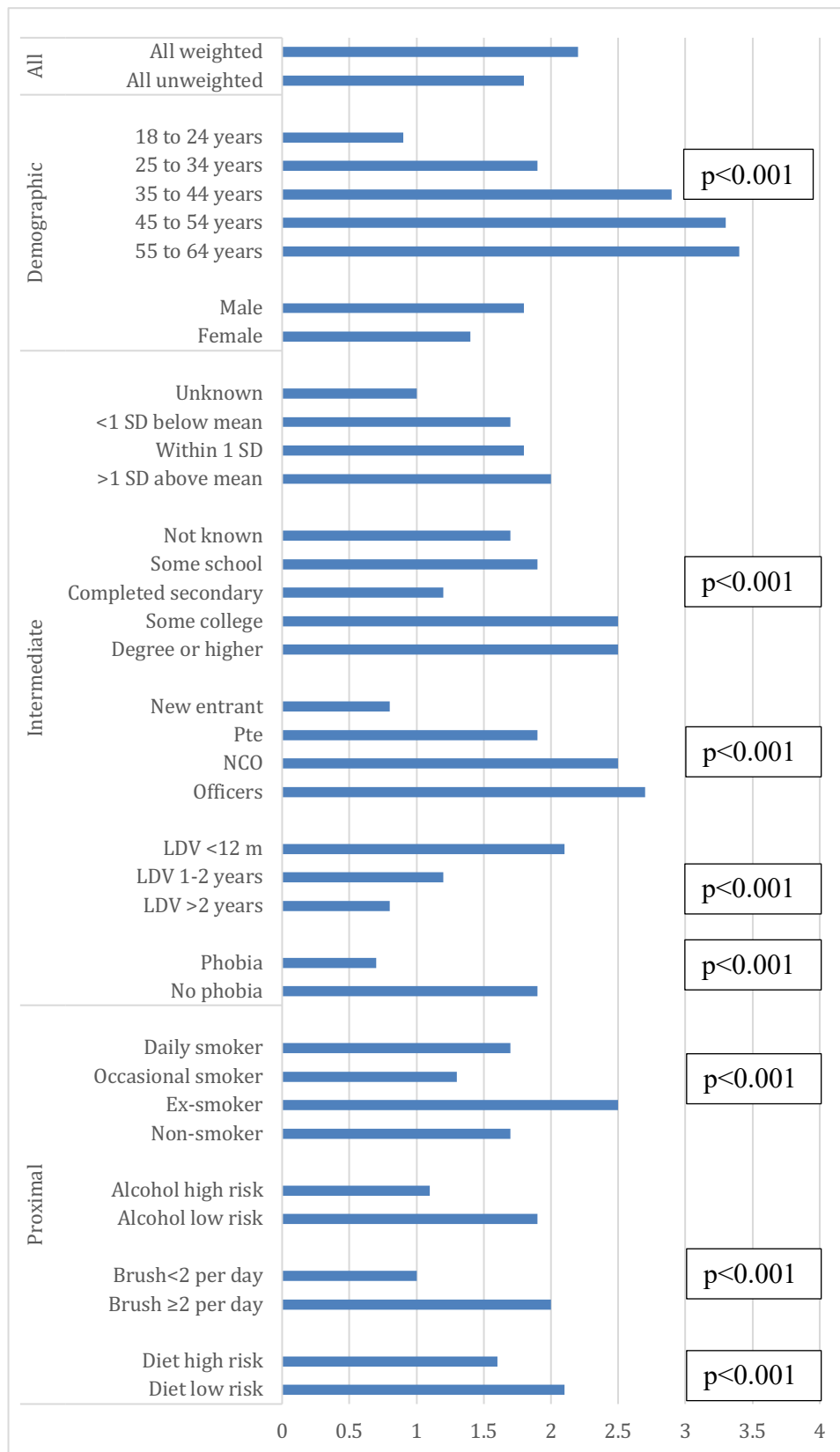


Figure 5-2: Mean number of times in previous seven days that dental floss or other device was used to clean between teeth

5.5.3 Use of mouthwash or other dental rinses in the previous 7 days

5.5.3.1 Summary statistics

The numbers of times that a mouthwash or other dental rinse product was used in the preceding seven days is displayed in Table 5-17 and shows a relatively high use by comparison with the use of interdental products.

Table 5-17: Summary statistics, use of mouthwash or other dental rinse product in the preceding seven days in the weighted and unweighted Army samples

Sample	K-S p-value	n	Mean	95% CI	Median	IQR	Min	Max
Weighted	3.93×10^{-31}	364	4.1	3.7, 4.5	3	7	0	14
Unweighted	1.40×10^{-100}	777	3.7	3.4, 4.0	2	7	0	14

The frequency distribution of mouthwash use is displayed in Figure 5-3. In the sample 60% had used a mouthwash or rinse in the previous seven days whereas only 47% had used an interdental device. The percentage who used a mouthwash or rinse at least once a week was higher in the Army than that reported in the national study in 2000 in Ireland (28.1% reported frequent use) and in national studies in high-income countries including the UK (31%) (Chadwick et al., 2011) and Australia (36.4%) (Luzzi et al., 2020).

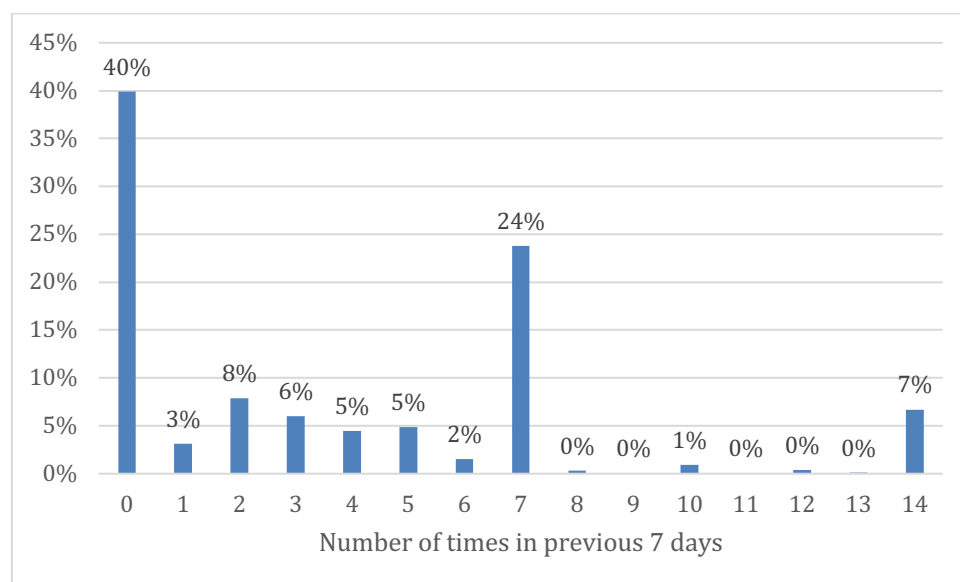


Figure 5-3: Frequency distribution of mouthwash use in previous 7 days

5.5.3.2 Prevalence in trained strength and new entrants

The use of mouthwash in the new entrants and trained strength is displayed in Table 5-18 and shows that there was higher prevalence and mean use in the trained strength than in the recruits, which fitted the pattern of other oral hygiene practices.

Table 5-18: Use of mouthwash and mean (95% CI) in the trained strength and recruits

	At least once in previous week	Mean number in previous week
Trained strength (n=553)	66.7%	4.1 (3.8, 4.5)
New entrants (n=224)	43.7%	2.6 (2.1, 3.0)
p value	<0.001	<0.001

5.5.3.3 Prevalence by demographic variables and determinants of oral health

The mean number of times that mouthwash or rinse was used in the previous seven days is displayed in Figure 5-4 by demographic variables and determinants of oral health. The pattern by age showed an increase to the 35 to 44 years age group and then a decline into older age, with statistically significant differences between the youngest and the “25 to 34 years” and “35 to 44 years” age groups (Kruskal-Wallis, $p<0.001$). A similar pattern was reported by age in the UK (Chadwick et al., 2011), whereas in Australia the peak was in the youngest age group.

When examined by social gradients, the highest use was in personnel living in the most deprived small areas (Kruskal-Wallis, $p=0.003$). In the UK the highest use was reported in the most affluent (Chadwick et al., 2011) whereas in Australia the peak was in the least affluent (Luzzi et al., 2020). These results may indicate the success of targeted marketing campaigns rather than specific oral health messaging. There was statistically significantly more use in the Private and NCO ranks than in new entrants, which may have been affected by the underlying age of these groups (Kruskal-Wallis, $p<0.001$).

In common with the UK findings (Chadwick et al., 2011), mouthwash was used more frequently by personnel who brushed more frequently (Mann-Whitney, $p<0.001$) and attended more regularly (Kruskal-Wallis, $p=0.004$). There was also clustering of risk in low frequency use in high-risk alcohol misuse (Kruskal-Wallis, $p=0.04$).

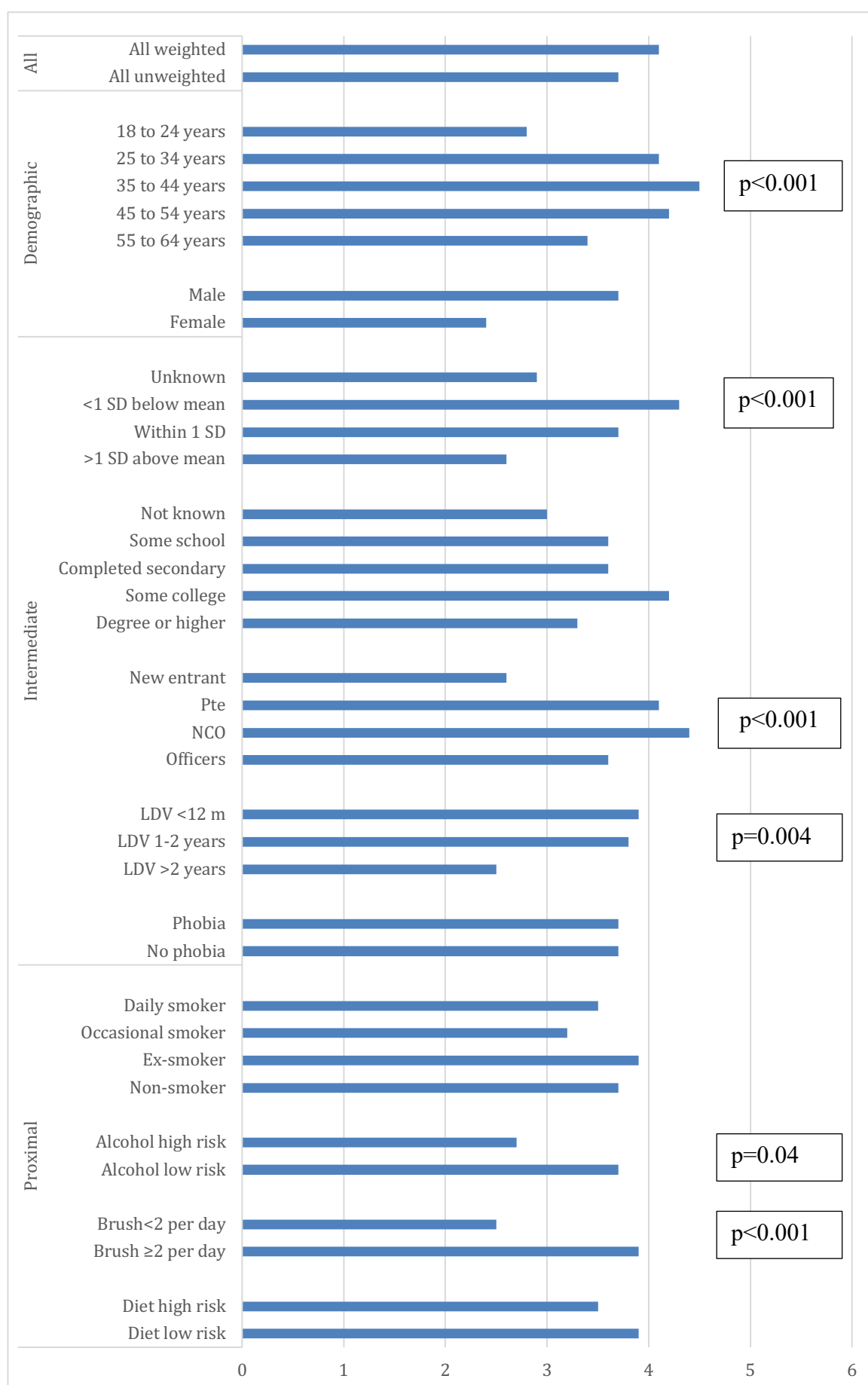


Figure 5-4: Mean number of times mouthwash or rinse used in the previous seven days in the Army and by associated risk indicators

5.5.4 Use of fluoridated toothpaste

5.5.4.1 Summary statistics

The declared use of fluoridated toothpaste is displayed in Table 5-19. A little over half stated that they used fluoridated toothpaste and around 5% stated that they did not use fluoridated toothpaste but the most striking finding was the large size of the group who didn't know whether their toothpaste was fluoridated, given the importance of this intervention (Twetman et al., 2003, Walsh et al., 2019). The reasons for selecting non-fluoridated toothpaste by soldiers requires further research.

Table 5-19: Use of fluoride toothpaste, weighted and unweighted Army sample

Sample	n	Yes (%)	No (%)	Don't know (%)
Weighted	361	57.2	4.9	37.2
Unweighted	772	52.6	4.5	42.2

5.5.4.2 Comparison between new entrants and the trained strength

The use of fluoride toothpaste in the trained strength and recruits is shown in Table 5-20 and shows that the declared use of fluoridated toothpaste was lower in recruits, driven by the larger "don't know" component ($\chi^2=38.1$, $df=3$, $p<0.001$).

Table 5-20: Use of fluoride toothpaste, trained strength and recruits

	Yes	No	Don't know
Trained strength (n=553)	59.4%	3.6%	36.3%
New entrants (n=224)	35.3%	4.9%	59.1%
p value	<0.001		

5.5.4.3 Fluoridated toothpaste by demographic and intermediate determinants

The use of fluoridated toothpaste in the demographic variables and determinants of oral health is displayed in Table 5-21. A large part of each response was the "don't know" component, which shows the need for education about the benefits of fluoridated toothpaste throughout the Army. The proportion who answered "don't know" was highest in the 18 to 24 years age group and tended to decrease with age while the proportion who answered "yes" increased with age.

There were social gradients in the responses by rank and education level, with more "yes" responses and fewer "don't know" responses in the higher ranks and education categories. There were no differences by deprivation group and the proportion answering "no" was reasonable constant across all the determinants.

Table 5-21: Use of fluoride toothpaste in demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Factor		Yes	No	Don't know	p value
Gender	Male	53.0%	4.5%	42.4%	<0.001
	Female	50.0%	7.7%	42.4%	
Age range	18 to 24 years	37.2%	2.4%	60.4%	<0.001
	25 to 34 years	53.6%	5.7%	40.7%	
	35 to 44 years	71.1%	5.4%	23.6%	
	45 to 54 years	80.7%	7.0%	12.3%	
	55 to 64 years	72.2%	5.6%	22.2%	
Rank	New entrant	36.7%	3.6%	59.6%	<0.001
	Pte	47.7%	5.3%	47.0%	
	NCO	65.6%	5.0%	29.3%	
	Officer	81.5%	3.4%	15.1%	
Deprivation group	<1 SD below mean	43.8%	6.6%	49.6%	0.14
	Within 1 SD	54.2%	4.6%	41.1%	
	>1 SD above mean	62.0%	1.3%	36.7%	
	Outside State	49.9%	2.7%	47.4%	
Education ⁷⁰	Some secondary	40.5%	6.8%	52.7%	<0.001
	Completed secondary	43.7%	3.6%	52.7%	
	Some college	64.9%	5.2%	29.8%	
	Degree or Masters	68.5%	4.2%	27.3%	
Last dental visit ⁷¹	LDV <12 m	54.8%	4.2%	40.9%	0.53
	LDV 1-2 years	46.0%	7.0%	47.0%	
	LDV >2 years	49.9%	3.7%	46.3%	
Phobia ⁷¹	No phobia	53.5%	4.4%	42.1%	0.31
	Phobia	43.5%	6.5%	49.9%	

⁷⁰ 29 missing cases

⁷¹ 1 missing case

5.5.5 Consumption of bottled or tap water

5.5.5.1 Summary statistics

Table 5-22 shows that about half of the Army used bottled water as their main supply, potentially increasing their risk of caries by using a non-fluoridated supply. Data from the Water Forum indicated that 23% of civilians only used bottled water and a further 34% did so sometimes (An Foram Uisce, 2023), indicating that bottled water use was higher in the Army. It is possible that because soldiers have to rely on bottled water on exercise and on deployment that they become used to this mode of delivery.

Table 5-22: Proportion of the weighted and unweighted Army who used tap and bottled water

Sample	n	Bottled water	Tap water
Weighted	364	50.9%	49.1%
Unweighted	777	57%	43%

5.5.5.2 Comparison between new entrants and the trained strength

The proportion using bottled water was lower in new entrants than in the trained strength, as displayed in Table 5-23 which might indicate price elasticity of demand in young people. The data indicates that efforts to maintain use of tap water should begin in recruit training.

Table 5-23: Proportion of the trained strength and new entrants who used bottled and tap water

	Bottled water	Tap water
Trained strength (n=553)	54.4%	45.6%
New entrants (n=224)	28.6%	71.4%
p value	<0.001	

5.5.5.3 Use of tap or bottled water by demographic and intermediate determinants

Table 5-24 displays the proportion of the Army sample who used tap or bottled water by the determinants of oral health. By age there was no particular pattern, with a large decrease from the 18 to 24 to 25 to 34 years age group. The uptake of bottled water appeared to have a social gradient in use, with a higher proportion of use by private soldiers and NCOs than officers ($\chi^2=73.7$, $df=6$, $p<0.001$) and by soldiers with lower education levels ($\chi^2=35.3$, $df=6$, $p<0.001$) but with no differences by area deprivation. As reported above, fewer new entrants used bottled water but the proportion increased in the trained strength, possibly due to Army culture. Hawkins (2017) suggested that part of the success of bottled water marketing rests on concerns about the safety of public water supplies, which has more resonance with the urban poor who have been more likely to suffer the adverse effects of contaminated water supplies (Hawkins, 2017). The international development of the bottled water market has been

strongly associated with incidents of potable water contamination (Parag et al., 2023) and in Ireland bottled water has been marketed aggressively as a 'safe' alternative to public water supplies (Collins and Wright, 2014). However, about half of the tap water users were between 18 and 24 years ($\chi^2=24.8$, $df=8$, $p=0.002$) which suggests that efforts to keep personnel drinking tap water should begin on entry before lifestyle changes have begun in the Army.

Table 5-24: Prevalence of tap and bottled water by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Factor		Tap water	Bottled water	p value
Gender ⁷²	Male	54.8%	45.2%	0.78
	Female	52%	48%	
Age range ⁷²	18 to 24 years	63.6%	36.4%	<0.001
	25 to 34 years	44.1%	55.9%	
	35 to 44 years	58.3%	41.7%	
	45 to 54 years	51.8%	48.2%	
	55 to 64 years	61.1%	38.9%	
Rank ⁷²	New entrant	73.1%	26.9%	<0.001
	Pte	39.1%	60.9%	
	NCO	46.9%	53.1%	
	Officer	73.2%	26.8%	
Deprivation group ⁷²	<1 SD below mean	43.8%	6.6%	0.14
	Within 1 SD	54.2%	4.6%	
	>1 SD above mean	62.0%	1.3%	
	Outside State	49.9%	2.7%	
Education ⁷³	Some secondary	40.5%	6.8%	<0.001
	Completed secondary	43.7%	3.6%	
	Some college	64.9%	5.2%	
	Degree or Masters	68.5%	4.2%	
Last dental visit ⁷²	LDV <12 m	54.8%	4.2%	0.53
	LDV 1-2 years	46.0%	7.0%	
	LDV >2 years	49.9%	3.7%	
Phobia ⁷⁴	No phobia	53.5%	4.4%	0.31
	Phobia	43.5%	6.5%	

⁷² 24 missing cases

⁷³ 52 missing cases

⁷⁴ 25 missing cases

5.5.5.4 Binary regression of the tap and bottled water use

A binary logistic regression model was developed to determine the effect of education, rank and deprivation on the presence of a tap or bottled water use and was adjusted for the effect of age and gender and is displayed in Table 5-25. The model was statistically significant ($\chi^2=84.3$, $df=11$, $p<0.001$), explained 15% of the variance in the prevalence of high-risk brushing and correctly classified 63.9% of the cases. Rank and education were statistically significant, with fewer personnel in the trained strength ranks drinking tap water than new entrants and the lowest consumption in soldiers with “some secondary” education.

Table 5-25: Binary regression for use of tap water by determinants of oral health, adjusted for age and gender, unweighted data (n=725).

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.2 (0.1, 0.4)	<0.001
	NCO	0.2 (0.1, 0.5)	<0.001
	Officer	0.4 (0.2, 0.9)	0.03
Deprivation	<1 SD	Baseline	
	±1 SD	1.2 (0.8, 1.8)	0.40
	>1 SD	1.6 (0.8, 3.0)	0.17
	Outside State	1.5 (0.6, 3.4)	0.38
Education ⁷⁵	Some secondary	Baseline	
	Completed secondary	1.8 (1.0, 3.2)	0.04
	Some college	1.7 (0.9, 3.1)	0.10
	Honours degree or Masters	3.5 (1.7, 7.4)	<0.001
Last dental visit ⁷⁶	Within 12 months	Baseline	
	12 to 24 months	0.8 (0.5, 1.3)	0.35
	>24 months	1.0 (0.6, 1.7)	0.89
Age		1.0 (1.0, 1.0)	0.16
Gender		1.6 (0.7, 3.8)	0.26

5.5.5.5 Key clinical indicators in the tap and bottled water groups

The clinical indicators associated with tap and bottled water use are displayed in Table 5-26 and show the benefit of access to fluoridated water. The tap water users (29.2 years 95% CI [28.2, 30.2]) were marginally younger than bottled water users (30.5 years 95% CI [29.6, 31.5]) and although the differences were statistically significant (Kruskal-Wallis, $p=0.006$) the difference was unlikely to solely account for the added burden in the bottled water group.

⁷⁵ 29 missing cases

⁷⁶ 1 missing case

As such the results were in line with expected outcomes from fluoridated, part-fluoridated and non-fluoridated communities reported in Ireland (O'Mullane and Whelton, 1992, Whelton, 2007).

Table 5-26: Clinical indicators in tap and bottled water users

Indicator	Bottled water	Tap water	p-value
SUNT	21.5 (20.6, 21.9)	23 (22.4, 23.5)	<0.001
SUNT $\geq$ 18	74.5%	85.9%	<0.001
DMFT	8.1 (7.4, 8.7)	6.3 (5.8, 6.9)	<0.001
MT	1.3 (1.1, 1.6)	0.9 (0.7, 1.1)	<0.001
FT	6.3 (5.7, 6.8)	4.8 (4.4, 5.3)	<0.001
BEWE $\geq$ 2	19.9%	14.6%	<0.05

5.5.6 Source of water supply

5.5.6.1 Summary statistics

The declared tap water source in the Army is displayed in Table 5-27 and shows that the vast majority (69.4%) used tap water from a mains supply, a proportion very similar to the nationally reported proportion of 71% obtaining water from fluoridated sources (Sharma et al., 2023). A small proportion sourced their tap water from group schemes or private wells, almost all of which are thought to be non-fluoridated (O’Sullivan, 2015) and as such are a group who would benefit from fluoride supplementation to optimize dental health (Twetman et al., 2004).

Table 5-27: Water supply in the weighted and unweighted Army sample

Sample	n	Main supply	Group scheme	Private well	Don’t know
Weighted	364	69.4%	5.6%	8.8%	11.6%
Unweighted	777	65.4%	4.8%	8.4%	17.5%

5.5.6.2 Water source in new entrants and the trained strength

The water supply in new entrants and the trained strength is displayed in Table 5-28 and showed statistically significant differences ($\chi^2=77.2$, $df=4$, $p<0.001$) due to the large size of the ‘don’t know’ group in new entrants. These show the need for information campaigns to highlight the importance of fluoridated water supplies.

Table 5-28: Water supply in the recruits and cadets and trained strength

Sample	n	Main supply	Group scheme	Private well	Don’t know
Trained strength	553	70.2%	5.8%	9%	10.3%
New entrants	224	53.6%	2.2%	6.7%	35.3%
p value		<0.001			

5.5.6.3 Water source in the demographic and intermediate determinants

Table 5-29 shows the prevalence of the declared water supply by determinants of oral health. The main difference across the groups was the relatively large size of the “don’t know” group, which were statistically significant in the gender, age, rank, deprivation and education groups. The impact of increased “don’t know” size tended to be a decrease in the “main water” group as the “group scheme” and “private well” groups were relatively small. Thus although the smallest prevalence of declared mains water source was in the new entrants, and the differences were statistically significant, the results must be evaluated in the context of 36.1% stating that they did not know their water source. Overall, the results are mainly useful in

identifying groups with a large “don’t know” component who would benefit from education about the benefits of fluoridated water supply.

Table 5-29: Source of water supply in the demographic variables and intermediate determinants of oral health, unweighted sample (n=777)

Factor		Mains	Group scheme	Private well	Don't know	p value
Gender ⁷⁷	Male	56%	5.1%	8.9%	17.5%	0.03
	Female	56%	0%	4%	40%	
Age range ⁷⁷	18 to 24 years	54.4%	2.8%	9.3%	33.5%	<0.001
	25 to 34 years	74.9%	4.9%	7.9%	12.4%	
	35 to 44 years	76.4%	5.5%	11.8%	6.3%	
	45 to 54 years	79.2%	13.2%	5.7%	1.9%	
	55 to 64 years	88.9%	11.1%	0%	0%	
Rank ⁷⁷	New entrant	54.8%	2.3%	6.8%	36.1%	<0.001
	Pte	69%	5.1%	7.8%	18%	
	NCO	77.9%	7.9%	10.5%	3.7%	
	Officer	78%	4.9%	12.2%	4.9%	
Deprivation group ⁷⁷	<1 SD below mean	73.55	2.3%	4.5%	19.7%	0.002
	Within 1 SD	66.1%	5.6%	11.2%	17.2%	
	>1 SD above mean	77.6%	6.6%	2.6%	13.2%	
	Outside State	56.8%	2.7%	2.7%	37.8%	
Education ⁷⁸	Some secondary	56.9%	1.4%	2.8%	38.9%	<0.001
	Completed secondary	61.9%	3.4%	9.5%	25.3%	
	Some college	76%	7.8%	10.6%	5.6%	
	Degree or Masters	76.4%	6.4%	7.9%	9.3%	
Last dental visit ⁷⁷	LDV <12 m	68.8%	5.5%	9.1%	16.6%	0.56
	LDV 1-2 years	65.7%	4%	7.1%	23.2%	
	LDV >2 years	67%	2.8%	8.5%	21.7%	
Phobia ⁷⁹	No phobia	68.1%	5.1%	8.9%	17.9%	0.58
	Phobia	66.7%	2.2%	6.7%	24.4%	

⁷⁷ 31 missing cases

⁷⁸ 58 missing cases

⁷⁹ 32 missing cases

5.5.7 Summary of the preventative data

These results present data for the use of a range of preventative measures that were not available in the Irish population or in the Army. Broadly, they show high frequency brushing and access to fluoridated tap water as preventative measures offset by use of bottled water by half of the Army. Most soldiers appeared to use fluoridated toothpaste but the proportions unsure of the content or selecting non-fluoridated toothpastes showed the need for fluoride information campaigns. Interdental use was in general infrequent and the use of mouthwash may have had more to do with advertising and marketing than oral health.

An important finding from these data was the difference between new entrants and the trained strength. In one measure, bottled water use, the new entrants were better than the trained strength, but in all others the new entrants had a greater proportion of behaviours that would increase the risk of future disease. The large proportion of new entrants who didn't know whether their toothpaste was fluoridated indicates that this basic information is not being provided during early life. Oral health promotion in recruit training is required.

Social gradients were present in a number of measures that if unaddressed have the capacity to widen inequality. A greater proportion of officers, those with university education and those living in the most affluent small areas used mains tap water and the converse was true for bottled water use. A similar pattern was present in the use of interdental devices and few officers did not know the benefit of fluoridated toothpaste. These results show the importance of oral health promotion that has the capacity to reach and speak to all sections of the Army community. The higher use of mouthwash by soldiers living in the most deprived small areas shows an interest in oral health that should be exploited.

Despite known benefits, few of the preventative behaviours showed strong benefits within the Army population. The differential between bottled and tap water had the strongest evidence, with a reduced number of SUNT and higher DMFT in bottled water users. These results show the need for longitudinal data and the ICT supports required.

5.6 Cumulative proximal determinants of oral health

Proximal determinants of oral health include many behaviours that affect general health, such as the relationship between diet and diabetes or smoking and cancer, that may be addressed using a common risk factor approach (Sheiham and Watt, 2000). International data has reported that multiple determinants may have a cumulative effect increasing morbidity, affecting quality of life (Khaw et al., 2008, Fransen et al., 2014) and increasing the rate of mortality (Loef and Walach, 2012). Multiple determinants of health have also been reported to increase the prevalence of periodontal disease (Liang et al., 2024). In the UK, 5% of the population were estimated to engage in all of four key negative lifestyle behaviours (smoking, alcohol, poor diet and limited exercise) (Buck and Frosini, 2012). However, only 6% engaged in none of these behaviours, showing how common they were in the population. An added complexity is selecting which behaviour to address first, with strong evidence that smoking is the most pressing and should be prioritized (Evans and Buck, 2018).

Data reporting cumulative proximal determinants of oral health were not available for the Irish population or in the military. The summed total of the following proximal determinants was collated for the Army sample, as these represent the range of topics that a general dentist may consider when providing preventative advice to a patient (Dental Health Foundation, 2013).:

- Smoking: Current smoking (daily or occasionally)
- Alcohol: Alcohol consumption above HSE safe limits
- Diet: High-risk diet
- Fluoride: Use of non-fluoridated toothpaste or consumption of bottled water
- Hygiene: Brushed less than twice a day or used interdental devices less than seven times a week.

Table 5-30 displays the prevalence and mean number of risk factors in the weighted and unweighted Army and by the demographic variables and determinants of oral health. One of the most striking findings from the results was the very small proportion without any risk behaviours that might compromise oral health, comprising 3% of the weighted Army. Similar outcomes have been reported in the UK, where only 6% were reported not to engage in any of four unhealthy behaviours that affect general health (Evans and Buck, 2018). Roughly half of respondents had a high-risk diet and half primarily consumed bottled water, driving the

proportion with at least one risk behaviour. The results show that almost every patient who attends a dentist while serving in the Army requires oral health promotion of some type – a considerable burden on resources. Over a third of the Army had three or more risk behaviours and similar clustering of behaviour has been reported in the UK (Evans and Buck, 2018) and the US (Schuit et al., 2002). Synergy between risk behaviours in the medical field has been associated with increased mortality (Khaw et al., 2008, Ding et al., 2015), which has relevance in the dental domain, not least because of the common risk factors.

The mean number of unhealthy behaviours in the weighted Army sample was 2.2 95% CI (2.1, 2.3). It is clearly not the case that all behaviours carry the same level of risk and the suggested prioritization of smoking (Evans and Buck, 2018) may have implications for an approach within the dental setting. Sequential change has been proposed in smoking cessation, particularly as other behaviours (such as an unhealthy diet) may increase in patients attempting to quit (Meader et al., 2016). This highlights the importance of an integrated approach across the medical spectrum in the Army.

A number of important findings were apparent from examination of the distribution by determinants of oral health. The mean number of risk behaviours and prevalence decreased with age, with statistically significant differences between the over 55 years age group and the 18 to 35 years age groups. New entrants joined the Army with a high disease burden and with underlying proximal determinants of oral health. However, there were no statistically significant differences between the new entrants and the trained strength, which showed that effective health messages were not being delivered. Social gradients were apparent in the results, as there were fewer risk behaviours in officers than all other ranks and in those with an Honours degree or Masters and a greater number in the “some secondary” group than other education groups. Soldiers who smoked, misused alcohol or had a high-risk diet also had a greater number of risk behaviours than their low-risk colleagues. The differences in some categories were stark: for instance, 84.9% of daily smokers and 79.5% of alcohol misusers had three or more risk behaviours by contrast with 23.1% of non-smokers and 33.6% of low-risk alcohol users. The results show the complexity of management of selected subgroups of the Army population.

Table 5-30: Prevalence and mean number of proximal risk factors in the Army by demographic, intermediate and proximal determinants of health. The p-value for the results of the Kruskal-Wallis test (K-W) for differences in the number of risk behaviours is displayed

Determinant		Missing (n)	Number of risk behaviours				Mean (95% CI)	K-W p value
			None	≥1	≥2	≥3		
Army (weighted)		12	3%	97%	75.7%	37.2%	2.2 (2.1, 2.3)	N/A
Army (unweighted)		24	2.5%	97.5%	75.2%	36%	2.2 (2.1, 2.2)	
Age group	18 to 24 years	7	0.7%	99.3%	78.5%	39.3%	2.3 (2.1, 2.4)	<0.001
	25 to 34 years	10	0.7%	99.3%	80.5%	39.3%	2.3 (2.2, 2.4)	
	35 to 44 years	6	6.3%	93.7%	67.7%	30.7%	2.0 (1.8, 2.2)	
	45 to 54 years	1	7.1%	92.9%	64.3%	23.2%	1.9 (1.6, 2.2)	
	55 to 64 years	0	16.7%	83.3%	44.4%	11.1%	1.4 (0.9, 1.8)	
Rank	New entrants	5	0.9%	99.1%	76.3%	35.6%	2.2 (2.1, 2.3)	<0.001
	Private	8	1.2%	98.8%	83.6%	46.1%	2.4 (2.3, 2.5)	
	NCO	6	4.1%	95.9%	70.9%	31.1%	2.1 (1.9, 2.2)	
	Officers	5	7.3%	92.7%	56.1%	17.1%	1.7 (1.5, 1.9)	
Trained vs recruits	New entrants	5	0.9%	99.1%	76.3%	35.6%	2.2 (2.1, 2.3)	0.75
	Trained strength	19	3.2%	96.8%	74.7%	36.1%	2.2 (2.1, 2.2)	
Deprivation group	Unknown	2	2.7%	97.3%	70.3%	32.4%	2.1 (1.7, 2.4)	<0.05
	<1 SD of mean	3	0.7%	99.3%	81.3%	44.8%	2.4 (2.2, 2.5)	
	Within 1 SD	17	2.6%	97.4%	74.5%	35.4%	2.2 (2.1, 2.2)	
	>1 SD of mean	2	5.2%	94.8%	71.4%	26%	2.0 (1.8, 2.2)	
Education	Some secondary	3	1.4%	98.6%	87.3%	52.1%	2.6 (2.3, 2.8)	<0.001
	Secondary	10	0.3%	99.7%	79.9%	39%	2.3 (2.2, 2.4)	
	Some college	5	2.7%	97.3%	72.7%	32.6%	2.2 (2.0, 2.2)	
	Degree or above	5	8.6%	91.4%	57.4%	20.1%	1.7 (1.6, 1.9)	
LDV	<12 month	19	3.3%	96.7%	74.8%	34.7%	2.1 (2.1, 2.2)	0.43
	1 to 2 years	2	0%	100%	76.5%	39.8%	2.3 (2.1, 2.4)	
	≥2 years	2	0.9%	98.1%	75.7%	39.3%	2.3 (2.1, 2.5)	
Phobia	Phobia	1	0%	100%	82.6%	47.8%	2.4 (2.1, 2.7)	0.08
	No phobia	23	2.7%	97.3%	74.6%	35.1%	2.2 (2.1, 2.2)	
Smoking	Daily	5	0%	0%	100.0%	84.9%	3.2 (3.1, 3.4)	<0.001
	Occasional	1	0%	100%	98.7%	80.0%	3.1 (2.9, 3.2)	
	Ex-smoker	5	5%	95%	63.5%	23.9%	1.8 (1.7, 2.0)	
	Non-smoker	13	2.5%	97.5%	70.4%	23.1%	1.9 (1.9, 2.0)	
Alcohol	High risk	3	0%	100%	97.4%	79.5%	3.3 (3.0, 3.6)	<0.001
	Low risk	21	2.7%	97.3%	73.9%	33.6%	2.1 (2.0, 2.2)	
Diet	High risk	11	0%	98%	60.4%	14.3%	2.7 (2.7, 2.8)	<0.001
	Low risk	13	5.4%	94.6%	49.4%	8.5%	1.5 (1.5, 1.6)	
Brushing	High risk	2	0%	100%	77.8%	40.5%	2.3 (2.1, 2.4)	0.19
	Low risk	22	3%	97%	74.6%	35.1%	2.1 (2.1, 2.2)	

5.7 Summary of chapter on proximal of determinants of oral health

This chapter has explored proximal determinants of oral health, for which little or no current data were available in either the national or Army population. As such it provides a valuable resource against which other surveys may be compared. The chapter on oral health status showed that new entrants had poor oral health and a large burden of untreated disease. An outstanding feature of the data was the degree to which the proximal determinants of oral health, with the exception of bottled water use, had a higher prevalence in new entrants than in the trained strength. Following entry, there was a reduction in risk behaviour but with evidence of a social gradient from officers to private rank. In certain subgroups there was a very high prevalence of risk behaviours – for example 68.9% of soldiers with “some secondary” education had a high-risk diet. These results point to the overlapping effects of intermediate and proximal determinants and the urgent need to provide accessible health promotion.

The assessment of the cumulative burden of proximal determinants showed the high prevalence of multiple proximal determinants in soldiers in the Irish Army. Evidence from the deployment of soldiers in 2020 to The Lebanon showed that a large number of emergencies developed in a group without recent access to dental services. These outcomes may be understood as a result of the high prevalence of risk behaviours, including a cariogenic diet and sub-optimal fluoride exposure. These results show the need for progressive strategies to reduce the number of proximal determinants in the Irish Army using oral health promotion and targeted recall.

6 The subjective experience of oral health in the Irish Army

In addition to the collection of forensic charting, the stated aims of the dental service are occupationally focussed and seek to make personnel dentally fit, thereby reducing the number of dental emergencies, and to return personnel with a dental emergency to work as quickly as is possible. In the Army, a central problem is the management of dental emergencies on deployment, where dental emergency services may not be available.

Patients with disease may not seek treatment for a variety of reasons and the dental service recognized the need to include the subjective assessment by patients of their oral health and its impacts, using the OHIP-14 instrument. Conceptual models linking professionally observed characteristics of disease, symptoms, loss of function, self-reported global rating of health and HRQoL have been described in detail (Wilson and Cleary, 1995, Ferrans et al., 2005). Limited data were available for the normatively determined oral health status of the civilian population and the Army, much quite dated, which included reports of severe tooth loss that would affect function (O'Mullane and Whelton, 1992, Hayden, 1995, Whelton, 2007, Naseer, 2020). However, information about symptoms, of which pain was the most pressing, self-reported oral health status or OHRQoL were unavailable. The data collected in this survey reported important metrics that were not available for the Irish population that may be used by military management to assess the outcomes of the service in a patient-centred manner.

6.1 Pain

Orofacial pain is a common acute symptom of underlying oral disease and is deserving of urgent management (Vickers et al., 1998). Pain can affect organizational outcomes in the Army by necessitating unscheduled visits by patients that affect the efficiency and effectiveness of the workforce. On deployment, unscheduled visits may pose risks to operations as well as exposing personnel to unnecessary risk when being transported to emergency dental services. Both acute and chronic orofacial pain has been reported to affect OHRQoL, as measured by the OHIP instrument (Shueb et al., 2015).

In the survey, personnel were asked, firstly, whether they had pain or a problem in their mouth and secondly, if they answered yes, whether the pain was from their teeth. In addition, two pain questions were captured in the OHIP-14 questionnaire, which asked for the frequency of painful aching or difficulty eating foods in the previous 12 months. For the purposes of analysis, the OHIP-14 questions were reported when respondents answered that the impacts occurred “very often”, “often” or “occasionally”.

6.1.1 Summary statistics

The percentage of the weighted and unweighted Army sample who reported pain is displayed in Table 6-1. In the weighted sample, 8.1% of personnel reported a current problem or pain in the mouth and 5.6% reported pain from their teeth, corresponding to 69.3% of those reporting a problem or pain in their mouth. In the OHIP-14 questions, there were 8.5% who reported painful aching at least occasionally in the previous 12 months and 13.5% who reported difficulty eating foods because of problems in the mouth. These data indicate that in the Army there were a small group who were in current pain, the bulk of whom had pain in their teeth, and 15.9% reported an impact in the physical pain domain in the previous 12 months, which highlighted the need for on-going access to services to manage problems.

Table 6-1: Prevalence of current pain or a problems in the mouth/ pain from teeth and painful aching/ difficulty eating foods in the previous 12 months

Pain questions		Weighted (n=364)	Unweighted (n=777)
Current problem	Problem or pain in the mouth	8.1%	9.4%
	Pain from teeth	5.6%	6.6%
OHIP-14	Painful aching	8.5%	10.4%
	Difficulty eating foods	13.5%	15.1%
	Physical pain domain	15.9%	18.7%

The reported pain prevalence was at the lower end of the prevalence scale reported in international surveys (Slade et al., 2004, Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011a, Brennan et al., 2020, Public Health England., 2020, Aldosari et al., 2021), albeit there were a variety of reporting mechanisms and a broader demographic mixture in international surveys. The Army survey used those questions asked in the UK national survey in 2009, which reported a composite measure of pain with a prevalence of 9%, very similar to the Army results, despite the different demographic mix (Steele et al., 2011a). The prevalence in the 2018 England survey was 18.3% for a pain or problem in the mouth and 16.1% for pain from teeth (Public Health England., 2020), approximately double the prevalence of the 2009 UK survey and the Army data. Better results in the Irish Army may be understood in the context of a military system that treats normatively assessed need.

The prevalence of impacts in the OHIP-14 physical pain domain was 15.9% over the previous 12 months and showed the extent to which pain is reported even a well-maintained population. The prevalence of pain over the previous 12 months was slightly higher than the value of 12% reported in the Healthy Ireland reports for national civilians (Dept. of Health, 2018). Since the Army has a system for treating oral disease in advance of deployment, it might have been expected that the value would be lower in the Army than the civilian population, although data on the normative need of the civilian population was unknown. For comparison, in the UK survey in 2009 the prevalence in the physical pain domain was 30% (Nuttall et al., 2011); in Australia the prevalence of toothache within 12 months was 20.2% (Brennan et al., 2020) and in the US the reported prevalence was 23.5% (Aldosari et al., 2021). Although weak correlations between normatively assessed disease and subjective oral health have been reported (Locker and Miller, 1994) the prevalence of pain in the Irish civilian population seems low by comparison with these surveys and was, perhaps, affected by recall.

6.1.2 Association of pain with clinical indicators

The association between clinical conditions and prevalence of pain or problems (Figure 6-1), pain from teeth (Figure 6-2) and the OHIP-14 pain domain (Figure 6-3) are displayed below, annotated with the statistically significant differences between the groups, where present. Unsurprisingly, pain and problems were associated with the presence of decayed teeth, and the associated metric of unrestorable teeth, as was reported in the US NHANES study (Aldosari et al., 2021). Despite the fact that the prevalence of pain or problems in respondents with PUFA symptoms was almost double that of those without, there were no statistically significant differences in the prevalence of current pain, which may be attributable to the low numbers in the PUFA present group. Only 2% of the respondents in the Army in 2020 with pain had PUFA symptomology by comparison with 27% of respondents in the UK in 2009 (Steele et al., 2011a). However, over longer time periods, such as was reported over 12 months using the OHIP-14 criteria, 64% of the patients with a PUFA involved tooth reported pain and the difference with the non-PUFA group was statistically significant. These data show the high need to treat caries for the management of pain.

The impact of denture wearing was evident in the pain data. Denture wearers reported more pain or problems and more pain from teeth, although only the former was statistically significant. In the OHIP-14 physical pain domain over half of denture wearers (54.5%) reported an impact, of which the vast majority (45.5%) were in the reported discomfort associated with eating foods. Although only a small proportion of the Army had a denture in 2020 (1.4%) they appeared to have a disproportionally high prevalence of pain. In the denture wearers about a third had decayed teeth and about a half had untreated periodontal disease, which might be assumed to be the source of the pain. These results align with the common observation of the impact of dentures on oral health (Preshaw et al., 2011), which was recognized by dental teams in the Army. However, the degree to which denture wearing was affecting ability to eat was unknown. Remedies to replace dentures in this group should be considered.

An unexpected finding was the degree to which pain was reported by patients with periodontal disease. Typically, periodontal disease is not reported to be associated with pain experience, except in acute or severe forms (Miranda-Rius et al., 2018). In this survey, 8.6% of respondents with a PSR score of three and 20% with a PSR score of four reported pain from their teeth and 25% of patients with PSR 3 and 30% of patients with PSR 4 reported an impact in the physical pain domain in the previous 12 months.

Table 6-2 shows the prevalence of pain presented by decayed teeth status and PSR score status. Even in patients with no decayed teeth and a PSR score of 0, 1 or 2, the prevalence of pain from teeth was 3.7%. Whether this pain was from wisdom teeth or other treatable sources was not captured in the survey and may represent the irreducible minimum in a treated population of young people.

Table 6-2: Prevalence of pain by decayed teeth status and PSR status, unweighted data (n=777)

DT	PSR	Problems or pain in the mouth	Pain from teeth	OHIP-14 physical pain
DT=0	0,1,2	4.7%	3.7%	12.4%
	3,4	11.9%	7.3%	22%
DT>0	0,1,2	14%	9.3%	27.9%
	3,4	23.5%	16.5%	34.1%

A series of binary regression analyses were carried out for the association of clinical indicators with pain outcomes. The model of pain or problems was statistically significant ($\chi^2=35.5$, $df=8$, $p<0.001$), explained 10% of the variance in presence of pain or problems, correctly classified 90.7% of the cases; the model of pain from teeth was statistically significant ($\chi^2=23.2$, $df=8$, $p=0.003$), explained 8% of the variance in presence of pain or problems, correctly classified 93.4% of the cases and the model of the OHIP-14 pain domain was statistically significant ($\chi^2=41.7$, $df=8$, $p<0.001$), explained 8% of the variance in presence of pain or problems, correctly classified 81.9% of the cases. In all three models, decayed teeth and the presence of periodontal disease were independently associated with pain experience. The presence of PUFA affected teeth and dentures were also associated with the OHIP-14 physical pain domain.

These findings support the observations of the descriptive data. Measures to prevent and manage untreated decay should continue in the Army. In addition, more aggressive measures to treat periodontal disease should be implemented in the Army as it had a significant association with pain in the sample and consideration should be given to the replacement of dentures, where possible.

Table 6-3: Binary logistic regression of clinical variables and pain outcomes, unweighted data (n=777)

	Pain or problems		Pain from teeth		OHIP-14 pain domain	
Variable	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
No teeth	1.0 (0.9, 1.1)	0.85	1.0 (0.9, 1.1)	0.85	1.0 (0.9, 1.1)	0.49
DT>0	2.5 (1.4, 4.3)	<0.001	2.2 (1.1, 4.2)	0.01	2.0 (1.3, 3.1)	0.001
Unrestorable>0	1.5 (0.4, 5.6)	0.50	3.1 (0.8, 11.5)	0.10	1.5 (0.5, 4.8)	0.46
PUFA>0	0.9 (0.2, 4.7)	0.91	0.6 (0.1, 4.8)	0.59	4.2 (1.1, 15.5)	0.03
Filled teeth	1.0 (0.9, 1.0)	0.13	1.0 (0.9, 1.0)	0.15	1.0 (1.0, 1.0)	0.83
Denture	3.1 (0.7, 13.9)	0.15	2.8 (0.5, 16.1)	0.24	4.3 (1.2, 15.5)	0.03
PSR 3 or 4	2.2 (1.3, 3.7)	0.002	1.8 (1.0, 3.3)	0.05	1.6 (1.1, 2.3)	0.01
BEWE severity	1.0 (1.0, 1.1)	0.46	1.0 (0.9, 1.1)	0.97	1.0 (1.0, 1.1)	0.38

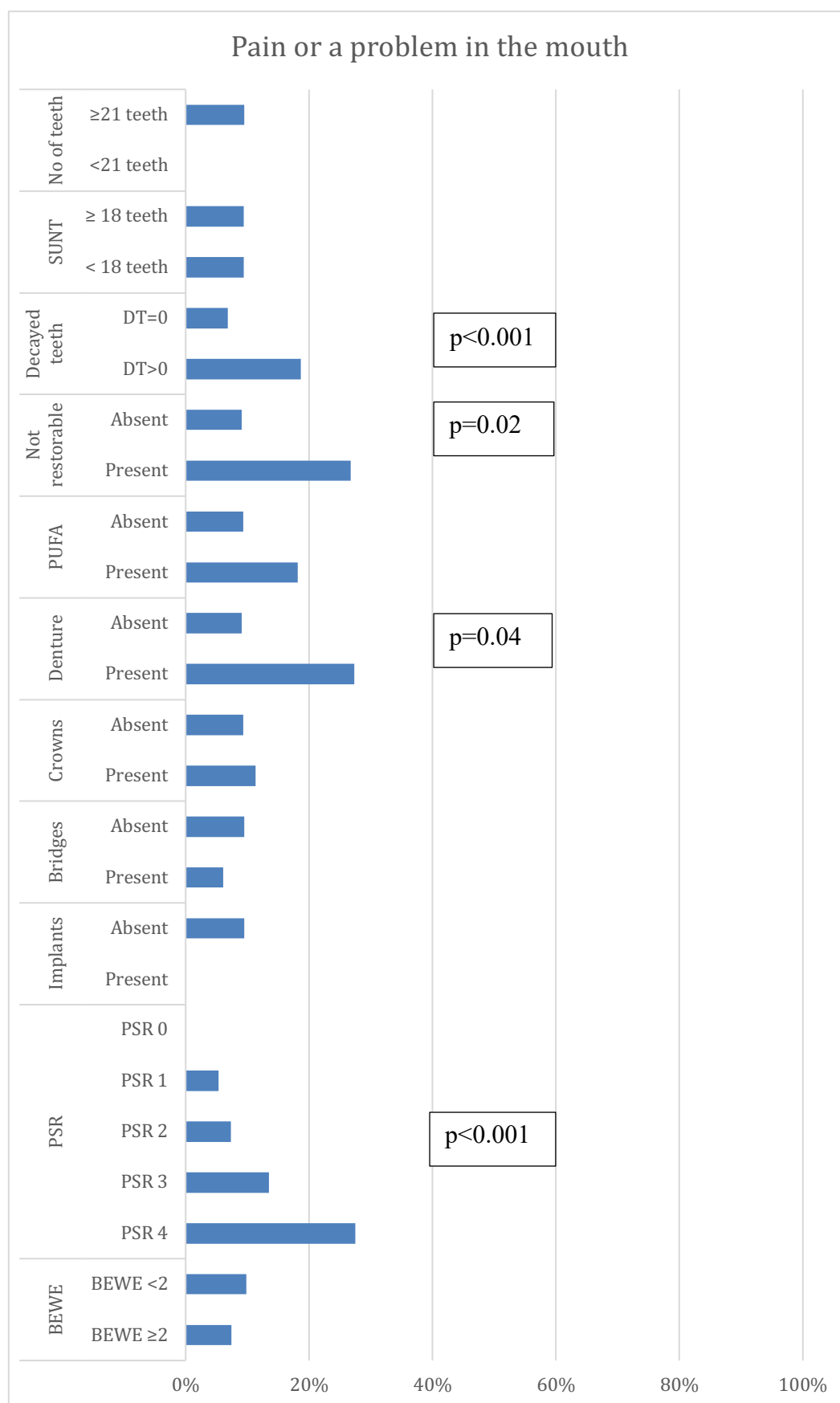


Figure 6-1: Prevalence of current pain or a problem in the mouth, unweighted data (n=777)

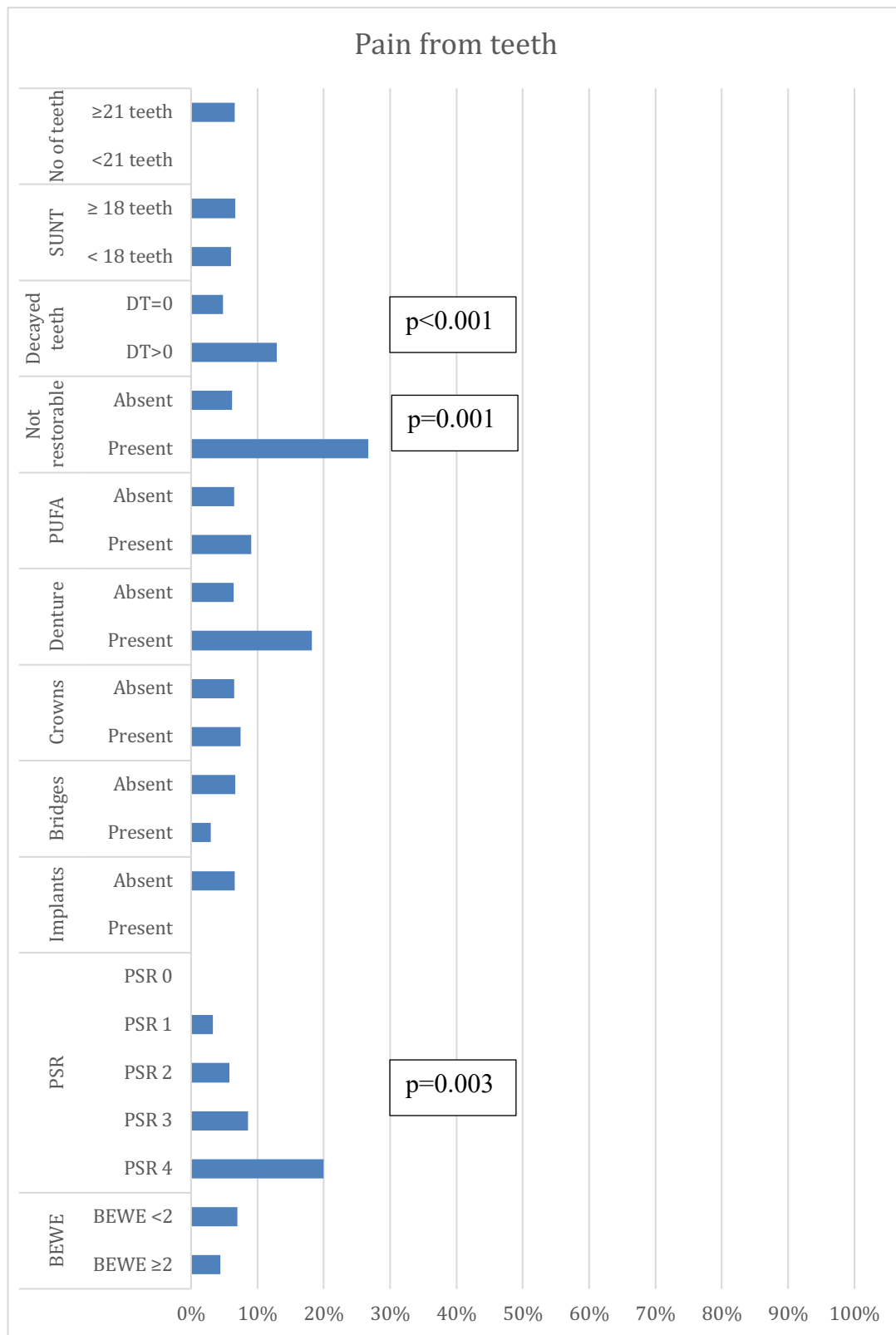


Figure 6-2: Prevalence of pain from teeth, unweighted data (n=777)

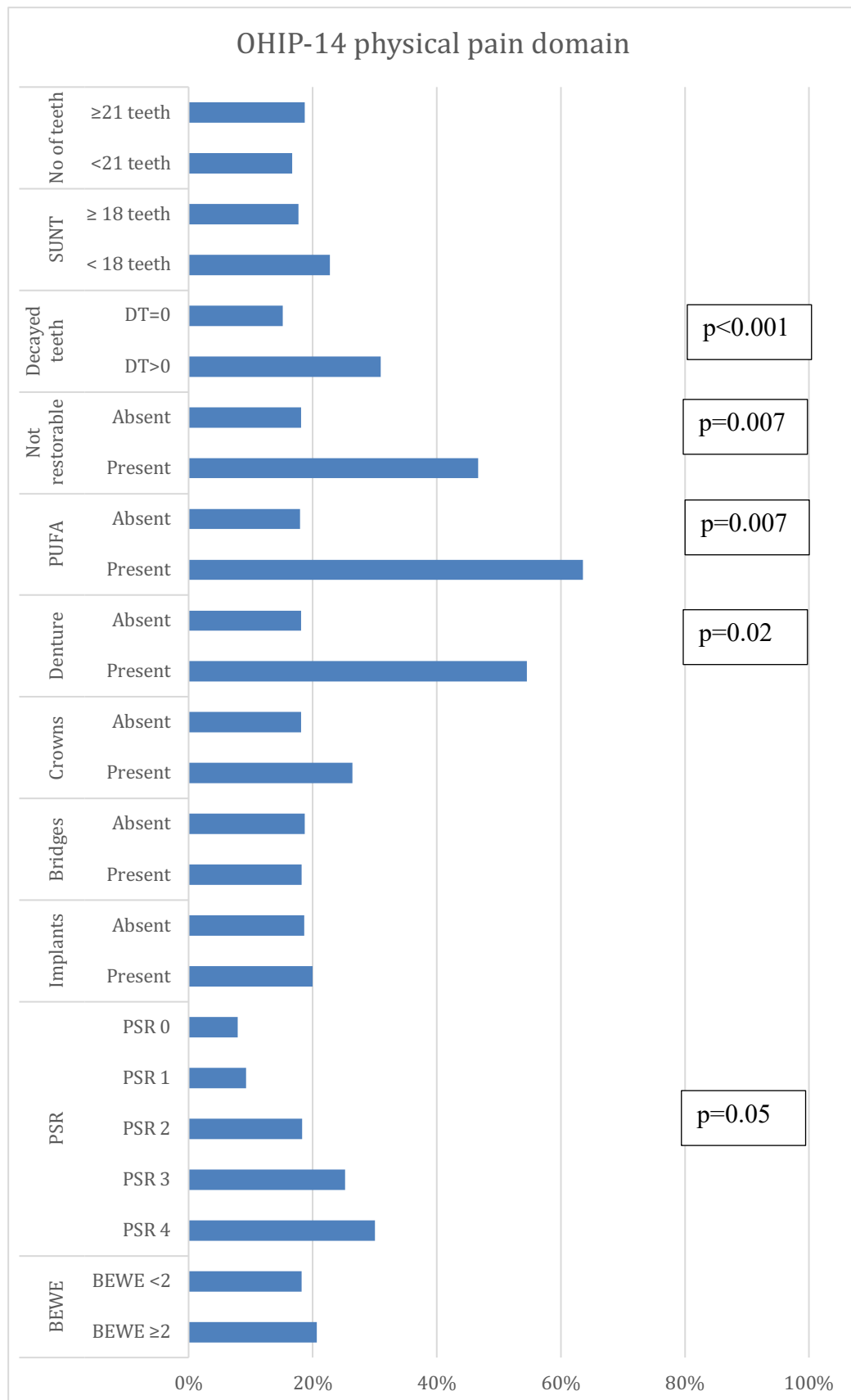


Figure 6-3: Prevalence of physical pain domain in previous 12 months at threshold of “occasional” or above, unweighted data (n=777)

6.1.3 Association of pain with demographic variables and determinants of oral health

The previous section showed that certain clinical variables were associated with pain experience in the Army sample. The chapter on the oral health status of the Army reported that certain groups had a higher prevalence of these diseases and conditions. Factors associated with dental pain experience in the literature include oral health status, dental anxiety and service utilization and in turn these may be modified by socio-demographic and behavioural risk factors (Pau et al., 2003). Identifying groups at higher risk of experiencing pain would enable the dental service to target preventative interventions and ensure that emergency services were available.

The prevalence in the Army of pain or problems in the mouth (Table 6-4), pain from teeth (Table 6-5) and painful aching in the previous 12 months (Table 6-6) are presented by demographic variables and by the intermediate determinants of oral health. National surveys in high-income countries have consistently reported a higher pain prevalence in younger people (Slade et al., 2004, Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011a, Brennan et al., 2020, Public Health England., 2020, Aldosari et al., 2021). However, in the Army there was little difference by age, which may reflect the treatment of normatively assessed need throughout military service.

International surveys have also reported a higher pain prevalence in women than in men (Slade et al., 2004, Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011a, Brennan et al., 2020, Public Health England., 2020, Aldosari et al., 2021) and in this survey women had a higher prevalence in all pain categories (statistically significantly in the pain or problems in the mouth and pain from teeth data). Caution must be exercised when interpreting these data due to the small sample size and the high proportion of new entrants in the female group.

Additional risk factors for higher pain prevalence in international reports include income, social class and education level (Maggirias and Locker, 2002, Aldosari et al., 2021). In the Army results the groups with a high prevalence of oral disease, dental anxiety and service utilization underpinned the differences in pain experience. A striking result of the oral health and risk factor assessment was that new entrants had higher prevalence of oral disease than the trained strength and low levels of service utilization, with only about a half attending a dentist within 12 months. Similarly, other groups with a high prevalence of dental disease had a high prevalence of dental pain: the “outside State” deprivation group had the highest mean

number of decayed teeth (41%) of any deprivation group; the “less than secondary” education level had the lowest SUNT, highest DMFT, DT and MT scores and the highest proportion with unrestorable teeth (9.5%). The results accorded with findings in England (Douglas et al., 2023), Australia (Brennan et al., 2020), the US (Aldosari et al., 2021) and New Zealand (Ministry of Health, 2010) which reported links between pain and education or deprivation level.

In terms of recency of attendance, these results reported that those who had attended within 12 months had the lowest pain prevalence, as has been reported in the UK (Steele et al., 2011a) and the US (Brennan et al., 2020). The underlying difference in caries prevalence reported above was stark as a third of respondents who had not attended in over 12 months had caries at the time of examination. Only about a half of recruits had attended within 12 months and recruits reported more than the trained strength in the OHIP-14 physical pain domain. Cost and access to services have been identified as barriers to care in the national survey (Whelton, 2007) but these barriers would have been eliminated on entry, which may explain why there was no statistically significant difference in the prevalence of current pain by visiting pattern.

Associations between pain and phobia were also present in the data. In the phobia group, there were statistical associations with pain or problems in the mouth, which possibly occurred because of avoidant behaviour, but not with pain from teeth, which indicated that patients with phobia had adequate access to pain relief measures. In the physical pain domain, 29.8% of patients with phobia reported an impact in the previous 12 months, showing the high prevalence of pain in this group. These impacts may have been mediated by oral health status as one third of patients with phobia had decayed teeth. Groups with a relatively high prevalence of phobia, such as the “unknown” deprivation group (13%) also reported a higher prevalence of pain.

Table 6-4: Prevalence of pain or problems in the mouth by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	9.8%	7.8%	11.3%	10.5%	11.1%	0.81
Gender	Male (n=749)		Female (n=28)			0.03
	8.9%		21.4%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.11
	12.9%	8.3%	8.9%	4.6%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.25
	17.9%	8.8%	8.6%	11.4%		
Education categories ⁸⁰	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.06
	17.6%	9.5%	8.9%	6.3%		
Last dental visit ⁸¹	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		0.001
	7.6%		19%	10.1%		
Phobia ⁸²	Phobia (n=47)			No phobia (n=729)		0.02
	19.1%			8.8%		

⁸⁰ 29 missing cases

⁸¹ 1 missing case

⁸² 1 missing case

Table 6-5: Prevalence of pain from teeth by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	6.6%	5.3%	7.5%	8.8%	11.1%	0.74
Gender	Male (n=749)		Female (n=28)			0.02
	6.1%		17.9%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	0.07	
	9.4%	6.1%	6.4%	1.1%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.03	
	17.9%	6.6%	5.9%	5.1%		
Education categories ⁸³	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	0.02	
	14.9%	6.5%	5.2%	4.2%		
Last dental visit ⁸⁴	<12 months (n=567)	12 to 24 months (n=100)		>24 months (n=109)	0.004	
	5.1%	14%		7.3%		
Phobia ⁸⁵	Phobia (n=47)		No phobia (n=729)			0.25
	10.6%		6.3%			

⁸³ 29 missing cases

⁸⁴ 1 missing case

⁸⁵ 1 missing case

Table 6-6: Prevalence of OHIP-14 pain domain by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	22.3%	14.9%	17.3%	19.3%	27.8%	0.18
Gender	Male (n=749)		Female (n=28)			0.06
	18.2%		32.1%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)	0.006	
	26.3%	14.8%	15.8%	17.2%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)	0.53	
	20.5%	19.7%	17.4%	24.1%		
Education categories ⁸⁶	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)	0.65	
	23%	19.2%	16.7%	17.4%		
Last dental visit ⁸⁷	<12 months (n=567)	12 to 24 months (n=100)	>24 months (n=109)	0.32		
	18%	17%	23.9%			
Phobia ⁸⁸	Phobia (n=47)		No phobia (n=729)			0.04
	29.8%		17.8%			

⁸⁶ 29 missing cases

⁸⁷ 1 missing case

⁸⁸ 1 missing case

6.1.4 Pain results in the trained strength and new entrants

The reported prevalence of pain and problems in the trained strength and new entrants is displayed in Table 6-7. In every pain category the new entrants recorded a higher prevalence of pain than the trained strength, which may be understood in terms of the greater normative need of new entrants. About one in ten recruits had pain from their teeth on entry and showed the need to provide emergency services for recruits on entry. There are few military studies with which these results can be compared. The prevalence of pain in Finnish recruits was reported as 7.5% in 1991 in a group with a DT mean of 1.3 95% CI [1.2, 1.4] and the Irish Army recruits had similar results with a prevalence of pain of 9.4% and a DT mean of 1.4 95% CI [1.1, 1.7] (Ankkuriniemi and Ainamo, 1997). However, in the British Army, despite the fact that 62.3% of recruits at the time of examination had decayed teeth, including 18% with PUFA lesions, only 4.7% reported pain at the time of initial examination (Edwards et al., 2022), demonstrating the weak link between normative treatment need and self-reported oral health status.

Table 6-7: Prevalence of pain and problems in the mouth and pain from teeth in recruits and the trained strength in the Army, unweighted data

Pain questions		Trained strength (n=553)	Recruits (n=224)	p value
Current problem	Problem or pain in the mouth	8.0%	12.9%	0.03
	Pain from teeth	5.4%	9.4%	0.04
OHIP-14	Painful aching	8.3%	15.6%	0.003
	Difficulty eating foods	13.4%	19.2%	0.04
	Physical pain domain	15.6%	26.3%	

There were also statistically significant differences between the reported prevalence in the trained strength and recruits of painful aching occasionally or more frequently in the previous 12 months ($\chi^2=9.1$, $df=1$, $p=0.003$) and difficulty eating foods ($\chi^2=4.2$, $df=1$, $p=0.04$). The prevalence of painful aching within the previous 12 months in the trained strength was about half that in recruits, which may indicate the success of the treatment programme in the Army and better access to services. One in five recruits reported difficulty eating foods in the previous 12 months, which showed the impact that poor oral health may have on operational effectiveness. About a quarter of the recruits had an impact in the physical pain domain within the previous 12 months, which was similar to the reported prevalence of 26% in the 16 to 24 years old respondents in the UK in 2009 (Nuttall et al., 2011).

A number of military publications have reported OHIP-14 physical domain impacts in the trained strength. In Japan, the prevalence of painful aching was about the same as in the Irish Army in 2020 at 7.4% but only 7.7% had difficulty eating in the previous 12 months by contrast with 13.4% of the Irish Army (Kudo et al., 2011). By contrast, in the Australian Army, the reported prevalence of painful aching was higher at 14.4% but a similar proportion reported difficulty eating foods at 12.8% (Crocombe et al., 2013). In the Croatian Army 30.3% had an impact in the physical pain domain, about double the prevalence in the Irish Army (Spalj et al., 2012). Unfortunately, oral health data was not published that would allow inferences to be made about the reasons for these differences. Agreed international reporting standards that will allow comparisons to be made are urgently required.

6.1.5 Binary logistic regression model

Binary logistic regression models were developed to determine the effect of education, rank, deprivation, last dental visit and phobia on the prevalence of the pain outcomes (and were adjusted for the effect of age and gender).

6.1.5.1 Logistic regression models – pain or a problem in the mouth

The model for pain or problems in the mouth was statistically significant ($X^2=28.2$, $df=14$, $p=0.01$), explained 8% of the variance in presence of pain or problems and correctly classified 90.5% of the cases. The results are displayed in Table 6-8 and shows that only dental visiting was statistically significant, with an OR 2.3 95% CI [1.3, 4.5] increase in pain in the “12 to 24 months” last dental visit group by comparison with the “within 12 months” group. These results are indicative of the benefit accruing to recent dental attendance in the Army.

Table 6-8: Binary logistic regression of presence of pain or a problem in the mouth, unweighted data (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.6 (0.3, 1.3)	0.21
	NCO	0.5 (0.2, 1.3)	0.15
	Officer	0.4 (0.1, 1.5)	0.15
Deprivation	<1 SD	Baseline	
	±1 SD	1.1 (0.5, 2.1)	0.85
	>1 SD	1.5 (0.6, 4.2)	0.39
	Outside State	1.7 (0.6, 5.3)	0.33
Education ⁸⁹	Some secondary	Baseline	
	Completed secondary	2.4 (0.8, 6.9)	0.12
	Some college	1.4 (0.6, 3.8)	0.47
	Honours degree or Masters	1.5 (0.6, 4.2)	0.42
Last dental visit ⁹⁰	<12 months	Baseline	
	12 to 24 months	2.3 (1.3, 4.5)	0.008
	>24 months	1.2 (0.5, 2.3)	0.79
Phobia ⁹¹	No phobia	Baseline	
	Phobia	2.1 (0.9, 4.7)	0.09
Age		1.0 (1.0, 1.1)	0.07
Gender		0.3 (0.1, 1.0)	0.06

⁸⁹ 29 missing cases

⁹⁰ 1 missing case

⁹¹ 1 missing case

6.1.5.2 Logistic regression models – pain from teeth

The results for the model for pain from teeth is displayed in Table 6-9. The model was statistically significant ($\chi^2=34.3$, $df=14$, $p=0.002$), explained 12% of the variance in presence of pain from teeth and correctly classified 93.4% of the cases. By contrast with the pain or problems results, a number of independent variables were associated with pain from teeth. Every unit increase in age was associated with a OR 1.1 95% CI [1.0, 1.1] increase in the prevalence of pain from teeth. As such the results differed from international civilian reports, which has tended to show higher prevalence in younger people (Slade et al., 2004, Cooney, 2010, Ministry of Health, 2010, Steele et al., 2011a, Brennan et al., 2020, Public Health England., 2020, Aldosari et al., 2021). The differences may be explained by the peaks in caries incidence in the teenage years that may be largely untreated in civilian communities (Peres et al., 2019). In the Army, the consequences of disease and treatment over time may lead to a higher risk of pain associated with teeth, captured by these results.

In line with international reports, men had a lower prevalence of pain than women, with an OR 0.3 95% CI [0.1, 0.8] decrease in prevalence. Anecdotally, it has been reported that fewer women deploy overseas and it is possible that mandatory pre-deployment inspections were missed that could optimize oral health. Supporting this interpretation, last dental visit was associated with dental pain, with an increased risk in patients who had not attended in over 12 months, but only the “12 to 24 months’ group was statistically significant. Further research is required to determine the reason for recency of dental visits, as problem-based attending may affect the interpretation of the results.

Table 6-9: Binary logistic regression of presence of pain from teeth, unweighted data (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.6 (0.2, 1.4)	0.22
	NCO	0.4 (0.1, 1.3)	0.12
	Officer	0.1 (0.0, 0.8)	0.03
Deprivation	<1 SD	Baseline	
	±1 SD	1.0 (0.4, 2.1)	0.91
	>1 SD	0.7 (0.2, 3.0)	0.67
	Outside State	2.7 (0.8, 8.7)	0.11
Education ⁹²	Some secondary	Baseline	
	Completed secondary	1.7 (0.5, 5.5)	0.36
	Some college	1.1 (0.4, 3.0)	0.94
	Honours degree or Masters	0.9 (0.3, 2.8)	0.80
Last dental visit ⁹³	<12 months	Baseline	
	12 to 24 months	2.4 (1.1, 5.1)	0.02
	>24 months	1.2 (0.5, 3.1)	0.64
Phobia ⁹⁴	No phobia	Baseline	
	Phobia	1.2 (0.4, 3.4)	0.75
Age		1.1 (1.0, 1.1)	0.009
Gender		0.3 (0.1, 0.8)	0.02

6.1.5.3 Logistic regression models – OHIP-14 physical pain domain

The results for the model examining the physical pain domain of OHIP-14 are displayed in Table 6-10 and were statistically significant ($\chi^2=27.5$, $df=14$, $p=0.02$), explained 6% of the variance in presence of complex prosthodontics and correctly classified 81.7% of the cases. In the prevalence of pain over the previous 12 months, pain prevalence increased with age, with an OR 1.04 95% CI [1.01, 1.06] increase with every unit increase in age. In the remaining categories, only rank was statistically significant, with higher pain prevalence in new entrants by comparison with other ranks.

⁹² 29 missing cases

⁹³ 1 missing case

⁹⁴ 1 missing case

Table 6-10: Binary logistic regression of presence of OHIP-14 pain domain, unweighted data (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.3 (0.2, 0.6)	<0.001
	NCO	0.3 (0.1, 0.6)	0.001
	Officer	0.4 (0.2, 1.1)	0.06
Deprivation	<1 SD	Baseline	
	±1 SD	0.9 (0.6, 1.6)	0.81
	>1 SD	1.3 (0.6, 2.7)	0.46
	Outside State	0.8 (0.3, 2.0)	0.61
Education ⁹⁵	Some secondary	Baseline	
	Completed secondary	1.4 (0.6, 3.4)	0.37
	Some college	1.4 (0.7, 2.7)	0.42
	Honours degree or Masters	0.7 (0.7, 3.0)	0.35
Last dental visit ⁹⁶	<12 months	Baseline	
	12 to 24 months	0.7 (0.4, 1.3)	0.28
	>24 months	1.1 (0.7, 1.9)	0.84
Phobia ⁹⁷	No phobia	Baseline	
	Phobia	1.9 (0.9, 3.7)	0.08
Age		1.04 (1.04, 1.06)	0.02
Gender		0.6 (0.2, 1.3)	0.13

In summary, these data have analysed the associations between the presence of pain in the Army and demographic variables or intermediate determinants of oral health. Age, gender, rank and dental visiting were important factors associated with the prevalence of pain. The main issue by rank was the untreated new entrants' group, which the dental service has identified as a risk group but has not developed a mechanism for completing treatment except in advance of overseas service. Mandatory risk-based recall may provide opportunities for treatment and obviate barriers that young soldiers need to overcome to access treatment. Mandatory recall may also assist in reducing gradients by age and gender.

⁹⁵ 29 missing cases

⁹⁶ 1 missing case

⁹⁷ 1 missing case

6.1.6 Association of pain with self-reported oral health

The prevalence of pain is displayed by self-reported oral health status in Table 6-11 and shows the decreasing prevalence of reported pain as self-reported status improved. The differences between the groups were statistically significant; similar results were reported in the UK (Steele et al., 2011a). The data suggests that the outcome measure of self-reported oral health status may have utility in the identification of the pain status of personnel in the Army.

Table 6-11: Prevalence of pain by self-reported oral health status, unweighted data (n=777)

Self-reported oral health	Problems or pain in the mouth	Pain from teeth	OHIP-14 physical pain domain
Excellent	0%	0%	0%
Very good	5.6%	4.9%	13.2%
Good	6.9%	3.3%	16.5%
Fair	11.6%	9.3%	22.2%
Poor	29.5%	21.3%	32.8%
p values	<0.001	<0.001	0.03

6.1.7 Summary of the pain data

In the sample, 8.1% reported a current pain or a problem in their mouth, 5.6% reported current pain from teeth and 15.9% reported a painful impact at the threshold of “occasional” or above in the previous 12 months. These data showed that a small proportion of the Army was in pain at any time and the need for access to emergency dental services. The reasons for pain were not asked in this survey, which should be included in future surveys. The data also shows the importance that must be attached to adequate pain histories when patients attend for dental examinations. It is also concerning that such a high prevalence of pain exists in a system of care which has as one of its primary goals the management of pain experience and which provides free basic dental care as a preventative measure.

The presence of caries and its sequelae and the presence of periodontitis were both associated with pain in this Army sample. The strong association between periodontitis and pain was surprising as this is an oft overlooked part of the periodontal literature. Further research is required to assess the links between pain and periodontal health in the Army.

6.2 Self-reported oral health status

Significant resources are allocated in the Army to the assessment of the dental fitness before deployment overseas. In the intervals between deployments self-reported health status offers the potential to monitor diseases and conditions in a low-cost manner and has correlated well with normatively assessed oral health status (Atchison et al., 1993, Jones et al., 2001, Nuttall et al., 2011, Lintula et al., 2014). In the military setting, self-reported oral health status in recruits has been used to predict the likelihood of the need for urgent care (Norris et al., 2021).

Limited self-reported oral health status data are available in Ireland which could be used as reference in the Army. In a group of community dwelling older adults, the prevalence of excellent, very good or good self-reported oral health status was reported as 81% in the 50 to 64 years age group (Naseer, 2020). The self-reported oral health status in this report correlated well with tooth number, DMFT and SUNT scores but poorly with periodontal health, as measured by CPITN.

The results of self-reported oral health status may be used in the Irish Army as a means to improve surveillance and provides a subjective assessment of an individual's overall experience of oral health within military service. The results will be used to determine how well self-reported oral health status correlated with the normatively identified oral health status, reported above.

6.2.1 Summary statistics

The self-reported oral health status in the weighted and unweighted Army sample is displayed in Table 6-12 by response and dichotomized into “good” or above and “fair” or below. The majority of personnel reported good or better oral health. About a third considered their oral health fair or poor and only 22% of the weighted sample considered that they had very good or excellent oral health even with the opportunity of freely accessible oral healthcare.

Table 6-12: Prevalence of self-reported oral health status in the weighted and unweighted Army sample

Response	Weighted (%)		Unweighted (%)	
Excellent	2.9	61.4	2.4	59.9
Very good	19.1		18.5	
Good	39.5		39	
Fair	27.8	36.7	29	36.9
Poor	8.9		7.9	
Don't know	1.9	1.9	3.2	3.2

Data with which these results may be compared in Ireland is limited in nature. In the Healthy Ireland report in 2018, 79% reported “very good” or “good” oral health, with only 17% describing their oral health as “fair” and 4% as “bad” (Dept. of Health, 2018), whereas in the Army 36.9% described their oral health as “fair” or “poor”. A limiting factor in comparison was the difference in demographic mix in the Army and the national population and the absence of normatively assessed need in the national population which might explain the differences. Table 6-13 displays the self-reported oral health status of 50 to 64 year old respondents in the Army and the TILDA survey (Naseer, 2020). A greater proportion of the TILDA survey in the 50 to 64 years age group reported “excellent/ very good/ good” oral health than in the Army despite the fact that the TILDA participants had fewer teeth, fewer SUNT, higher DMFT scores, more DT. In addition, one third of the TILDA participants had a denture whereas only 6.1% of the soldiers had a denture. An additional interesting observation was that in this age group no soldiers reported “excellent” oral health whereas 12% of the TILDA group reported “excellent” oral health.

Table 6-13: Comparison between the TILDA and Army surveys in the 50 to 64 years age group in the self-reporting of oral health, unweighted data (n=777)

Response	Army	TILDA
Excellent	0%	12%
Very good	18.4%	31%
Good	42.9%	38%
Fair	30.6%	15%
Poor	6.1%	4%

When compared with international civilian surveys, in general better oral health was reported by the civilian populations. In the 1999 to 2014 US NHANES data 38% reported excellent or very good oral health (Li et al., 2019) whereas the comparable proportion was 22% in the Irish Army. In the UK national survey in 2009 71% reported good or very good oral health whereas in the Army 61.5% reported from good to excellent oral health (Nuttall et al., 2011). Only in a recent survey conducted without clinical examination in England did the results

approximate the Army results as reported that they had 66% had “very good” or “good” oral health (OHID, 2024) but direct comparison was hampered by the different reporting schemes and demographic composition.

When compared with military reports with a similar demographic mix, the prevalence of excellent or very good self-reported oral health status was lower in the Irish Army. For example, in Israel the proportion reporting “excellent” or “very good” oral health was 50.9% (Zadik et al., 2009) and in the US the proportion was 62.5% (Norris et al., 2021) whereas it was only 22% in the Irish Army.

In summary, the overall prevalence of “excellent/ very good/ good” self-reported oral health was lower in the Army than by comparison with national civilian and international civilian and military comparators, despite a low prevalence of decayed teeth or active periodontal disease.

6.2.2 The association between clinical indicators and self-reported oral health status

The prevalence of excellent/ very good/ good self-reported oral health is displayed in Figure 6-4 using the main clinical indicators. The results show the wide variety of clinical indicators that affect the perception of optimal oral health. The results accord with the findings of the pain data the same conditions that affect pain experience also affect perceptions of oral health, including decayed teeth and their sequelae, denture wearing and periodontal disease. In the case of periodontal disease, a gradient from PSR 0 to PSR 4 was evident and only 38% of patients with PSR 4 reported excellent/ very good/ good self-reported oral health. About one in five patients with unrestorable teeth, PUFA or a denture reported excellent/ very good/ good self-reported oral health but whereas unrestorable teeth and PUFA affected teeth may be readily treated, denture wearing is a more complex problem and often difficult to replace. The data suggests that efforts to prevent denture wearing should be prioritized in the Army.

Table 6-14 displays the prevalence of good or higher self-related oral health by the clinical indicators reported in the UK national survey (Nuttall et al., 2011). The results showed that poorer self-reported oral health was associated with normatively assessed need including fewer teeth and fewer sound teeth, as has been reported internationally (Nuttall et al., 2011) (Norris et al., 2021). However, the values were much lower for soldiers in the Army in 2020 than civilians in the UK in 2009 for reasons that are not clear. Further research is required on this topic.

Table 6-14: Prevalence of self-reported oral health by clinical metrics in the unweighted Army sample (n=777), compared to UK survey 2009

Metric		Army 2020 (Excellent/ very good/ good)	UK 2009 (Very good/ Good)
No teeth	≥21 teeth	60%	74%
	<21 teeth	33%	53%
SUNT	≥18 teeth	64%	77%
	<18 teeth	42%	63%
Decayed teeth	DT=0	65%	78%
	DT>0	41%	54%
Filled teeth	FT<12	62%	71%
	FT ≥12	46%	71%
Periodontitis	PSR 0,1,2	66%	86%
	PSR 3 or 4	49%	78%
	PSR 4	38%	72%

A binary logistic regression was undertaken to assess the association between excellent/ very good/ good self-reported oral health and a number of clinical indicators. The initial model was weak and only predicted 62% of cases. Removal of BEWE $\geq$ 2 improved the model slightly to identify 67.8% of cases, explained 11% of the variance in outcome and was statistically significant ($\chi^2=64.4$, df=7, $p<0.001$). The results are displayed in Table 6-15 and show that number of teeth, presence of decayed teeth, number of filled teeth and presence of PSR 3 or 4 were associated with excellent/ very good/ good self-reported oral health. These results show the importance of preventative programmes in the context of self-reported oral health.

Table 6-15: Binary regression self-reported excellent/ very good/ good oral health and clinical indicators, unweighted sample (n=777)

Variable	OR (95% CI)	p value
No teeth	1.1 (1.1, 1.2)	<0.001
DT>0	0.4 (0.3, 2.0)	<0.001
Unrestorable>0	0.5 (0.1, 2.0)	0.33
PUFA>0	0.4 (0.1, 1.9)	0.23
Filled teeth	0.95 (0.92, 0.98)	0.003
Denture	0.3 (0.1, 1.3)	0.10
PSR 3 or 4	0.6 (0.4, 0.8)	0.001

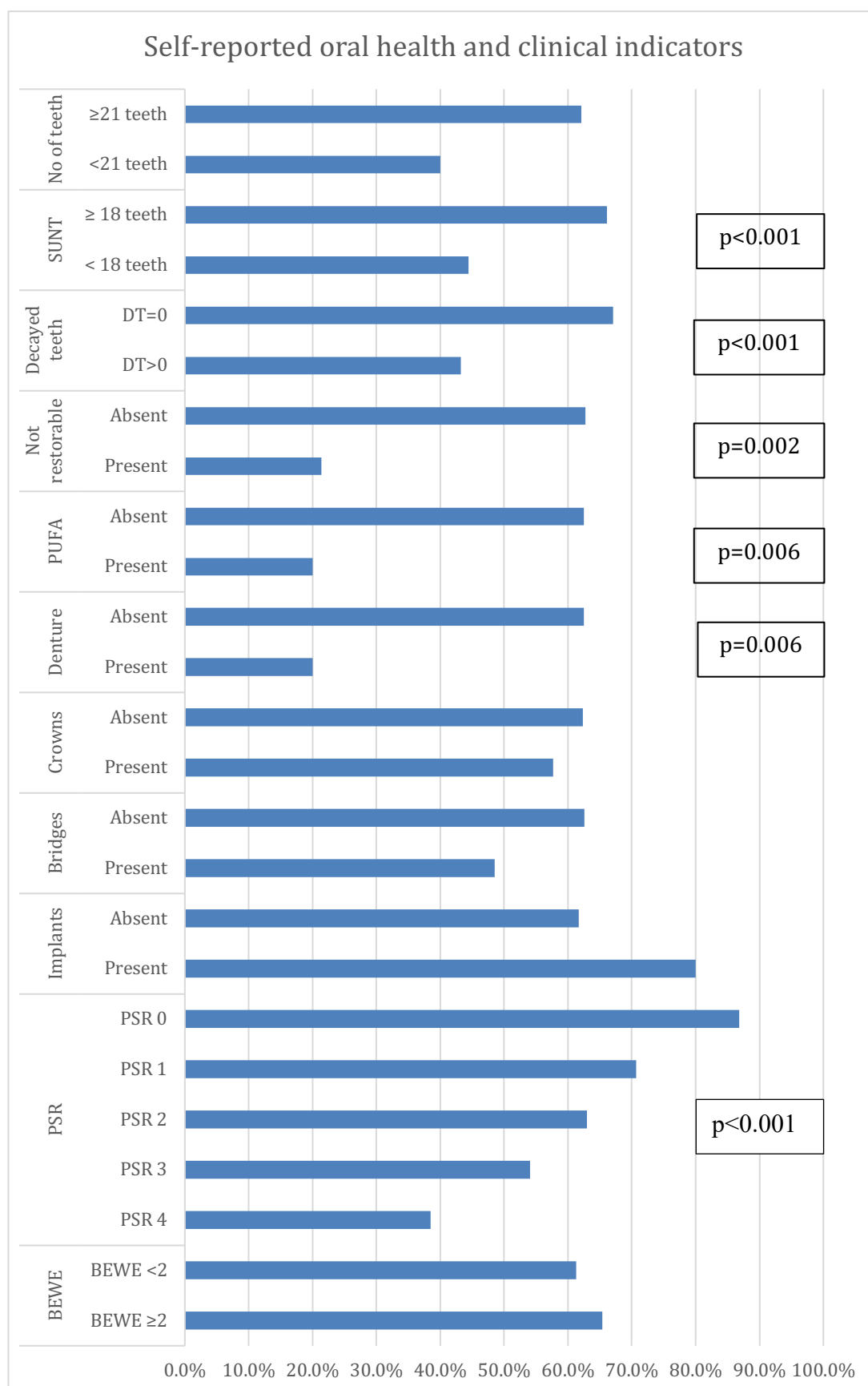


Figure 6-4: Self-reported oral health and clinical indicators, unweighted data (n=777)

6.2.3 Association with determinants of oral health

The prevalence of excellent/ very good/ good self-reported oral health is displayed in Table 6-16 by the demographic variables and intermediate determinants of oral health. In the sample, there were no statistically significant differences by gender or by age. National and international surveys had mixed results reporting both better self-reported oral health in women (Cooney, 2010, Nuttall et al., 2011, Dept. of Health, 2018) and no difference by gender (Li et al., 2019, OHID, 2024) which may just mean that the results are applicable to the population under observation rather than an accepted norm. The results by age were at odds with national and international surveys that have consistently reported a decrease in self-reported oral health with age (Cooney, 2010, Nuttall et al., 2011, Dept. of Health, 2018, Li et al., 2019, OHID, 2024). The fact that the youngest age group had such a low percentage reporting better oral health may have been a factor in this trend as it led to a flattening of the results. For example, in the UK the 2021 survey reported that 82% of 18 to 24 year old respondents reported “good” or “very good” oral health (OHID, 2024) and decreased into older age, whereas the comparable figure in the Army for “excellent or very good or good” was 56%.

Social gradients in the prevalence of excellent/ very good/ good self-reported oral health were evident in the data, with a gradient by education status from the “some secondary” group to the “honours degree or Masters” group. Similar results have been reported in Canada and the US by education level (Cooney, 2010, Li et al., 2019). In the rank groups, although officers had a higher prevalence (72.4%) than other groups, the differences did not reach statistical significance. There were no little differences by deprivation status, which have been widely reported nationally (Dept. of Health, 2018) and in international publications when using indicators such as income (Cooney, 2010), poverty level (Li et al., 2019), deprivation quintile (OHID, 2024) or occupation (Nuttall et al., 2011). It is known that averaging of effect when using small areas for deprivation may mask individual risk (Haynes and Gale, 2000). Given the overall lower levels of reported optimal oral health it would appear that there was “levelling down” of the scores to a lower standard.

There were statistically significant differences by dental attendance ($\chi^2=6.3$, $df=2$, $n=752$, $p=0.04$) with poorer self-reported oral health in personnel who hadn’t attended in over two years. There have been similar reports in the UK (Nuttall et al., 2011), Canada (Cooney, 2010) and England (OHID, 2024), albeit using different time frames. The differences by

dental phobia ($\chi^2=6.9$, $df=4$, $n=752$, $p=0.009$) may have reflected a complex mix of avoidant behaviour and disease status.

Table 6-16: Prevalence of excellent/ very good/ good self-reported oral health status by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	59.6%	65.5%	57.7%	64.3%	66.7%	0.50
Gender	Male (n=749)		Female (n=28)			0.65
	62.1%		57.7%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.16
	59.1%	60.1%	62.8%	72.4%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.92
	62.3%	61.8%	64.5%	57.9%		
Education categories ⁹⁸	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		>0.05
	53.1%	60%	64.9%	70.6%		
Last dental visit ⁹⁹	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		0.04
	64.2%		61%	51%		
Phobia ¹⁰⁰	Phobia (n=47)			No phobia (n=729)		0.009
	42.5%			63.2%		

6.2.4 Self-reported oral health status in new entrants and the trained strength

The prevalence or self-reported oral health in the trained strength and recruits is displayed in Table 6-17. Although the distribution between the groups was statistically significant ($\chi^2=16.5$, $df=2$, $n=777$, $p<0.001$), differences were only recorded in the “don’t know” category and when these cases were excluded there were no statistically significant differences between the groups. Consequently, further analysis of the data at this level of granularity was not undertaken. However, it is interesting that there was little difference between the proportion in the trained strength and new entrants despite the marked difference in oral health, outlined in the chapter on oral health status.

⁹⁸ 29 missing cases

⁹⁹ 1 missing case

¹⁰⁰ 1 missing case

Table 6-17: Prevalence of dichotomized self-reported oral health in the trained strength and recruits, unweighted data

Response	Trained strength (n=553)	Recruits and cadets (n=224)
Excellent, very good/ good	62%	54.9%
Fair/ poor	36.3%	37.9%
Don't know	1.6%	7.1%

6.2.5 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank, deprivation, last dental visit and phobia on the presence of optimal self-reported oral health and was adjusted for the effect of age and gender. The initial model was not statistically significant and was affected by the inclusion of the deprivation categories. Removal of the deprivation category produced a model that was statistically significant ($X^2=19.7$, $df=8$, $p=0.01$), explained 4% of the variance in presence of complex prosthodontics and correctly classified 63.9% of the cases. The results are displayed in Table 6-18 and show that patients with phobia had an OR 0.4 95% CI [0.2, 0.8] decrease in the prevalence of optimal self-reported oral health, compared with patients without phobia. No other factors were associated with self-reported oral health status in the Army.

Table 6-18: Binary logistic regression of presence of self-reported oral health, unweighted data (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.7 (0.3, 1.5)	0.34
	NCO	0.7 (0.4, 1.5)	0.38
	Officer	0.8 (0.4, 1.7)	0.61
Education ¹⁰¹	Some secondary	Baseline	
	Completed secondary	0.5 (0.4, 1.7)	0.08
	Some college	0.7 (0.4, 1.2)	0.19
	Honours degree or Masters	0.8 (0.5, 1.5)	0.49
Last dental visit ¹⁰²	<12 months	Baseline	
	12 to 24 months	1.6 (1.0, 2.5)	>0.05
	>24 months	1.5 (0.8, 2.6)	0.21
Phobia	No phobia	Baseline	
	Phobia	0.4 (0.2, 0.8)	0.01
Age		1.0 (1.0, 1.0)	0.40
Gender		1.1 (0.5, 2.4)	0.91

Association between self-reported oral health and OHIP-14

¹⁰¹ 29 missing cases

¹⁰² 1 missing case

Table 6-19 displays the prevalence, extent and severity of OHIP-14 impacts in each of the self-reported groups, with the results of the χ^2 and Kruskal-Wallis tests for differences in distribution. The results show that there was a gradient in the prevalence, extent and severity of impacts from the “excellent” to “poor” group. There were statistically significant differences in the distribution of impacts between the “excellent”, “very good” and “good” groups and the “fair” and “poor” groups, which suggests that dichotomization into the merged “excellent/ very good/ good” and “fair/ poor” groups had utility.

Table 6-19: Prevalence of oral health metrics in the self-reported oral health categories, unweighted data (n=777)

OHIP-14 metric	Excellent	Very good	Good	Fair	Poor	p-value
Prevalence	5.3%	18.8%	34%	48%	82%	<0.001
Extent	0.1 (0, 0.2)	0.5 (0.3, 0.7)	0.9 (0.7, 1.1)	1.5 (1.2, 1.8)	3.5 (2.7, 4.4)	<0.001
Severity	0.5 (1, 1.1)	1.8 (1.1, 2.4)	3.2 (2.5, 3.8)	4.9 (4.1, 5.7)	11.1 (8.7, 13.6)	<0.001

6.2.6 Summary of the self-reported oral health results

In the Army sample 61.4% of the weighted sample reported “excellent/very good/good” oral health. The proportion reporting better oral health was lower than in national surveys (Dept. of Health, 2018), reports in high-income countries (Nuttall et al., 2011, Li et al., 2019) and in military studies (Zadik et al., 2009, Norris et al., 2021). When compared with age matched 50 to 64 years old respondents in the TILDA survey (Naseer, 2020), soldiers had better normatively determined oral health, including a lower prevalence of dentures, but had a lower proportion who reported better oral health. Soldiers with better self-reported oral health had better normatively assessed oral health metrics than soldiers, as might be expected (Wilson and Cleary, 1995).

A gradient in self-reported oral health was present across the deprivation, education and rank groups but only the differences across the education categories were statistically significant. Completing progressively complicated and demanding educational requirements requires a degree of self-efficacy (Artino, 2012), which has shown to positively affect self-reported oral health (de Silva-Sanigorski et al., 2013, Jamieson et al., 2014, Parker et al., 2022). The Army provides leadership and development courses designed to foster self-efficacy and adaptability (Ulmer Jr, 2010). Suppression of individuality in recruit training and paternalism in the Army may have the opposite effect, at least for some soldiers, as suggested by the rates of homelessness in military veterans (Tsai and Rosenheck, 2015). In this respect it was

noteworthy that the proportion of officers with better self-reported oral health was greater than any of the enlisted ranks and comparable to civilian reports.

6.3 OHIP-14

Health-related quality of life measures have been used to report the subjective interpretation of health, which may be modified by patient expectations, culture, social status and individual capacity (Wilson and Cleary, 1995). The most widely used instrument in the oral cavity has been the OHIP-14 instrument (Riva et al., 2022) which has shown correlations between clinical indices and OHIP-14 scores (Locker and Slade, 1994). Of these, tooth loss has proven to be the most important measure and the association with a minimum number of teeth or occluding units has widely been reported (Steele et al., 2004, Lawrence et al., 2008, Marino et al., 2008). Dental caries experience (Lawrence et al., 2008, Marino et al., 2008, Slade and Sanders, 2011, Masood et al., 2017), severe periodontitis (Ng and Leung, 2006, Lawrence et al., 2008, Slade and Sanders, 2011) and pain states (Slade and Sanders, 2011, Cimilli et al., 2012, Magraw et al., 2015, Masood et al., 2017, Oghli et al., 2020) have all been reported to affect OHRQoL.

Although normatively assessed need has been reported in the Army, albeit a number of decades prior to this survey (Hayden, 1995), no survey has recorded the oral health related quality of life of soldiers in the Irish Army. Several of the domains in the OHIP-14 instrument have direct bearing on the occupational aspect of dental service provision including the physical pain and physical disability domains. In addition, the identification of risk groups with a higher prevalence, extent or severity of impacts will allow the dental service to move beyond traditional measures of oral health and provide a more patient-focussed service.

6.3.1 OHIP-14 summary scores

The summary statistics for the OHIP-14 scores in the weighted and unweighted Army samples are displayed in Table 6-20. The results show that about a third of the sample reported an impact at the level of “occasionally” or above, with a mean of about a single item affected at this threshold and a severity score of 3.8 95% CI [3.2, 4.5].

In the absence of national data, it is only possible to compare with UK data from 2009 (Nuttall et al., 2011) and 2021 (OHID, 2024), which reported at the threshold of “occasionally” or above. In 2009, the prevalence (39%) and extent (1.2) of impacts was very similar to the Army data but the UK results had a far higher severity score (17.4). In 2021 the UK data reported higher impacts across each of the measures of prevalence (47%), extent (1.7) and severity (19.7). These data would suggest that military personnel continue to have impacts but by comparison with UK civilians they were less frequent in nature.

The few international military reports available that report OHIP-14 data also reported at the threshold of “occasionally” or above. In the Australian Army the reported prevalence (8.5%) and extent 0.2 [0.1, 0.2] were lower than the Irish Army with lower fewer impacts in the psychological discomfort and psychological disability domains (Crocombe et al., 2013). The mean severity score in the Irish Army was similar to that reported in the Australian Army (5.0 [4.4, 5.6]) and Japanese Army 4.6 [4.1, 5.0] (Kudo et al., 2011) and lower than that reported in the Croatian Army (9.7 [3.1, 16.3]) (Spalj et al., 2012) and each of these scores was considerably lower than the severity scores in the UK civilian population.

Table 6-20: Summary statistics for OHIP-14 scores in the Army sample at the level of “occasional” or above

	Weighted	Unweighted
Prevalence	35.5%	38.5%
Extent	1.1 (0.9, 1.3)	1.2 (1.0, 1.3)
Severity	3.8 (3.2, 4.5)	4.0 (3.5, 4.4)

For completeness, the summary statistics for OHIP-14 scores for the Army at the level of “fairly often” or above are displayed in Table 6-21 so that comparison may be made with international surveys that reported at this threshold. The prevalence and extent of impacts at this threshold was very similar to that reported in the UK in 1998 (Kelly et al., 2000) but lower than was reported in Australia in 1999 (Slade et al., 2005) and New Zealand in 2008 (Lawrence et al., 2008). In summary, the results from the Irish Army compared favourably with international civilian and military reports and indicate that only a small number of personnel had frequent oral health impacts.

Table 6-21: Summary statistics for OHIP-14 scores in the Army sample at the level of “fairly often” or above

	Weighted	Unweighted
Prevalence	13.9%	13.3%
Extent	0.3 (0.2, 0.4)	0.3 (0.2, 0.4)
Severity	3.8 (3.2, 4.5)	4.0 (3.5, 4.4)

6.3.2 Frequency of item responses

The frequency distribution of impacts in the weighted Army sample is displayed in Figure 6-5 and shows that about half of personnel (49.6%) reported no impacts – a large “floor” effect, which may indicate that less severe effects that might bring a soldier into contact with dental emergency services, such as sensitive teeth, may have been excluded from the assessment. Overall, 89.6% had a summed score of twelve or less, showing that severe effects were confined to a very small proportion of the sample.

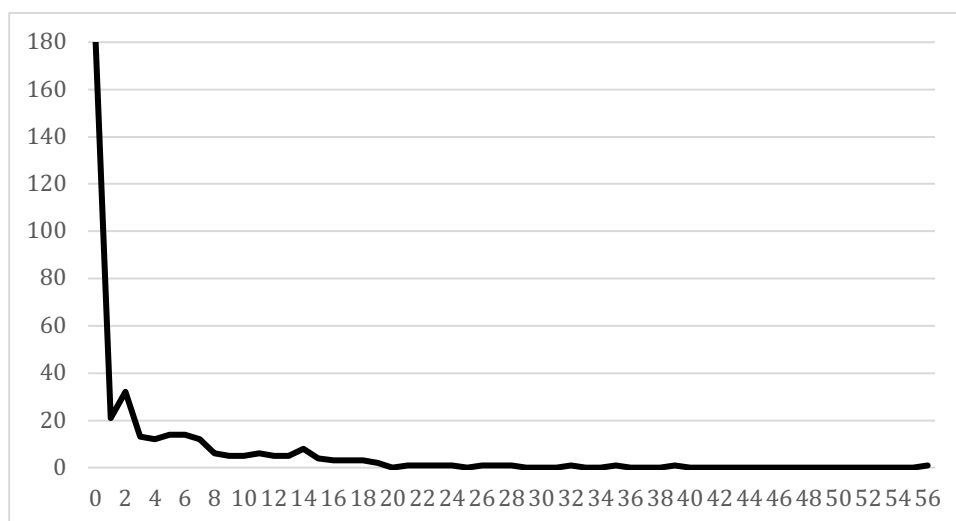


Figure 6-5: Frequency distribution of number of impacts, OHIP-14, weighted Army (n=364)

The frequency of item responses in the OHIP-14 questionnaire is displayed in Table 6-22 and shows that the frequency of item responses was between 0.8% and 27.3%, with the most commonly responded items in the psychological discomfort, psychological disability and physical pain domains and few responses in the functional limitation, physical disability, social disability and handicap domains.

Only 0.8% of respondents said that they had an occasional or more frequent impact that rendered them totally unable to function and 2.4% stated that they had difficulty doing their usual job, showing both a low prevalence of the impacts of oral diseases that could affect the operational effectiveness of the Army and the need to provide ready access to emergency services. In the UK survey results in 2009 the prevalence of these items was 1% and 2% respectively (Nuttall et al., 2011), but in the 2021 survey had increased to 4% and 5%, respectively (OHID, 2024) and may indicate a changing perception of the impacts of oral disease in the intervening years, at least in a civilian population in the UK.

The highest prevalence of impacts was in the psychological discomfort and psychological disability domains, with over a quarter of respondents reporting an impact in the psychological discomfort domain and about a fifth in the psychological disability domain. Most of these impacts were in the “felt self-conscious” and “a bit embarrassed” items. In this respect, it was interesting to note that the greatest impact in the UK 2009 survey was in the “painful aching” item (22%) in the physical pain domain (Nuttall et al., 2011) whereas in the 2021 survey the greatest impact was in the “self-conscious” item (28%) in the psychological discomfort domain (OHID, 2024). These data may indicate a changing perspective on oral health in populations, with an increasing focus on aesthetics driving the responses.

Table 6-22: Frequency of item responses in the OHIP-14 instrument, unweighted data (n=777)

Domain	Item	n	%	%
Functional limitation	Trouble pronouncing words	23	3	5
	Sense of taste worsened	24	3.1	
Physical pain	Painful aching	81	10.4	15.9
	Uncomfortable to eat foods	117	15.1	
Psychological discomfort	Been self-conscious	212	27.3	27.1
	Felt tense	104	13.4	
Physical disability	Diet been unsatisfactory	38	4.9	5.8
	Interrupt meals	26	3.3	
Psychological disability	Difficult to relax	57	7.3	19.4
	Felt a bit embarrassed	133	17.1	
Social disability	Irritable with people	33	4.2	5.7
	Difficulty doing usual jobs	19	2.4	
Handicap	Life in general less satisfying	40	5.1	5.4
	Totally unable to function	6	0.8	

6.3.3 Prevalence of OHIP-14 impacts and clinical conditions

An explicit purpose of the OHIP-14 instrument was to allow discrimination between groups on the basis of having lower and higher levels of disease (Slade, 1997). Figure 6-6 displays the prevalence scores associated with clinical conditions and the results of statistical tests between the groups, where they are statistically significant. The reliability of the data in the groups with less than 21 teeth, denture wearers and those with unrestorable teeth or PUFA symptoms must be interpreted with caution given the small numbers in these groups.

There were statistically significant differences in the prevalence of impacts between those with and without poorer oral health including decayed teeth, unrestorable teeth, PUFA symptomology, active periodontitis, fewer than 18 SUNT and denture wearers. These results aligned with the purpose of the instrument (Slade, 1997), previous reports (Lawrence et al., 2008, Bernabe and Marcenes, 2010, Daly et al., 2010, Jansson et al., 2014) and systematic reviews (Haag et al., 2017). The results mirrored the results of the differences between clinical markers in the distribution of self-reported oral health. A number of the results were similar to the results of the analysis in the 2009 UK survey; for example, the prevalence in the UK survey was 49% and 38% for respondents with and without decayed teeth while the corresponding prevalence in the Army was 53% and 34% respectively. Similar approximations were present in the SUNT results.

Unlike international reviews (Gerritsen et al., 2010) there were no statistically significant differences recorded for number of teeth but this may have been a result of the small number of respondents in the “less than 21 teeth” group. The highest prevalence of impacts was in denture wearers, of whom 90% reported an impact and the mean number of items impacted was 4.7 95% CI [2.1, 7.4]. The next nearest prevalence was in respondents with the pathological states of unrestorable teeth and PUFA symptoms but whereas these may be expected to be resolved by relatively brief dental interventions, denture wearers may be living with these devices over extended periods of time. It would be useful for dental staff in the Army to conceptualize that denture wearing had the same order of magnitude of impacts as these pathological states as patients with PUFA symptoms are often treated on an emergency basis whereas patients with dentures are typically given non-urgent appointments. On foot of these findings, systemic approaches to transition personnel from dentures to alternative devices should be considered.

A binary regression model was developed to determine the effect of clinical indicators on the presence or absence of OHIP-14 impact and was statistically significant ($\chi^2=62.5$, $df=11$, $p<0.001$), explained 11% of the variance and correctly identified 65.6% of the cases.

The results are displayed in Table 6-23 and show that decayed teeth, denture wearing and PSR 4 were associated with OHIP-14 prevalence. As such, the results were in line with the pain and self-reported oral health outcomes reported above.

Table 6-23: Binary logistic regression model OHIP-14 prevalence, unweighted data (n=777)

Variable		OR (95% CI)	p value
≥ 21 teeth		10.8 (0.8, 154.8)	0.08
SUNT ≥ 18		1.2 (0.7, 2.0)	0.49
DT>0		1.8 (1.2, 2.6)	0.003
Unrestorable>0		2.8 (0.8, 10.8)	0.13
PUFA>0		3.7 (0.7, 18.1)	0.11
Filled teeth		1.0 (1.0, 1.1)	0.29
Denture		22.3 (2.1, 242.4)	0.01
PSR	0	Baseline	
	1	1.4 (0.6, 3.1)	0.50
	2	1.6 (0.7, 3.5)	0.24
	3	2.1 (0.9, 4.7)	0.07
	4	4.0 (1.5, 10.9)	0.006

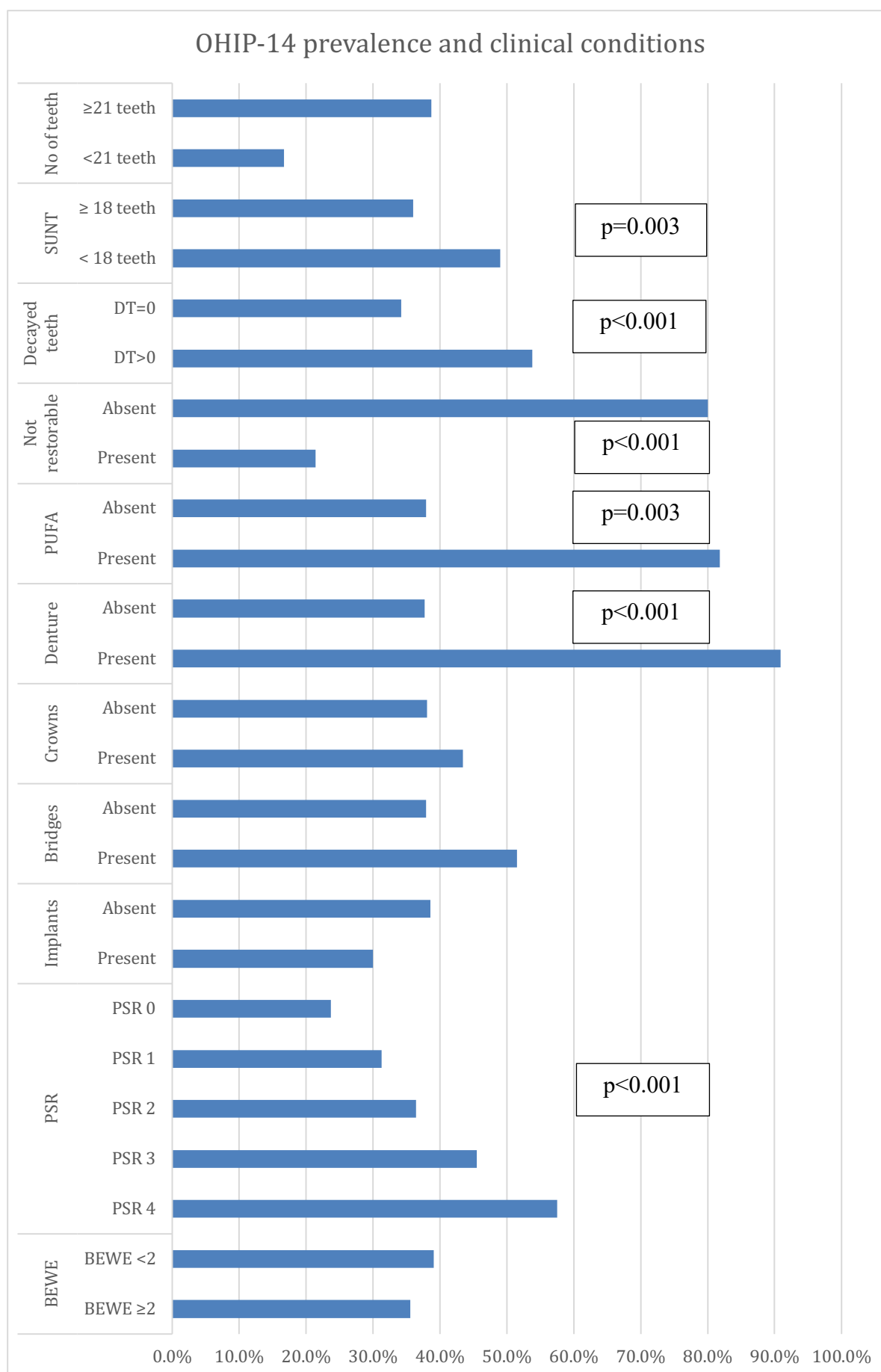


Figure 6-6: Prevalence of OHIP-14 impacts and clinical indicators, unweighted data (n=777)

6.3.4 OHIP-14 scores and determinants of oral disease

The prevalence of OHIP-14 impacts is displayed in Table 6-24 by demographic variables and intermediate determinants of oral health. Overall, there was little variation between the groups or by pattern of response. In the rank category the differences were between the recruits and other ranks, which aligned with the high prevalence of untreated disease in this group. However, there were no differences by education level or by deprivation group. Crocombe *et al* suggested that the impacts of deprivation were reduced in the Australian Army as a result of optimal access to basic oral healthcare and may explain the results in the Irish Army (Crocombe et al., 2013). The most dramatic difference was between those with and without phobia, which has been reported elsewhere (McGrath and Bedi, 2004, Mehrstedt et al., 2007, Johansson et al., 2010, Boman et al., 2012). The phobia group had a high prevalence of untreated caries (36.2%), pain from teeth (11%) and pain in the previous 12 months (30%) and only 33.8% rated their oral health as “excellent/ very good/ good”.

Table 6-24: Prevalence of OHIP-14 impacts by demographic variables and intermediate determinants of oral health, unweighted data (n=777)

Age groups	18 to 24 years (n=287)	25 to 34 years (n=282)	35 to 44 years (n=133)	45 to 54 years (n=57)	>55 years (n=18)	p value
	41.5%	34%	38.3%	45.6%	38.9%	0.33
Gender	Male (n=749)		Female (n=28)			0.09
	37.9%		53.6%			
Rank groups	New entrant (n=224)	Private (n=264)	NCO (n=202)	Officer (n=87)		0.01
	46.4%	31.8%	38.1%	39.1%		
Deprivation categories	Outside State (n=39)	<1 SD below mean (n=137)	± 1 SD of mean (n=522)	>1 SD above mean (n=79)		0.21
	33.3%	40.9%	36.8%	48.1%		
Education categories ¹⁰³	Some secondary (n=74)	Completed secondary (n=338)	Some College (n=192)	Honours degree/ Masters (n=144)		0.99
	39.2%	39.1%	38.5%	38.2%		
Last dental visit ¹⁰⁴	<12 months (n=567)		12 to 24 months (n=100)	>24 months (n=109)		0.42
	37.9%		36%	44%		
Phobia ¹⁰⁵	Phobia (n=47)		No phobia (n=729)			<0.001
	70.2%		36.4%			

¹⁰³ 29 missing cases

¹⁰⁴ 1 missing case

¹⁰⁵ 1 missing case

6.3.5 Comparison between the trained strength and recruits

The prevalence, extent and severity in the trained strength and recruits is displayed in Table 6-25 and shows that the impacts were higher for recruits than the trained strength. In this research, recruits had a greater normative need, higher symptomology reported as prevalence of problems or pain and a lower proportion reporting better oral health, which may explain the higher OHIP-14 scores in recruits. When compared with international military reports, the severity score in the trained strength was considerably lower than that reported in Croatian soldiers (9.7 [3.1, 16.3]), but a greater proportion (35.6%) of the Croatian soldiers were dentally unfit (Spalj et al., 2012). The mean severity score only differed by about a unit from the results of the Japanese (4.4) (Kudo et al., 2011) and Australian (2.8) (Crocombe et al., 2012b) armies, which may show that the frequency of impacts was low in military forces with optimal access to care. Only Tay *et al* have reported impacts in recruits, with severity scores slightly lower than in the Irish Army (Tay et al., 2020). However, the results were dichotomized by the presence of TMJ and bruxism disorders, rendering comparison difficult.

Table 6-25: Prevalence, extent and severity of OHIP-14 impacts at threshold of occasional or above and associated statistical tests

	Trained strength (n=553)	Recruits and cadets (n=224)	Statistical test
Prevalence	35.3%	46.4%	$\chi^2=8.4$, df=1, n=777, p=0.004
Extent	1.1 (0.9, 1.3)	1.3 (1.1, 1.6)	Mann-Whitney, n=777, p=0.008
Severity	3.8 (3.3, 4.3)	4.4 (3.6, 5.2)	Mann-Whitney, n=777, p=0.003

Table 6-26 and Table 6-27 display the domain and item responses in the trained strength and recruits in the Irish Army and shows that statistically significant differences were only present in the “painful aching” and “uncomfortable to eat foods” items in the physical pain domain and the “been self-conscious” item in the psychological discomfort domain. The results in the physical pain domain aligned with the results from the questions about current pain, which were higher in recruits and cadets than in the trained strength. The results indicated that the system of oral healthcare reduced these impacts by improving access to services and rendering personnel fit for duty. The prevalence of the “been self-conscious” item was lower in the trained strength than recruits and it is possible that treatment of conditions in the anterior maxilla and mandible reduced the prevalence of these impacts.

Table 6-26: Percentage of domain responses in the trained strength and recruits (frequency in brackets). P-values reports differences between trained strength and new entrants.

Domain	Trained strength (n=553)	New entrants (n=224)	p-value
Functional limitation	4.9% (27)	4.9% (11)	0.99
Physical pain	15.6% (86)	26.3% (59)	<0.001
Psychological discomfort	26.9% (149)	34.4% (77)	0.04
Physical disability	5.8% (32)	6.7% (15)	0.63
Psychological disability	19.2% (106)	23.2% (52)	0.20
Social disability	6% (33)	2.7% (6)	0.06
Handicap	5.4% (30)	4.9% (11)	0.77

Table 6-27: Percentage of item responses in the trained strength and recruits. P-values reports differences between trained strength and new entrants.

Item	Trained strength (n=553)	New entrants (n=224)	p-value
Trouble pronouncing words	2.9% (16)	3.1% (7)	0.86
Sense of taste worsened	3.3% (18)	2.7% (6)	0.67
Painful aching	8.3% (46)	15.6% (35)	0.003
Uncomfortable to eat foods	13.4% (74)	19.2% (43)	0.04
Been self-conscious	25.5% (141)	31.7% (71)	0.08
Felt tense	12.7% (70)	15.2% (34)	0.35
Diet been unsatisfactory	5.1% (28)	4.5% (10)	0.73
Interrupt meals	2.9% (16)	4.5% (10)	0.27
Difficult to relax	6.9% (38)	8.5% (19)	0.44
Felt a bit embarrassed	16.5% (91)	18.8% (42)	0.44
Irritable with people	4.9% (27)	2.7% (6)	0.17
Difficulty doing usual jobs	2.9% (16)	1.3% (3)	0.20
Life in general less satisfying	5.2% (29)	4.9% (11)	0.85
Totally unable to function	1.1% (6)	0% (224)	0.12

6.3.6 Binary logistic regression model

A binary logistic regression model was developed to determine the effect of education, rank, deprivation, last dental visit and phobia on the prevalence of OHIP-14 impacts and was adjusted for the effect of age and gender. The model was statistically significant ($\chi^2=45.1$, $df=14$, $p<0.001$), explained 8% of the variance in presence of complex prosthodontics and correctly classified 64.8% of the cases. The results are displayed in Table 6-28 and shows that age, rank and phobia were statistically significant. Every unit increase in age was associated with an OR 1.03 95% CI [1.01, 1.05] increase in the prevalence of OHIP-14 impacts. Due to the high prevalence of impacts in new entrants, the private and NCO ranks were more likely to have fewer impacts.

Table 6-28: Binary logistic regression of prevalence of OHIP-14, unweighted data (n=777)

Variable		OR (95% CI)	p value
Rank	New entrant	Baseline	
	Private	0.4 (0.2, 0.6)	<0.001
	NCO	0.4 (0.2, 0.7)	0.003
	Officer	0.6 (0.3, 1.2)	0.14
Deprivation	<1 SD	Baseline	
	±1 SD	0.8 (0.6, 1.3)	0.42
	>1 SD	1.2 (0.7, 2.3)	0.48
	Outside State	0.5 (0.2, 1.2)	0.13
Education ¹⁰⁶	Some secondary	Baseline	
	Completed secondary	1.2 (0.7, 2.1)	0.54
	Some college	1.2 (0.7, 2.3)	0.48
	Honours degree or Masters	0.9 (0.4, 1.8)	0.69
Last dental visit ¹⁰⁷	<12 months	Baseline	
	12 to 24 months	0.7 (0.4, 1.1)	0.15
	>24 months	1.0 (0.6, 1.5)	0.85
Phobia ¹⁰⁸	Absent	Baseline	
	Present	4.4 (2.3, 8.6)	<0.001
Age		1.03 (1.01, 1.05)	0.01
Gender		0.7 (0.3, 1.5)	0.36

An important finding was the OR 4.4 95% CI [2.3, 8.6] increase in the prevalence of impacts reported by patients with phobia. This small but important group had more decayed and

¹⁰⁶ 29 missing cases

¹⁰⁷ 1 missing case

¹⁰⁸ 1 missing case

missing teeth, a greater prevalence of dentures, reported more pain or problems and pain in the previous 12 months than patients without phobia and only 42.5% reported good/ very good/ excellent oral health. At the time of writing, there were no dedicated services for the management of patients with phobia and the dental service was conscious that this matter needed to be addressed. An addition urgency in this matter was that the rates of phobia have been widely reported to be higher in women than men (Humphris et al., 2013, Silveira et al., 2021) and the declared aim of the Defence Forces to increase female participation to 35% in the near future (Dept. of Defence, 2022b) would therefore place additional strains on the management of dental fitness if not addressed. Consequently, services should be developed in advance of this recruitment surge to provide timely solutions.

6.3.7 Summary of the OHIP-14 data

The results showed that soldiers had a low prevalence, extent and severity of impacts, as measured by OHIP-14, with only 50.4% reporting an impact and 35.5% reporting an impact occurred at the threshold of “occasionally” or more often. The large “floor” effect of 49.6% of respondents having a severity score of zero may indicate that less severe effects that might bring a soldier into contact with dental emergency services, such as sensitive teeth, may have been excluded from the evaluation. However, rather than expanding the range of questions to try to capture a wider range of impacts, John has proposed that OHIP-5 should be used due to the high correlation of summary scores across variations of the OHIP instrument (John, 2022).

In the item frequency responses, the psychological discomfort (27.1%), psychological disability (19.4%) and physical pain domains (15.9%) had the highest prevalence of impacts. While the physical pain domain has been addressed in the actions of the dental service in the Army, little thought has been given to aspects of oral health that might be linked with aesthetics. It was interesting to note that in the UK in 2009 the physical pain domain had the highest prevalence of impacts (22%) (Nuttall et al., 2011) whereas in the 2021 survey in England the greatest prevalence of impact was in the “self-conscious” item (28%) in the psychological discomfort domain (OHID, 2024), which might indicate a changing perspective on oral health in populations, with an increasing focus on aesthetics driving the responses.

The OHIP-14 instrument was successful in discriminating between groups of respondents based on their clinical characteristics, which included decayed teeth and the presence of periodontitis. A striking feature of the results was the prevalence of impacts (90.9%) in

patients with dentures and the importance of providing pathways for patients to replace these devices where possible. A high prevalence of impacts was also recorded in patients with phobia (70%) which probably reflected the severity of untreated disease and showed the need for dedicated pathways of care in the Army.

6.4 Summary of the findings of the subjective experience of oral health

This chapter reported symptoms (pain), self-reported oral health and OHIP-14 results and their association with normative need and determinants of oral health (Wilson and Cleary, 1995). Relief of pain is a high priority for the Army dental service and these results reported that 8.1% reported a current pain or a problem in their mouth, 5.6% reported current pain from teeth and 15.9% reported a painful impact at the threshold of “occasional” or above in the previous 12 months. These impacts may prevent soldiers from working and show the importance of an emergency dental service. Despite the fact that there was a low prevalence of untreated oral disease, the proportion who reported “excellent or very good or good” oral health was 62%, and as such was lower than was reported by Irish civilians (Dept. of Health, 2018), high-income countries (Nuttall et al., 2011, Li et al., 2019), in military studies (Zadik et al., 2009, Norris et al., 2021) and in the age-matched respondents in the TILDA survey (Naseer, 2020). The difference may be a combination of hypervigilance in a low disease population (Sen, 2002), a high prevalence of determinants of oral health or a lack of self-efficacy in a paternalistic organization. However, a half of respondents reported no impacts using the OHIP-14 instrument and only a third reported an impact at the threshold of “occasional” or above. The prevalence ranged from 5.3% of those reporting “excellent” oral health to 82% of those reporting “poor” oral health and reflected underlying disease rates in these groups. The highest prevalence of impacts was in the psychological discomfort and psychological disability domains which may signal a shift in the perception of dental services; similar findings were reported in England in 2021 (OHID, 2024).

Recruits and cadets were assessed as having a higher normative need than the trained strength and reported a higher prevalence of pain and OHIP-14 impacts but with little difference in the proportion with self-reported oral health. This group had not been exposed to the military system of care and had many of the behaviours that carried into military life, including smoking, which may have affected self-reported oral health. Although a wide range of determinants other than rank were associated with pain experience and poorer self-reported oral health, only brushing frequency and phobia were statistically significant in OHIP-14 impacts. The results highlighted the urgent need to develop pathways of care for patients with

phobia who were anonymous to the system of dental care provided by the Army. Subgroup analysis of the prevalence, extent and severity of impacts in the self-reported oral health groups showed widening inequality by deprivation group, with an underlying effect caused by recency of dental visit that might be corrected by mandatory attendance.

The responses were successful in discriminating between groups with better and poorer oral health. As expected, untreated dental caries was associated with pain, poorer self-reported oral health and a higher prevalence of impacts. An unexpected finding was the degree to which pain was associated with periodontitis and at the same prevalence as dental caries, but without a recording of the severity of experience it is difficult to meaningfully compare the results. Further research is required to explore this topic in greater depth. The prevalence of impacts in the denture group was 90.9% and indicated that efforts to replace dentures with fixed options should be facilitated.

In summary, the results of the measurement of impacts in Army personnel showed common trends between recorded symptoms, self-reported oral health and the OHRQoL measure OHIP-14. Personnel with a higher prevalence of untreated disease, including recruits, respondents with phobia and respondents who had attended less recently had a higher prevalence of impacts across all the measures.

7 Discussion and conclusions

7.1 Introduction

This study had three aims: firstly, to evaluate the oral health status of the Irish Army; secondly to evaluate the effect of the determinants of oral health associated with oral diseases and conditions prevalent in the Irish Army and thirdly to evaluate the subjective experience of oral health in soldiers in the Irish Army. These aims must be understood within the context of a system of care with an organizational focus, of which oral healthcare is a small but important component. This chapter summarizes briefly the main findings of the aims of the study and discusses some of the main issues that the research identifies. Strengths and limitations of the study are discussed before making recommendations for policy, practice and research.

7.2 Main findings of the survey

The first aim of the study was to assess the oral health status of the Irish Army. The results showed a high degree of tooth retention, with an associated low prevalence of denture wearing, a low prevalence of untreated caries (15.9%) and its sequelae of unrestorable teeth or teeth with PUFA symptom, a relatively low prevalence of untreated periodontitis (25%), compared with estimates from international populations (Eke et al., 2015) and there were no personnel in the sample with severe TSL. Together, these results showed that the dental service was successful in reducing the prevalence of disease, particularly caries, and specifically in advance of deployment. However, as will be discussed below, the maintenance of oral health in the Army is a complex problem, with missed opportunities for tackling health behaviours evident in the system and the focus on “operational fitness” relegating individual oral health into a subordinate position.

The second aim was to evaluate the effect of the determinants of oral health associated with oral diseases and conditions prevalent in the Irish Army. The chapter on oral health had highlighted the vast differences in disease prevalence experienced by new entrants by comparison with the trained strength and confirmed the anecdotal observations of dental teams over many years. The regression analyses carried out on the key clinical indicators showed effects in both rank and education level but no such effect was evident for deprivation level, suggesting that optimal access in the Army or some other aspect of military service may have modified the effect. The key findings of the regression analysis were that ≥ 18 SUNT, DT, MT, FT, DMFT=0, complex prosthodontics, PSR ≥ 3 and BEWE ≥ 2 were affected by rank

or education, when adjusted for age, gender and last dental visit. As expected from descriptive data in national surveys (O'Mullane and Whelton, 1992, Whelton, 2007), age was associated with an increased risk in most clinical indicators, but not decayed teeth, which was greatest in the youngest age group. An additional interesting finding in the context of setting mandatory dental recall in the Army was that personnel who hadn't attended in over 12 months were more likely to have decayed teeth but conversely less likely to have filled teeth and more likely to have teeth with DMFT scores of zero. Patients with phobia were also more likely to have decayed teeth and missing teeth, which could affect fitness to deploy overseas or complexity in management where emergencies arise. Underlying these outcomes were proximal determinants with a high prevalence, including bottled water use and a high-risk diet. The high prevalence of smoking and e-cigarette use was also a long-term concern. About three-quarters of the Army had two of five selected proximal determinants of oral health and a third had three or more. These results showed the need to establish systems for managing risk within the Army.

The third aim was to evaluate the subjective experience of oral disease in the Army. Despite the delivery of free, basic oral healthcare, with unrivalled free coverage in the national population, soldiers continued to report the negative impacts of oral health. In the sample 8% reported a pain or problem in the mouth, 5% reported pain from teeth and 15.9% reported pain occasionally or more often in the previous 12 months, all of which showed the need for competent emergency dental care. In the regression analyses, recency of dental visit increased risk in pain or problems and pain from teeth, as might be expected as a result of access to treatment. Age, gender and rank were also significant for pain from teeth. The proportion who self-reported better oral health was lower than national and international surveys, which hinted at a wider realization by soldiers that their oral health had the potential for flux. The prevalence, extent and severity of OHRQoL impacts were lower than civilian populations in HIC, and very similar to military reports, indicating that soldiers benefited from the management of dental and oral disease. Regression analysis of OHIP-14 prevalence showed that the odds of having an impact at the threshold of "occasional" or above increased with age. These findings have implications for the Army in light of recent decisions to increase the age at which soldiers may retire.

All told, these results present a complex interplay of risk behaviours modified by life experience before and after joining the Army and the optimal availability of dental care that limited the worst impacts of disease. However, the interpretation of the 'anchor' question

about self-reported oral health suggests a deeper understanding by soldiers that the very risks that dental teams seek to manage are poorly controlled. These issues are explored in greater detail in the sections below.

7.3 Implementation of organizational aims

The dental service in the Army does not exist in isolation but rather reflects the operational requirements of the Army which has accepted that forensic dental charting and dental health are integral to Army service. This survey was the first survey of soldier oral health that allowed for a comprehensive assessment of the success of the program in meeting the service aims of capturing dental charting, making personnel dentally fit and managing the experience of dental pain.

7.3.1 Dental forensic charting

The survey identified that service aim of capturing a dental forensic chart was compromised by the presence of 7.1% of the Army with a DMFT score of zero, which would not allow for identification *post mortem* using traditional dental markers. Regression analysis of the presence of DMFT score of zero showed that officers were 3.6 95% CI [1.0, 12.2] times more likely than new entrants to have a DMFT score of zero, when adjusted for age and gender. Since officers deploy on austere missions, often without supporting troops as unarmed observers, there is additional risk in this specific group. The evidence suggests that alternative methods such as scanning should be incorporated into clinical practice to support traditional dental forensic charting measures (Nagi et al., 2019, Brown et al., 2023) and that this risk should be communicated to military management. Dental policy should be adapted so that soldiers attending for pre-deployment assessment with a DMFT score of zero should not be classified as fit unless a scan or alternate method has been used to capture potential forensic markers.

7.3.2 Dental fitness objectives

The second aim of the Army dental service was to get personnel fit for duty at home and overseas, on the basis that soldiers with active disease were more likely to demand a dental emergency appointment if dentally unfit (Chaffin et al., 2001, Dunn, 2004, Chaffin and Moss, 2008). In reality the application of this policy was entirely in relation to making personnel fit for duty overseas. Soldiers were examined as recruits and cadets on entry and the evidence from this survey confirmed the anecdotal reports of a large burden of untreated disease. Nonetheless, no system approach was in place to resolve these problems until these young

soldiers were due to be deployed. At that point soldiers were funnelled into civilian providers who made personnel fit by treating the normatively assessed need for which they were paid, with a large focus on the resolution of caries. The outcome of these interventions was reported in the survey, which showed a remarkable improvement in oral health when compared with the results from the Army in 1990/ 1992 (Hayden, 1995) or previous national oral health surveys (O'Mullane and Whelton, 1992, Whelton, 2007). Soldiers had retained more teeth and more sound teeth, had a low prevalence of dentures and a low prevalence of untreated decayed teeth, which indicated that the Army system was largely successful in making personnel fit for duty. However, no system existed for recording the proportion who were fit as a dental ICT system was not in use. Without such supports the service cannot implement reform and monitor outcomes and is urgently needed. In addition, no system-wide attempts were made to understand or address the determinants of oral health, although undoubtedly individual dentists addressed some of the proximal determinants. The results collected in this survey is the first time that such data are available and are discussed in the sections below.

Lingering questions remained in the Army about the possible negative effects of mandatory dental fitness requirements on soldier oral health. Dental teams expressed a concern that the requirement for dental fitness may have resulted in a higher number of extractions and greater tooth loss in older age in soldiers than in civilian peers. When the results from the soldiers of 50 to 64 years of age were compared with civilians in the TILDA sample (Naseer, 2020), the soldiers had much better oral health, retaining more teeth, more SUNT and with a lower prevalence of untreated caries and periodontal disease. Importantly, from a functional perspective, only 6.1% of the soldiers had a denture by comparison with 31.2% of their civilian peers. The results suggest a protective effect in the Army that exceeded the overall benefits seen in the Irish population since 1990. A little care must be taken when interpreting the data. The civilian sample was large (n=1218) but may have over-represented groups not working who were more readily available to attend for examinations. Tooth loss in civilians may have derived from medical conditions associated with risk of dental disease such as diabetes that are excluded in the Army population. In the Army sample, the numbers in this age group were small (n=49) and although representative of the age group tended to be composed of more senior ranks who may have had better life opportunity. Nonetheless, the differences between the groups were so large as to exceed possible margins of error. The data from the prevalence of proximal determinants in the Army would suggest that any protective effect did not arise from a preponderance of low-risk behaviour as 75.7% of soldiers had two or more proximal determinants and 37.2% had three or more proximal determinants of oral

health and with little difference in the frequency between new entrants and the trained strength. The results suggest that attendance was an important modifier of oral health in the Army and is discussed in later sections.

An ancillary matter that emerged was the possible over-treatment of personnel. About a quarter of new entrants had a DMFT score of zero but the proportion decreased rapidly with age, being present in only 6% of 25- to 34-year-old soldiers. The results highlighted the problem of monitoring oral health in the absence of longitudinal data that can identify changes in oral health status. Sheiham *et al.* reported that regular attenders had lower numbers of decayed teeth but higher DMFT scores as a result of more filled teeth, which might offer an explanation for the problem (Sheiham *et al.*, 1985). During calibration, the examining dentists observed restorations that appeared to be counter to modern principles of tissue preservation (Banerjee *et al.*, 2020). In a review of attitudes towards intervention, Innes *et al.* reported that 12% of dentists or therapists said that they would provide a restoration even when caries was confined to the enamel on visual or radiographic assessment (Innes and Schwendicke, 2017), which indicated that a sizeable section of dental operators may be using outmoded principles. The results suggest that training of Dental Officers and education of external dentists in an approach that is less interventionist is required (Banting *et al.*, 2005). Recall of personnel on a risk-based basis may also reduce the potential exposure to over-treatment in low-risk groups (NICE, 2004). An audit system to detect supplier-induced demand should be established to act as a deterrent to utilization of outmoded treatment philosophies.

7.3.3 Impacts of oral health

The final stated organizational aim was to return personnel in pain to duty as quickly as is possible. The phraseology of this aim reflected an outmoded approach, which aligned with the normatively assessed objective of the treatment of dental pain but did not consider other subjective measures of oral health. In the first instance the dental service should rephrase the system aim and seek to *reduce the impacts of oral diseases and conditions*, rather than having a narrow focus on dental pain. That is not to say that the pain data were not important. The data showed that there was still a relatively high prevalence, considering the ready availability of dental services, with 8% reporting a pain or a problem and 5.6% reporting pain from teeth. The majority of personnel with pain in teeth (75.2%) were between 25 and 44 years of age and therefore had been soldiers for some time, which showed that a subgroup existed with unresolved dental problems, including a third of this group with decayed teeth. An outstanding finding of this survey was that the prevalence of pain in patients with periodontal disease matched that of patients with caries and increased with disease severity. Binary

regression of pain outcomes showed that patients with decayed teeth or periodontal disease were twice as likely to report pain or problems, pain from teeth and pain in the previous 12 months. In this regard, it is important to note that the severity of pain was not graded so direct comparison of the pain experience is not possible. Nonetheless, in an organization that allows for a dental emergency appointment for the management of what might be considered trivial complaints, these results are indicative of the need to treat periodontal disease in a more comprehensive manner. The overall pain results confirm the need for accessible pain management but also the need for mechanisms to reach these personnel with both preventative and treatment programmes. A lacuna in the research is the lack of detail in relation to the frequency and type of dental emergency experienced in the overseas setting as this will allow inferences to be drawn on the effectiveness of the dental treatment and prevention programmes. Further research on this topic is required.

The prevalence of “excellent” to “good” self-reported oral health was 61.4% and was much lower in soldiers than the nationally reported data (79% “very good” or “good”) (Dept. of Health, 2018). Similar effects were reported in Israeli and US Air Force recruits (Zadik et al., 2009, Norris et al., 2021), which probably reflects an international trend of recruitment of soldiers from subgroups of the national population with untreated disease on entry. Trends in the data showed that the proportion with “excellent” to “good” self-reported oral health decreased in line with the number of proximal determinants of oral health, which may show that soldiers had a deeper appreciation of the potential risks associated with accumulated proximal determinants than was being acknowledged by the dental professional staff. The results may also show that soldiers are more open to interventions to improve oral health than has been recognized and that one of the barriers to intervention existed with the dental staff.

The prevalence, extent and severity of OHIP-14 impacts were low, but a limiting factor was in the lack of comparable national data. The two most prevalent domains were in the psychological discomfort and psychological disability domains, which may have reflected the orientation of civilian dental services towards cosmetic service delivery. About half reported no effects – a large “floor” effect - which may be taken as an indicator of the overall stability of oral health for most soldiers. The large floor effect may mask impacts that occurred less frequently or impacts removed from the OHIP-49 instrument that are likely to cause a dental emergency in the military setting, such as dentine hypersensitivity, and further research is required on this topic.

It was interesting to consider the relationship between normatively assessed need, pain as a symptom, self-reported oral health and OHRQoL as measured by OHIP-14 within the

framework of the Wilson and Cleary model (Wilson and Cleary, 1995). The data have shown that soldiers had a low disease burden, a low prevalence of current pain with a correspondingly low prevalence of impacts recorded by OHIP-14. In light of these results the relatively low prevalence of good to excellent self-reported oral health might seem at odds with these finding. It is possible that soldiers have a large degree of physical and psychological robustness, which may have been channelled as lower reported impacts. In addition, soldiers continued to have a large number of determinants associated with poorer oral health, including a large group who smoked and vaped. Soldiers, recognizing that these determinants affect health and oral health, may then have reported poorer self-reported oral health, while at the same time reporting few current impacts. These results show that measures taken to provide services must ensure that they do not inadvertently exacerbate social gradients present in the Army and show the utility of self-reported measures in the Army context.

7.4 Social disadvantage in the recruitment pool

National (Rigby et al., 2017) and international publications have shown poorer general health in more deprived communities (Marmot et al., 2012, Keller et al., 2023) and the national oral health surveys reported poorer oral health in holders of Medical Cards (O'Mullane and Whelton, 1992, Whelton, 2007). Dental teams have observed over many years that many new entrants to the Army had high levels of untreated disease. Medical Officers had commented on malnutrition in some new entrants and training officers had commented on learning difficulties that impact integration into the technologically focussed modern Army. These observations suggested that many new entrants (particularly recruits) appeared to be derived from a specific subgroup of the Irish population but data supporting these observations were unavailable. The data reported in this survey showed the extent to which the Army was recruiting soldiers from disadvantaged backgrounds, with 21.7% of new entrants coming from the most disadvantaged small areas in Ireland. Only 80% of recruits had completed the Leaving Certificate, by contrast with 95% of recent school leavers (Dept of Education, 2018).

A striking finding was that 35.7% of new entrants smoked on entry, which resonated with the reported smoking prevalence in the unemployed in Ireland (40%) (Dept. of Health, 2019). These indicators point to a marginalized and disempowered group who may lack the tools necessary to manage general and oral health.

The differential in opportunity in new entrants is, however, not as openly acknowledged in the Irish Army as it has been in other military forces, which this data can help to address (Elmer et al., 2011, Cooper, 2019, Edwards et al., 2022). Jeffers and Lillis commented that fragmented solutions to the management of societal inequality ignore the fact that the “dimensions of inequality are interwoven” (Jeffers and Lillis, 2024). It has also been found that piecemeal interventions to address health inequality may inadvertently widen inequality (Marmot, 2013). Thus, a structured approach across the Army is required. At the time of writing, the Army had appointed a gender and diversity ‘champion’ and the findings of this survey should be communicated to that office to allow the data to be utilized Army-wide and not siloed in the dental service. Measures to reduce inequality must begin on entry and be applied progressively throughout military service.

7.5 Oral health and behaviour in the recruitment pool

The complex interplay of early childhood disadvantage and low educational attainment affects beliefs, outlooks and behaviours and has been shown to have negative associations with health outcomes (van de Mheen et al., 1998, Wardle and Steptoe, 2003). In this survey the new entrants displayed a very high prevalence of untreated disease with 39.7% having untreated caries and 53.1% with inflammatory disease requiring hygienist attention. Regression analysis of clinical variables indicated that the new entrants appeared as an untreated population and were more likely to have decayed teeth and untreated periodontal disease but were also more likely to have 18 or more SUNT and less likely to have missing teeth due to caries or filled teeth. Underpinning these clinical outcomes were numerous proximal determinants that adversely affected oral health, including a third who had smoked or vaped in the previous month, 58.5% with a cariogenic diet and a fifth who brushed their teeth less than twice a day. Clustering of behaviour was evident as 76.3% had two or more and 35.6% had three or more of five high-risk behaviours. Dental attendance was also poor with only a half attending within the previous 12 months. These results showed a deep social patterning of disease in new entrants and challenged the ability of the Army to respond in a meaningful manner.

Bartley *et al.* described entry into the labour market as one of the “socially critical periods” during the life course which can affect the “degree to which citizens experience a sense of control over their lives” (Bartley et al., 1997). The first step is that the Army must acknowledge that recruit training not only transitions civilians into soldiers but also presents an opportunity to reduce disadvantage in health. Antonovsky has suggested that workplaces

with a higher sense of coherence may become health promoting (Antonovsky, 1996) and international evidence has shown an increased sense of coherence in recruits (Gillberg et al., 2021, Weiss-Dagan and Taubman–Ben-Ari, 2024), which might be understood to be a result of employment, purpose and meaning in a military setting. Recruit training is known to be robust and challenging but also promotes a positive psychology (developing a “can-do attitude”) to enable recruits to overcome the landmark tests that occur during the training process and might be mobilized to improve health behaviour (Seligman and Csikszentmihalyi, 2000). Cann *et al.* (2010) used the Core Belief Inventory to show that stressful events can disrupt base assumptions but showed the need for adaptability, which is fostered in recruit training (Cann et al., 2010). Much of recruit training is about improvements in physical fitness, which might be harnessed to raise improvements in overall health. Overall, the Army should recognise that recruit training is an opportunity to ‘reset’ health beliefs, such as diminishing the role of chance in health outcomes (Wardle and Steptoe, 2003). In fact, this approach may have more resonance in the Army than might be thought, as a maxim in the infantry is to “take risks, not chances” and could be used to challenge attitudes and beliefs. Integrated approaches between the directorates responsible for recruitment, medical service provision, training and diversity are required.

7.6 Social gradients in the trained strength

In Ireland, the Commission on the Defence Forces recognised the need to increase diversity within the Defence Forces and stated that that a profile of soldiers was required “as an essential starting point to underpinning longer-term approaches to strategic HR and ensuring the Defence Forces is more reflective of the diversity of Irish society” (Recommendation 40, pxxiii) (Dept. of Defence, 2022b). These comments highlighted the paucity of data available and showed the utility of the data collected in this survey that extended beyond the dental service.

The data from the new entrant analysis showed that a high proportion of recruits were drawn from the most disadvantaged small areas in Ireland and many had low educational attainment but the extent to which this filtered into the ranks in the Army was unknown. Anecdotal observation was of a difference in the proportion of officers and enlisted personnel who came from disadvantaged backgrounds or who had university education but data to support these observations were unavailable.

In this survey deprivation scores were one of the few measures recorded that were normally distributed and the mean value of -1.9 95% CI [-2.9, -0.9] showed that the values were only slightly different from the national results. The range included soldiers drawn from the most and least affluent small areas in the State. In the Army about one in five soldiers had an Honours degree or Master's degree and about a third had some college education with a prevalence similar to the national population (CSO, 2016). However, the results of the analysis of the trained strength showed an unequal distribution of deprivation and education by rank which created a strong social gradient with marked differences between officers and the other ranks. About a quarter of the private soldiers lived in the most disadvantaged areas whereas 4.2% lived in the most affluent areas and only 4.9% had an honours degree or Master's degree. By contrast 6.9% of officers lived in the most disadvantaged areas, 21.8% lived in the most affluent and 89.7% had an honours degree or Master's degree. Stevens *et al.* have described education as a social 'sieve' for stratifying populations (Stevens et al., 2008) and this would seem to be explicitly the case in the Army as the ranks groups were characterized by having progressively higher education with higher rank. In reality, these differences were as a result of a form of structural determinism as the courses offered to soldiers were aligned with the *expected* rank that they might achieve rather than the *potential* rank based on their ability – for example, engineering private soldiers are offered technical education or trades, not engineering degrees that might facilitate commissioning as an officer. These disparities served to underpin differences in opportunity, access to services, understanding, attitudes and beliefs in the ranks that affect health and oral health outcomes and served to reinforce perceived social class differences between the officer and other ranks.

It is widely accepted in high-income countries that the military exists to uphold democracy and must be subordinate to civilian control (Venice Commission, 2008). However, the military is categorically not an example of democracy in action and has a hierarchy and a segmented rank structure with identified handicaps to being in junior ranks (Dept. of Defence, 2022b). Differentiation into the social classes of officer and enlisted ranks begins on entry with self-selection based on expectations, education level and perceived suitability, as has been reported internationally (Bachman et al., 1987). Recent criticism of the Defence Forces has highlighted the need for increased diversity and culture change within the Army and these data support the underlying observations (Dept. of Defence, 2022b). These results should be reported to the General Staff and senior leaders in the Department of Defence. Efforts to expand the diversity of the officer corps can only begin when the underlying social patterning is recognized.

7.7 The effect of social gradients in the trained strength

In this survey three measures were used to assess the putative links between social advantage and oral health: deprivation group, education level, and rank. The extent to which these determinants affected oral health outcomes in the Army was unknown. In addition to descriptive data, binary regression analyses were undertaken of key clinical indicators, proximal determinants and subjective measures of oral health to determine whether social gradients were present in the data.

One of the most interesting findings in the analysis of the effect of social gradients on oral health was that there were no statistically significant differences in the distribution of diseases and conditions, proximal determinants or subjective measures of oral health by deprivation group in the trained strength of the Army. These results were at odds with national reports by Medical Card status in Ireland (Whelton, 2007) and with international reports (Ministry of Health, 2010, Jamieson et al., 2021) that have consistently shown poorer oral health in people living with deprivation. The results are particularly interesting when contrasted with those of the new entrants in which a social gradient existed. Conflicting evidence exists linking childhood socio-economic status and adult health. For example, Woo *et al.* have reported that early childhood disadvantage was a risk factor for adult obesity independent of adult socio-economic status (Woo et al., 2023) and similar findings have been reported for a variety of medical conditions (Lundberg, 1993, Schwartz et al., 1995, Felitti, 2002, Power et al., 2007, Conroy et al., 2010). As a cumulative disease process, it is perhaps unsurprising that measures of childhood disadvantage have been also been reported as risk factors for poorer oral health outcomes in adult life (Thomson et al., 2000, Bastos et al., 2007, Peres et al., 2011, Listl et al., 2014). However, others have argued that these effects were mainly mediated by adult socio-economic status or education in both general (Blane et al., 1996, Lawlor et al., 2005, Luo and Waite, 2005) and oral health (Pearce et al., 2004). The results in the Army suggest that an ‘Army effect’ was in operation that transcended both childhood and adulthood deprivation and was probably a result of free basic oral healthcare. If this is a measure of what may be achieved by access to free oral healthcare then the results have wider applicability, not least in what has been suggested by national oral health policy (Smile agus Slainte) (Kavanagh et al., 2019). The data also showed that soldiers from the poorest communities smoked and vaped more than soldiers from less disadvantaged areas, which showed that increased risk in some matters continued to be experienced by the most socially deprived soldiers. It is perhaps indicative of the difference in outcome in smoking and dental health prevalence by deprivation group that routine dental treatment is provided in the civilian community, where

the rank of soldiers is unknown to the civilian healthcare providers, whereas smoking cessation is routed through the military system, with its attendant rank and class hierarchy. The results of the rank and education data also showed that access was not sufficient to overcome all the barriers to optimum oral health.

Oral health improvements were seen in all ranks in 2020 by comparison with 1990 and 1992 and the effect of providing treatments via an outsourced civilian system that is 'rank blind' should not be under-estimated. When examined for differences in the distribution of diseases and conditions by rank in this survey there were statistically significant differences between private soldiers and the NCO ranks in the number of SUNT, missing teeth and DMFT scores. Since the NCO ranks are a promotion rank from the private ranks much of the difference may be explained by the younger age of private soldiers, as would be expected from the results of national data (O'Mullane and Whelton, 1992, Whelton, 2007).

An important finding in the data was the lack of difference in clinical outcomes between the older officers and younger private soldiers that hinted at the advantage accruing to officers. A number of factors in the military culture of the Irish Army may have created the relative advantage in oral health that officers enjoyed. Firstly, self-selection for cadet officer positions requires a large degree of self-confidence, a minimum standard of education and a strong sense of coherence that will facilitate management of stressful cadet training (Antonovsky, 1996). These characteristics are supported by early life advantage (Feldt et al., 2005, Barnard, 2013) that in turn translates into a lower prevalence of oral disease experience on entry in cadets that establishes a more favourable life course in oral health. Secondly, officers had access to a wider suite of treatments than enlisted personnel and of particular importance was access to specialist endodontic therapy as an alternative to extraction. In theory, this should only be impactful for enlisted personnel when pain or other symptoms create a decision point but in practice the dental assessment in advance of deployment has identified many asymptomatic lesions. In these situations, relatively low paid private soldiers typically have chosen extraction over more costly endodontic therapy. The effect of these actions may be to create an external locus of control in matters dental in enlisted personnel (Rotter, 1975), which might act to create avoidant behaviour or develop fatalism in the long-term prospect of tooth retention. Thirdly, the military hierarchy confers power to officers that affects the way that others act and think and has been shown to lead to preferential treatment in supposedly equitable systems of care (Schwab and Singh, 2024). In the international military literature officers had better oral health than enlisted personnel, retaining a greater number of teeth, fewer decayed teeth and a greater number of filled teeth (Gaare et al., 1989,

Marker et al., 1997, Horev et al., 2003, Skec et al., 2006, Mahoney et al., 2008, Jasmin and Jaafar, 2011, Mombiedro Sandoval and Llena Puy, 2008, Wahid et al., 2014) and a similar result was reported in the deployed Irish Army battalion in 1992. These results showed officers as a treated population by comparison with enlisted personnel which suggested the preferential access to services enjoyed by officer rank. It has been reported that ethical conflicts arise in the military setting as patients of healthcare workers may also be of higher rank thus creating a “dual loyalty” system (Vinson, 2022). Sidel and Levy (2003) have taken the extreme view that there are no circumstances in which a physician (or other healthcare worker) may ethically work in the military due to the inherent potential conflict with the chain of command (Sidel and Levy, 2003). It is not difficult to conceptualize that optimal access by senior ranks may cause an inequitable redistribution of healthcare resources, as has been reported in the civilian literature by social class (Brill and Storow, 1960). Anecdotally, dental and medical teams have also reported that appointments made by private soldiers have been cancelled by NCOs or officers for reasons that solve the latter’s problem. Aside from the opportunity cost of lost appointments, episodes such as these display the power dynamic and may order the priority of medical appointments in a soldier’s mind. Efforts to improve the self-efficacy of young soldiers trying to negotiate the medical system may be negated by suppression of their initiative (Bandura, 1977).

In the education categories soldiers with “some secondary” education emerged as a high-risk group with poorer oral health in both the new entrants and the trained strength and with a high frequency of proximal determinants associated with poorer oral health. Regression of the clinical indicators showed that soldiers with “some secondary” education had an increased risk of not having 18 or more SUNT or a DMFT score of zero and a higher risk of having decayed teeth and missing teeth as a result of caries, adjusted for age and gender, by comparison with other education groups. These results brought into question the reason for the disparity in the “some secondary” education with other groups. Education has been postulated to improve health by providing better paid work that increases the affordability of medical therapies (Mazumder, 2008). This may have been a factor in the Army as recruits with “some secondary” education may not have been able to afford therapies before entry and may have ‘carried’ poorer oral health into the Army. Following induction, lower education may limit behaviour change by restricting the capacity to visualize health status in the far future and continue with former beliefs and practices (Becker and Mulligan, 1997, Lynch et al., 1997). Lower education has been shown to lessen the understanding of health conditions (Goldman and Smith, 2002) and lower the adaption to new medical technologies (Glieb and

Lleras-Muney, 2003) but in the absence of specific dental health education programmes in the Army these soldiers will not be reached by intermittent pre-deployment assessments. An ancillary problem is that labelling of patients by any socio-economic metric is unhelpful and may cause stigmatization that worsens disadvantage.

Overall, the results show the successful implementation of dental service policy that has reduced many of the impacts of social gradients in the clinical indicators of oral health. A notable finding was that soldiers could not be differentiated by deprivation status but soldiers with “some secondary” education had poorer outcomes and officer advantage was present in the data. Although the Army cannot act directly on the structural determinants of health, it can certainly bring salient observations to government to add to the evidence of early life advantage and help advocate for change. In the years since these data were collected enlisted personnel have acquired access to the same suite of treatments as officers, which should be monitored to determine whether this reduces the social gradients by rank. Historical access by rank remains a factor that can affect outcomes that is difficult to change in a hierarchical organization. System-wide approaches are required to classify medical appointments as duty appointments that are subject to the same sanctions for non-attendance as other duty roles and healthcare workers should be counselled about the dangers of bias in the delivery of care.

7.8 Dental attendance as a modifier of oral health in the Army

The comparison of oral health in the 50 to 64 years age group in the TILDA and Army surveys showed that soldiers enjoyed much better health than their civilian peers. However, only 3% of the Army did not have a proximal determinant that affected oral health and most (75.7%) had at least two, which suggested that the differences could not be accounted for by low-risk behaviour in soldiers. An outstanding feature of the data was the very high level of dental attendance by comparison with civilian norms: in the Army 80.2% had attended within 12 months whereas the reported prevalence in civilians in 2018 was 47% (Dept. of Health, 2018). Barriers identified as a result of cost in civilian populations (Whelton, 2007, Morris et al., 2011, Thompson et al., 2014) were removed in the Army and as such acted as an enabling factor in improved attendance (Andersen, 1995). Desire for scale and polish, which soldiers had ready access to in civilian practices, is also known to be a demand factor in dental service provision (Jones et al., 2013). Examinations prior to deployment form a system process that modifies behaviour as it is widely known that these examinations are mandatory and soldiers attend civilian contractors to be “made fit” before attending a Dental Officer. However, this may have inadvertently created an external locus of control in soldiers who see themselves as

passive receivers of dental treatment, rather than actively seeking to modify health damaging behaviours.

In the Army there are annual requirements to undertake fitness testing, medical examination and shooting practice and it is possible that some of the driver of dental attendance was alignment with institutional norms in these other domains. These appointments were driven by demand, which suggested an interest in maintaining oral health that extended beyond the mandatory requirements. Attendance in dental practice has been shown to be associated with self-efficacy (Kakudate et al., 2008, Steinvik et al., 2023), which can be measured using the Generalized Self Efficacy Scale (Schwarzer and Jersulaem, 1995) as a construct with a single dimension (Scholz et al., 2002). As such it may be a useful tool to use in recruit intake as a potential predictor of soldiers less likely to attend on a regular basis who might. Other groups that avoid attending include patients with phobia, who had more missing teeth and decayed teeth. The dental service is currently blind to the existence of these patients, except on an *ad hoc* basis. The evidence from this survey showed that a small proportion of soldiers presented with phobia (5.4%) but this group had the same attendance pattern as soldiers without phobia. Further research is required on this topic as it was not clear from the questions asked what the purpose of the last visit was and whether the attendance was problem-based or for routine attendance. Screening of recruits routinely using the Modified Dental Anxiety Survey may help to identify and assist these soldiers.

Regular attendance has been shown to improve oral health by allowing for early intervention and receipt of preventative advice (Mohd Khairuddin et al., 2024) and long-term dental visiting has been reported to result in a lower prevalence of untreated caries and fewer missing teeth (Thomson et al., 2010, Astrom et al., 2011, Broadbent et al., 2016). In the Army, the prevalence of untreated decayed teeth was 11.8% in the “within 12 months” group but over 30% in the “12 to 24 months” and “over 24 months” groups. Binary regression analysis showed that soldiers who had attended within 12 months had a lower risk of having decayed teeth but had a higher risk of having filled teeth and a lower risk of having a DMFT score of zero, which was suggestive that the “under 12 months” was a treated group (Sheiham et al., 1985). Few differences were present in the proximal determinants with only brushing less than twice a day being more likely in the “over 24 months” group, which suggests that the differences in clinical outcomes were not associated with a ‘healthy user’ effect in the “within 12 months” category. Although care must be taken when examining cross-sectional data, the fact that the distribution of risk factors did not differ between the new entrants and

the trained strength suggests that the very behaviours that affected oral health and created such a high prevalence of disease in the new entrants was only being suppressed in the trained strength by active treatment. In other words, soldiers had not adopted a preventative approach, or reduced the number of proximal determinants of oral health but recent treatment may have masked the outcome. These results are an additional indicator that the Army dental service needs to pivot towards a more preventative approach.

Best practice suggests that recall should be risk based, with suggested intervals from three to twenty-four months (NICE, 2004). Standardized recall intervals have not been utilized within the Army as the contact dental teams have with soldiers has been occupational in nature, with primary care being provided in the private practice environment. However, private practice has been paid on a fee-per-item basis for the provision of dental treatment, which represents the endpoint of the long disease process preceded by behaviour. This suggests that alternative strategies are required. Firstly, at every contact in the Army soldiers should be classified according to risk and a risk classification and associated recall interval recorded on a dedicated dental ICT. The Army dental teams should recall patients where they serve in barrack locations where it is easy to access military dental clinics. Secondly, the funding model for outsourced dental services should change from a treatment-oriented to preventatively-orientated model of care through a capitation scheme or fee per item for the delivery of preventative services.

7.9 Dental anxiety as a modifier of oral health in the Army

There was a high prevalence of dental anxiety in the weighted sample, with 71.9% reporting some degree of anxiety, including 5.4% with phobia. Although phobia was confined to a very small part of the Army, as has been reported internationally (Silveira et al., 2021), the implications in the Army are vastly different from those in civil society. In the Irish Army, dental examinations are compulsory on entry and completion of dental treatment is mandatory before deployment overseas, which may present significant barriers to patients with dental phobia. Dental visits in patients with phobia have been reported to be symptom driven resulting in attendance only when in pain and complicating the provision of care (Armfield et al., 2007). In regression analysis, patients with phobia in the Army had a higher risk of decayed teeth and missing teeth, increasing the likelihood of not being dentally fit for deployment. On deployment, an irreducible minimum number of dental emergencies occur (Chaffin and Moss, 2008) and management can be particularly challenging as patients are often not co-located with dental facilities and may require transportation with an escort, affecting unit strength and presenting risks to the personnel being transported. A complexity

associated with managing patients with high levels of dental anxiety is that they may require repatriation from deployments to access the care required and it is for these reasons that dental phobia has been reported as a non-deployable condition in the international military setting (Edwards, 2023). However, policy in this matter has not been formulated in the Irish Army. In this respect it is important to note that the prevalence of phobia has been reported to be higher in women than men (Thomson et al., 1996, Humphris et al., 2013) and the aim of the Defence Forces to increase female participation to 35% in the near future would therefore likely sharply increase the prevalence of patients with phobia (Dept. of Defence, 2022b). The current screening of recruits on entry does not include dental examination so the identification of phobia would not become apparent until after entry. Planning for the management of patients with dental phobia should only be undertaken following the determination of a policy for the retention or discharge of such patients.

Patients with dental anxiety may access a range of management interventions including psychotherapeutic and pharmacological strategies (Hoffmann et al., 2022). In the model of care in operation at the time of this survey the bulk of treatment was carried out by civilian practitioners in their private practices. An important part of this research was to be able to quantify the degree of dental anxiety in the Army so as to be able to advise practitioners about the extent of the requirement to provide specific management strategies. Patients that civilian practitioners were not able to manage had been referred back to in-house dental teams in an *ad hoc* manner and were typically provided with dental sedation as the dental service lacked training in psychotherapeutic techniques. However, it is important that practitioners are educated in managing patients at all levels of dental anxiety (Mac Giolla Phadraig et al., 2020) as patients who are anxious but not phobic who receive sedation services may become dependent on sedation to access care, complicating and potentially saturating the service (Goodwin et al., 2012). Significant costs are also associated with the provision of sedation and general anaesthesia services to dental patients (Boyle et al., 2009). The prevalence of phobia and anxiety in the Army suggests that dental teams in the Army should expand their clinical remit to develop skills in the provision of the full range of psychotherapeutic and pharmacological strategies to provide the appropriate management interventions. The strategies should incorporate a suite of preventative interventions that may reduce the prevalence of diseases and conditions in patients with phobia.

7.10 Risk rating of oral health

Paternalism in the Army derives from the knowledge that soldiers are intentionally put at risk, and may be compelled to do so, which brings a higher responsibility to reduce risk where possible. In the dental service there was an awareness that myriad risks existed associated with military service that might affect oral and general health such as deployment to non-fluoridated countries, exposure to sunlight, cariogenic diets on operations and access to cheap cigarettes. The overall results in the Army showed the success of general measures taken to manage oral health that aligned with the organizational goals of capturing a forensic chart, reducing the prevalence of pain and treating disease to minimize dental emergencies, particularly in light of the high prevalence of disease in new entrants. The dental service was aware that the prevalence of diseases and conditions and the prevalence of determinants of oral varied widely within subgroups in the Army but no mechanism was in place to identify and stream these patients into high-risk pathways. When recruits and cadets joined the Army, they were seen and had an initial examination and impression for provision of a mouthguard but no follow-up was undertaken in the dental service and as such represented a missed opportunity for intervention. Similarly, before deployment soldiers were examined with a view to the evaluation of normative need, without any consideration of subjective oral health or the potential for prevention of future disease development.

The data collected in this survey reported a number of important findings in relation to normatively assessed and subjective oral health and the associated determinants. Regression analysis of the clinical indicators identified groups with advantage relative to others (officers, soldiers with higher levels of education) and disadvantage (new entrants, soldiers with “some secondary” education). The findings confirmed the anecdotally reported prevalence of disease in new entrants but also identified a high prevalence of negative health behaviours. New entrants are readily identifiable within the Army and specific targeting is possible during and after initial training. In the trained strength soldiers with “some secondary” education were identified as a high-risk group but it is not advisable to identify or label soldiers with poorer educational opportunities or for that matter those from more socially deprived communities. By contrast, a plethora of readily available self-reported data was collected that can be used to cross-reference for the association with normatively assessed need Table 7-1 and proximal determinants of oral health (Table 7-2). These data can be used by the dental service to develop a risk assessment matrix for the risk rating of personnel based on individual oral health to be used in parallel with the NATO/ Pfp classification. Whereas the NATO/ Pfp status may act as a snapshot of oral health status that can be used to determine suitability for

status that can be used to determine suitability for deployment, the risk rating should be used to classify personnel at increased risk of the development of future disease. In this regard there are many risk assessment tools for oral health that could be integrated into a risk assessment matrix including for caries (Young and Featherstone, 2013, Featherstone et al., 2021), periodontal disease (Lang et al., 2015), tooth wear (Lussi and Hellwig, 2006), oral cancer (Krishna Rao et al., 2016) and dental anxiety (Humphris et al., 1995). The risk assessment matrix will allow the service to develop a more patient-centred model of care that aligns with the organizational requirements. The codes used for the risk rating and the NATO/PfP status should be incorporated into the military medical classification code to bring visibility to oral health in the Army as exists for general, visual and auditory health.

Table 7-1: Prevalence of normatively assessed oral health in high-risk groups, unweighted data (n=777)

Group	>20 teeth	≥18 SUNT	DT>0	DMFT=0	PUFA	PSR >2
Army (weighted)	99%	75.6%	16.1%	7.1%	1.5%	27.2%
Trained strength	99.2%	80.8%	22%	12.2%	1.4%	25.8%
New entrants	100%	96%	39.7%	26.3%	1.3%	53.1%
Most deprived	99.3%	80.3%	27%	8.8%	2.2%	38%
Some secondary education	97.3%	59.5%	36.5%	4.1%	1.4%	48.6%
LDV >24 months	99.1%	87.2%	38.5%	18.3%	2.8%	45%
Phobia	97.9%	72.9%	35.4%	6.3%	2.1%	41.7%
Smoked or vaped	98.1%	80.2%	26.9%	10.2%	1.2%	47.3%
Alcohol high risk	100%	85.7%	35.7%	9.5%	0%	40.5%
Diet high risk	99.5%	80.5%	23.2%	13.6%	1%	33.7%
Brush <2 per day	99.2%	79.7%	31.3%	13.3%	1.6%	41.4%
Pain or a problem	100%	80.8%	43.8%	12.3%	2.7%	56.2%
SROH “fair” or “poor”	99%	72.4%	32.2%	9.1%	2.8%	42%
OHIP-14 >0	99.7%	75.6%	30.8%	10%	3%	41.4%

Table 7-2: Prevalence of proximal determinants of oral health in high-risk groups, unweighted data (n=777)

Group	Smoked	Alcohol high risk	Diet high risk	Brush <2 per day	LDV >24 months
Army (weighted)	20.7%	4%	51.3%	14.5%	11%
Trained strength	19.9%	3.8%	50.5%	14.1%	10.5%
New entrants	25.4%	9.4%	58.5%	22.3%	22.9%
Most deprived	28.5%	5.8%	54%	13.1%	14.6%
Some secondary education	31.1%	8.1%	68.9%	13.5%	12.2%
LDV >24 months	27.5%	9.2%	52.3%	33.9%	-
Phobia	22.9%	2.1%	60.4%	20.8%	22.9%
Smoked or vaped	-	9.6%	68.9%	22.8%	18%
Alcohol high risk	38.1%	-	54.8%	23.8%	23.8%
Diet high risk	28%	5.6%	-	18.8%	13.9%
Brush <2 per day	29.7%	7.8%	60.2%	-	28.9%
Pain or a problem	23.3%	16.4%	57.5%	13.7%	15.1%
SROH “fair” or “poor”	26.2%	7.7%	57.3%	19.6%	17.1%
OHIP-14 Prevalence	25.4%	7%	54.2%	20.7%	16.1%

7.11 Incorporating oral health into a holistic health programme

One of the features of the data collected in this survey was the clustering of proximal determinants of oral health with three-quarters having two and a third with three of five determinants of oral health. Soldiers have a “dynamic life trajectory”, as described by Baker *et al.*, in which it is impossible to separate out all the influences shaped by social structure, power imbalances and opportunity (Baker and Gibson, 2014) and which are further shaped by military service and rank. These create an environment in which the proximal determinants are the final expression of life experience. In the UK 25% of the population has been reported to have three or more unhealthy behaviours (Poortinga, 2007) and international evidence has shown greater prevalence in men, younger people and those from deprived communities (Berrigan *et al.*, 2003, Poortinga, 2007, Tobias *et al.*, 2007). However, as stated by Buck and Frosine (2012), “policies and actions that work for populations as a whole often inadvertently entrench inequalities” (Buck and Frosini, 2012). In the Army, a common risk factor approach is required across medical and social services to avoid duplication of resources or contradictory messaging (Sheiham and Watt, 2000). The use of soldiers as health trainers recruited in the battalions and other units should be explored to increase the workforce and deliver tailored advice in a relatable manner and has been executed with some success in

other settings (South et al., 2010, Singla et al., 2021). The devastating impacts of smoking signifies that smoking cessation should be prioritized and the high proportion of ex-smokers (25.4%) in the Army indicates a large pool of potential trainers may exist. Medical facilities exist in some form in every Army barracks in Ireland and consideration should be given to forming wellness centres that integrate healthcare provision with lifestyle advice, welfare advice and community development programmes so that the delivery of health promotion can pivot from a medicalized programme to a patient centred holistic endeavour (Winters et al., 2010). The success of programmes must be carefully measured to ensure that all ranks and groups are equally targeted so that inequality is not widened.

7.12 Reliability and validity of the collected data

An important consideration in the analysis of any epidemiological survey is to consider the reliability and validity of the data collected. In this survey, three main states of disease and conditions were examined: caries; periodontal disease and TSL. In the case of examinations for the identification of caries and its sequelae, the criteria developed for the UK national survey were utilized (Pitts et al., 1997). The examiners reported some difficulty identifying small composite restorations with good colour matching, many of which were smaller than might have been expected using tissue conservative principles (Banting et al., 2005). The kappa scores for examiner agreement indicated “substantial” or ‘almost perfect” scores (Landis and Koch, 1977, Munoz and Bangdiwala, 1997) which supported the reliability of the data in this survey. However, the increasing use of composite in high-income countries (Lamsal et al., 2024) may be a factor in future surveys.

The collection of periodontal data was more problematic. In the trained strength the prevalence data were in line with expected results by age reported in international surveys (Eke et al., 2015) whereas in the new entrants the prevalence data were higher than expected. The results in the new entrants were suggestive of over-diagnosis which raised questions about the reliability and validity of the data. In this survey the PSR methodology was used, reporting the presence of periodontitis using the single maximum score at a patient level (Khocht et al., 1995). Prior to the fieldwork, examiner calibration for the presence of periodontal disease was undertaken by discussing methodology and observation of patients in the standardization process but inter-examiner reliability estimates were not undertaken. The rationale for this approach was that repeated measurements have been shown to over-estimate pocket depths (Larsen et al., 2009), with suggestions that a fifteen-minute rest time between repeated measurements may suffice to allow the tissues ‘recover’ (Polson, 1997) but without

histological evidence for the principles involved. Measures of bleeding on probing are similarly affected (Lang et al., 1991). However, it has been shown that 81% of pocket depth measurements are within 1mm of each other (Hill et al., 2006) *albeit* in exercises recording detailed periodontal measurements in older patients (Hefti and Preshaw, 2012). Thus, the evidence suggests that pocket depth measurements have a high degree of reliability in periodontal surveys without the need for specific calibration exercises and the question therefore arises in relation to the validity of the measured pockets in the new entrant group.

Pseudo-pockets may be recorded by the more coronal positioning of the alveolar crest and the gingival margin in young patients (Hausmann et al., 1991) or by the presence of partially erupted teeth (Ainamo et al., 1984). These findings have been reported in clinical studies in young patients (Gjeramo et al., 1983, Miyazaki et al., 1987) and the findings were relevant to the young new entrant respondents. Over-estimation of pocket depths also occurs by over-penetration of the probe in the presence of inflammatory disease (Fowler et al., 1982). In this respect the fact that only 0.4 95% CI [0.2, 0.5] sextants were recorded without bleeding, calculus or pocketing in new entrants in the Irish Army suggests that inflammatory disease was partly responsible for the over-estimation of disease. The prevalence was similarly high in recruits in 1990 (30% in the 16 to 24 years age group and 52% in the 25 to 34 years age group) which is suggestive of similar problems.

Tran *et al* (2013) suggested that CPITN, when compared to full mouth probing records, acts as a maximum measure index with good sensitivity at a 4mm pocket depth threshold but poor sensitivity for sites ≥ 6 mm and a large bias when assessing the extent of periodontitis (Tran et al., 2013). This would certainly explain the swingeing differences in the prevalence of severe periodontitis reported in previous national (O'Mullane and Whelton, 1992, Whelton, 2007) and Army surveys (Hayden, 1995). Khocht commented that over-estimation “will be resolved when a conventional examination is recorded” (Khocht et al., 1995) and Leroy *et al.* (2010) recommended measurement of attachment level as well as bleeding and pocket depth (Leroy et al., 2010). The NHANES surveys overcame the issues by limiting the sample to patients over the age of 30 years and by carrying out full mouth examinations (Eke et al., 2015, Eke et al., 2018, Eke et al., 2020). However, full mouth records require significant resources and limiting the respondent pool to soldiers over the age of 30 years would exclude a large part of the Army. Realistically, both dentists and hygienists would be required for such an epidemiological survey in the Army as dentists rarely undertake these records in Ireland. Optimizing throughput would require the use of multiple dental chairs, which were not available at all survey locations. The investment in time and the cost necessary to carry out full mouth probing in an epidemiological survey would have to be

balanced with the benefits accruing from improved accuracy in the surveillance of periodontitis. An important final point to note is that the results for the new entrants were heavily weighted in the Army sample, causing negligible impact on the reported overall prevalence.

Fundamentally, the PSR and CPITN indices were developed as epidemiological indices with applications in treatment need estimation (Croxon, 1984, Ainamo et al., 1987, Cutress et al., 1987). Clinical practice in the Army was to refer all patients with PSR 3 or greater to staff hygienists for detailed periodontal examination, oral hygiene instruction and therapy, as required. As such, although the validity of the measurements in identifying a *diagnosis* may be questioned in the new entrant group, the measurements were valid for the identification of the prevalence who had *treatment need* and justified use of this index in both new entrants and the trained strength.

Calibration of TSL scores involved discussion of the methodology and observation of patients in the caries standardization process. The greatest measurement challenge occurred in the identification of incipient lesions and differentiation from physiologic processes as has been reported in the literature (Mulic, 2010). For these reasons TSL was reported at the threshold of BEWE ≥ 2 . However, in the risk categories 2.2% of the “no risk” group, and 46.1% of the “low risk” group had at least one sextant at this threshold suggesting that these risk categories are not useful in a population with a low prevalence of medium and high-risk TSL. Since most of the management of TSL, especially in the none and low risk categories, is applied at the patient level rather than a site level (Bartlett et al., 2008), categorization by the single worst sextant would appear to be a more logical choice for the Army population and is simpler to report. Further analysis showed that 98.3% of the sample with a BEWE score ≥ 1 had incisor TSL which suggests that significant simplification of the measurement and validity of TSL in the Army population could be undertaken by reporting the prevalence of patients on the basis of incisor TSL alone.

7.13 Limitations of the survey

This survey was the first comprehensive and representative survey of the oral health of soldiers in the Irish Army that has been undertaken. However, it is important to note a number of limitations. National evidence has shown differences in the prevalence of caries and periodontal disease in men and women (O'Mullane and Whelton, 1992, Whelton, 2007, Naseer, 2020) but recent evidence for differences in the age groups found in the Army is very

dated. Consequently, it would have been useful to identify differences by gender, particularly as the Army hopes to increase female participation to 35% in the coming years (Dept. of Defence, 2022b). At the outset it was calculated that about half of the serving women would have to be examined to form a representative sample and it understood that this was not a realistic expectation. Ultimately only 28 women were examined in the survey, a disappointing number, corresponding to about 5% of the women in the Army. The results reflected the fact that soldiers attend military dental clinics when deploying overseas or seeking access to therapies outside the remit of the outsourced component. The reality of low female participation in overseas deployments hindered access to women in this survey and points to a broader problem, discussed below. In light of these results, future surveys should consider efforts to directly sample female soldiers.

An additional consideration in the survey was the extent to which soldiers presenting to military dental clinics were representative of the Army. Most of the soldiers examined in this survey attended clinics prior to overseas service. It is possible that a group of soldiers exist that do not deploy for family or other reasons and as such would not be made dentally fit in the same manner as deployable troops. At the time of the survey soldier contracts were tied to deployment status such that non-deployable soldiers would be discharged at the end of their contract period. Since these contract periods range from three to seven years the system to some degree self-corrects to reduce the non-deployable component. It is possible that the non-deployable fraction was large enough to affect the external validity of the collected data but it is unlikely that the impact would be so large that it affected the implications of the data collected. In addition, soldiers were also attending to access specialist clinics and for some routine dentistry outside of the deployment cycles which would potentially reduce the effect. Future surveys should consider this problem in greater detail to determine whether it is possible to assess the proportion of the Army that is non-deployable and to determine whether the size would have an untoward effect.

A large body of self-reported data was collected in this survey and included measures that were dependent on the recall of events that may have happened many years previously (for example the time since last dental visit). Most questions on the survey (with the exception of age at which started smoking) had a relatively short recall period, which has been reported to be an important factor in the validity of data collection (Coughlin, 1990, Ho et al., 1997, Van Zyl, 2014). Under-reporting of socially undesirable practices such as smoking has been long known (Parry and Crossley, 1950, Warner, 1978) and may have been a problem in

the declaration of the number of units of alcohol a week consumed, dietary practices or other behaviours. Although recall bias may have affected a part of the results, self-reports have been successfully used in national clinical studies (O'Mullane and Whelton, 1992, Whelton, 2007) and in Healthy Ireland reports (Dept. of Health, 2018, Dept. of Health, 2019) which suggests that their use in this format in this survey was a valid means of collecting data.

Although the Army sample was reasonably large and exceeded the sample size in all ranks, a number of cautions must be expressed about the analysis of the statistical testing. The division of the sample into subgroups resulted in some cells having small numbers, which may have affected statistical power and the subsequent interpretation of results. Further subdivision into the new entrants and trained strength may have exacerbated the problem. The results of the analyses in this research should be considered within the context of the small cell sizes. Collection of anonymized data within clinical information systems may enable the Army to increase the numbers in these categories but will have to be tempered by consent in the particulars of the military setting.

Multiple testing of samples is known to increase the risk of false positives (Type I error) (Albers, 2019). Familywise error rates can be controlled using a number of statistical methods, including Bonferroni, Holm, Hochberg, Dubey/Armitage-Parmar and Stepdown techniques (Vickerstaff et al., 2019). The choice of technique is affected by study design, number of tests and the balance between Type I and Type II errors (Senn and Bretz, 2007). In this survey a large number of clinical indicators, risk factors, and subjective oral health indicators were tested as dependent variables. Bonferroni adjustments were included in the calculations as a means of controlling the potential for Type I error. Future studies should consider this problem and develop statistical approaches in the design phase to minimize Type I error in the results.

7.14 Recommendations

This section presents the recommendations of the survey under the headings of policy, practice and research. These recommendations are considered within the context of the overall aims of the dental service and are designed to be read by dental teams, unit commanders and others interested in the practical implementation of dental policy in the Army.

7.14.1 Policy

A flexible, adaptable and responsive dental policy should be developed in the Irish Army that meets the aims of the organization and optimizes the oral health of individual soldiers.

Dental policy in the Irish Army should be designed so that it achieves the system outcomes but also aims to optimize the oral health of soldiers during and after their military career. Dental diseases are preventable and dental policy in the Army should reflect the fact that soldiers are streamed through a system that allows dental teams the opportunity to identify and manage initial lesions and signs of disease as well as treating established disease. The Army is uniquely placed in Irish society to implement such a policy as it recruits soldiers at a very young age, many directly out of school, and provides a holistic medical system that includes active monitoring of health and oral health at various stages throughout their military career. Missed opportunities to intervene and prevent disease should not be allowed to continue. The dental policy should include devolved and cascading budgets that will allow a flexible and adaptable response at lower levels of authority sufficient to meet local needs. The policy should include redesign of contracts with external civilian dentists to move from a fee-per-item treatment-oriented service to one that includes fees for evaluating, monitoring and preventative interventions.

This research has shown that social gradients in disease experience existed in both the new entrants and the trained strength. The proposed dental policy should ensure that the implemented policy does not inadvertently widen social gradients as has been reported elsewhere (Marmot, 2013). A wide range of supports may be needed, tailored to specific subgroups of the Army population. These may be informed by needs assessments that identify the skills required, training requirements, infrastructure and pathways of care that are necessary and sufficient to fulfil policy.

Dental policy should also specify the competencies required of dental teams to achieve the policy aims and may include communication, clinical skills, informatics and leadership training. This will require liaison with the Director of Training and Education in the Army to ensure sufficient funding is available to develop the dental teams in-house and to determine pathways for funded external training.

Dental policy should be fully integrated into medical policy.

Dental policy in the Army does not exist in isolation. Rather, dental teams are embedded in medical units that have a parallel purpose but with independent logistical, HR and financial supports. Dental service delivery in the Army is often seen as an isolated and specific part of healthcare, allied to healthcare, but not a central and fundamental component. Medical policy makers should recognize the ubiquitous nature of dental diseases (Peres et al., 2019, Watt et al., 2019a) and the widespread impacts on daily lives, including pain and dental emergencies (Currie et al., 2015) (Pau et al., 2003, Barasuol et al., 2020, Aldosari et al., 2021).

Recognition of the importance of oral health should begin by incorporating a dental status within the medical grading system, which should include the NATO/PfP grade and a risk rating. The increased visibility of dental health status within the medical and administrative processes will aid in the promotion of oral health policy.

The integration of dental and medical policy is also important to allow the development of programmes for the management of negative health behaviours. The results of this survey showed that many soldiers have proximal determinants that affect oral health such as a high-risk diet, smoking, vaping and alcohol misuse. These determinants are also responsible for a variety of medical conditions and should be managed using a “common risk factor” approach to avoid unnecessary duplication of resources or mixed messaging (Sheiham and Watt, 2000). Common policy objectives in the reduction in the prevalence of negative behaviours should be agreed, with actions by dental staff forming part of the wider policy framework.

Forensic charting of the oral cavity should be provided to all soldiers.

An important aspect of military service is the knowledge that attempts will be made by the Army to identify bodies post mortem and return the remains for burial (where possible) by the family. Significant distress has been caused to family members in Ireland when bodies have not been recovered (Dept of Defence, 2018). Current mechanisms that might aid in post

mortem identification include dental forensic charting and this is the only biological marker recorded. The results of this survey showed that 7.1% of Army personnel had a DMFT score of zero and as such could not be identified using traditional means. Communication of these results to the General Staff should be expedited so that they can consider the use of alternate methods. Aside from the civil liberties concerns, alternate methods, such as fingerprinting or DNA sampling, are constrained by sample degradation in fire or explosion (Kumar et al., 2019, O'Hagan and Calder, 2020). This indicates that dental policy should expand into the current vacuum and set as policy that military dental teams should record other markers in the oral cavity, such as palatal rugae or the dimensions of teeth, as a repository of forensic data. These markers had traditionally been captured using study models (Hinchliffe, 2011) but this has been superseded by scanning technology (Evans et al., 2010, Yu et al., 2024). The policy should consider the frequency of recall outside of deployment cycles to ensure that forensic records of non-deployable personnel are retained in case of accidents in training, air crashes or other incidents. The data should be stored in centralized repositories and accessed using a dedicated dental ICT.

The oral health status of soldiers should include a risk rating appropriate for organizational and patient need.

The dental service should develop a risk rating for each soldier that is recorded on their record and used to stream them into pathways according to their risk. Currently soldiers are classified using the NATO/ PfP standard, which is based on the normative needs assessment and the likelihood of an imminent dental emergency (NATO, 2017). A weakness of the classification system is that it does not include an assessment of the likelihood of the development of future disease, based on individual risk factors or behaviours. This research has shown that new entrants and soldiers in the trained strength have many unhealthy behaviours that affect oral health and continue to experience disease throughout military service. The results also showed that certain vulnerable groups, such as soldiers with “some secondary” education or those with phobia or irregular attenders, had a higher experience of disease. The current system has no capacity for classifying these patients as a means of identifying soldiers who would benefit from recall for enhanced prevention and behavioural interventions (McGrath, 2019). The use of a risk rating will aid in the transition of the dental service from one that is treatment oriented to a preventative basis on a number of levels. Firstly, at the organization level, the risk rating should be added to the dental fitness classification, which will increase the visibility of risks to oral health in the organization. The

risk rating should be used to determine the suitability of soldiers for deployment to particularly austere environments for protracted periods of time where dental support is not available. The risk classification should be used at an organizational level to determine the proportion in low and moderate risk categories who would be suitable for more effective outsourcing, which in turn would allow management to estimate the costs associated with each care delivery model. The risk rating should also be used by military management to run reports displaying the percentage in each risk class associated with the intermediate determinants of oral health to ensure that policy has not adversely affected any group or widened social gradients.

From the perspective of the dental team, the use of risk classifications and the assignment of a grade should be used using a workflow that ensures that patients are provided with tailored advice and interventions. Interventions using fluoride and chlorhexidine have been found to be successful in reduce caries incidence in high-risk groups and should be utilized in the Army where possible (Chaffee et al., 2015). The use of dedicated documentation in the risk assessment of caries has been shown to improve the delivery of appropriate care and should be developed by the dental service (Afuakwah and Welbury, 2015). Caries risk assessments have reported greater distinction between high-risk and other groups, which endorses the practicality of retention of this group for in-house advanced prevention and behaviour modification (Tellez et al., 2015).

There is a high visibility of the medical classification code in the Army as it relates to fitness for service. The inclusion of a dental risk rating will therefore be a highly visible marker for patients to begin the conversation with dental teams about strategies for reducing risk. The more complete outsourcing of low and moderate risk soldiers, including pre-deployment assessments, would contrast with the compulsion of high-risk patients to attend dental centres. The service should develop means of avoiding the 'labelling' of such patients by the random inclusion of low and moderate risk cases for recall as part of an audit process. Although there is limited evidence for the effectiveness of interventions to prevent disease in high-risk patients (Doméjean et al., 2017), the rating has utility by enabling patients to see the specify behaviours and actions that are a risk to oral health and plan for appropriate modifications (Fontana and Gonzalez-Cabezas, 2012, Twetman et al., 2013).

7.14.2 Practice

The dental service should develop a preventatively-oriented and minimally invasive model of care.

Caries is a relatively slowly progressing disease process that has well-described clinical, radiographic and histological stages (Featherstone, 2008). Dental teams should be trained to identify early stages of lesions to allow appropriate monitoring and provide interventions that can arrest or reverse lesions (Young and Featherstone, 2013). The use of coding from the International Caries Detection and Assessment System should be used to shift the threshold of detection to that of the early enamel lesion, which includes an assessment of disease activity (Pitts and Stamm, 2004, Pitts et al., 2014). This will require the use of dedicated ICT that can record the appropriate codes. Dentists and nurses will require training in the use of the codes and the associated care pathways.

The provision of restorations represents an irreversible point where dentists determine that operative treatment is required to manage a dental caries lesion, but evidence has shown that many dentists will intervene in a manner not consistent with biologically conservative approaches (Innes and Schwendicke, 2017). Dental teams should be taught to use minimally invasive approaches using adhesive dentistry, where possible, to avoid unnecessary extension of the prepared cavity (Tyas et al., 2000, Frencken et al., 2012, Banerjee, 2013). Since most of the primary care provided to soldiers is undertaken in civilian practices contracted by the Army, a system for the payment of dentists that replaces outmoded fee per item models should be developed. The proposed system should include payments for the application of sealants or other preventative measures that will encourage dentists to act in a tissue preserving manner. Training and mentoring of civilian dentists should be provided to enable them to adapt to this model of care.

Periodontal disease is largely preventable by the application of effective oral hygiene regimes, maintenance of health and cessation of smoking, where necessary (Petersen and Ogawa, 2005, Chapple et al., 2015, Scannapieco and Gershovich, 2020). Soldiers join the Army at a relatively young age where the prevalence of periodontitis is low, which facilitates the potential for prevention (Eke et al., 2015, Eke et al., 2016). The prevention of periodontitis is aided by having a precursor in gingivitis that can act as a target for intervention and systems of care should evolve to provide enhanced monitoring and prevention of gingivitis as well as the reduction in smoking that will act as primary preventative measures (Claffey et al., 1990).

Pathways of care for patients for the management of proximal determinants of health should be developed and fully integrated with the medical system of care.

The high prevalence and number of proximal determinants underpins the oral health status of soldiers recorded in this survey and shows the need for programmes to aid them to achieve and maintain optimal oral and general health. These supports must be delivered in a manner that prevents inadvertent widening of social gradients (Marmot et al., 2012, Marmot, 2013). This will require the on-going collection of data that should be reported using the measures reported in this survey (education, rank and small area deprivation).

Common risk factors exist in general and oral disease, with clustering of smoking, alcohol, diet and exercise identified as responsible for much of the ill health in adult populations (Poortinga, 2007). The NICE guidance should be consulted for a general approach that includes coordination across multiple interventions that have common aims and objectives (NICE, 2014). Full integration and co-operation with medical services are required to avoid duplication of resources or the delivery of contradictory messaging (Sheiham and Watt, 2000). As medical centres are updated, they should pivot to act as wellness centres that integrate medical and social aspects of disease management in one location to prevent the medicalization of social or behavioural factors (Winters et al., 2010).

Interventions to promote oral health should be tailored to act at different levels of granularity from the individual to the whole population (McNeil et al., 2022). The results of this survey have shown a very low level of oral health knowledge in certain domains such as fluoride, which was probably duplicated in other areas. Since soldiers may spend many years in non-fluoridated areas, information about the benefits of fluoride should be widely disseminated using campaigns on Army apps and social media channels.

One on one interventions have been found to be successful in certain areas, such as dietary modification (Harris et al., 2012). The techniques involved, such as setting goals, reinforcement and feedback, will require training of dental staff to optimize delivery of the advice (McGrath, 2019). The HSE approach of “every contact counts” should be utilized to integrate short interventions into every day practice (HSE, 2016) and such brief interventions have been found to be effective in smoking cessation in the dental practice setting (Ramseier et al., 2020). As the most immediate and serious risk to health, smoking typically presents as the priority for intervention but to be effective requires an integrated approach with medical

colleagues (Evans and Buck, 2018). Dental staff should recognize that many attempts are typically needed to quit (Borland et al., 2012) and that patients may need referral to specialized services such as HSE quit-lines (HSE, 2022). Equally, the Army should develop the capacity to give patients in remote barracks an opportunity to make contacts for smoking and other interventions using remote or telehealth as measures to improve access, increase opportunities for monitoring and reducing the environmental impact of attendance at centralized centres (Duane et al., 2019).

*Caries and periodontal disease should be managed in an equal manner
to reduce the impacts of both diseases.*

The system approach of the dental service should shift from the prioritization of the treatment of dental caries to completion to a system that shifts focus to the management and prevention of caries and periodontal disease in equal measure. As stated, periodontal diseases are largely preventable using strategies to stop smoking and improve oral hygiene (Petersen and Ogawa, 2005, Chapple et al., 2015, Scannapieco and Gershovich, 2020). Recruits who are seen on entry with precursors of periodontitis, such as gingivitis (Claffey et al., 1990) should be targeted with appropriate advice as a preventative measure and the dental service should establish a recall system to capture at risk recruits after initial training. Inevitably, some recruits will present with active periodontal disease on entry and many other soldiers will develop active disease later in service. Untreated disease causes loss of teeth, but typically at an older age when many soldiers have left military service (Phipps and Stevens, 1995). Thus, the provision of appropriate treatment and maintenance programmes can become an expression of a whole life perspective of oral health in soldiers rather than a solely occupationally focussed service. In order to provide greater access to periodontal care, the Army should extend the availability of periodontal care to contract practices, with suitable oversight and monitoring of cases to ensure value for money and to ensure that optimum standards of care are achieved.

Dental ICT should be implemented and should include scanning solutions.

At an organizational level, intraoral scans are an effective means of extending the coverage of dental forensic charting to the part of the Army with a DMFT score of zero, who lack the markers of caries that are traditionally used (Evans et al., 2010, Hinchliffe, 2011, Nagi et al., 2019). This technology may also be used in the forensic charting of other personnel and may

usefully be used to extend forensic coverage to other soldiers, aircrew and sailors who do not routinely deploy overseas on Army missions but who may be at risk in their occupational role.

Implicit in the use of scanners is suitable dental ICT. In addition, dental ICT is required to operationalize a preventatively oriented system as Army patients move frequently from barracks to barracks and dental records need to be accessible from multiple locations. The dental ICT should include the capacity to record both the NATO/ PfP and the proposed risk rating codes and should have the capacity to provide detailed management reports so that trends can be captured that show the success or failure of programmes.

7.14.3 Research

Monitoring of the oral health of soldiers should be undertaken using a combination of cross-sectional and longitudinal surveys.

A period of thirty years elapsed between the first epidemiological survey undertaken on the oral health of the Irish Army and the current survey (Hayden, 1995). In the interim, significant changes occurred in Irish society, including community water fluoridation, a reduced smoking prevalence and better general and oral health (O'Mullane and Whelton, 1992, Whelton, 2007, Naseer, 2020) and the data from 1990 was of little use in the planning of service delivery or assessing the impact of interventions. Future surveys are required on a regular basis to ensure that the delivery of care can be attuned to system and individual need. Cross-sectional data as reported in this thesis is an invaluable tool for reporting the prevalence of diseases and conditions in a population and has the advantage of relative ease of implementation, good population coverage and no loss to follow-up (Yee and Niemeier, 1996). An additional benefit in the Army is the transient nature of the population, with movement in Ireland, deployment overseas and discharge that may affect the potential for longitudinal monitoring.

Longitudinal monitoring of the oral health of the Army or the national population has not been reported. Ideally, longitudinal monitoring should be undertaken to identify the time-order of causes and effects, which in turn will allow for the development of theories and practical solutions (Cummings, 2018). Although a difficulty in longitudinal monitoring is undoubtedly loss to follow-up, longitudinal monitoring of recruits and cadets following entry would be beneficial, particularly in the assessment of subjective oral health measures, following treatment of disease and exposure to the Army system of care. Longitudinal monitoring of the general population should be supported by the investment in dedicated ICT, which would also allow for the retention and use of data generated by the treatments carried out externally under contract by civilian practitioners.

The oral health of female soldiers in the Irish Army should be collected in a dedicated survey

A dedicated survey should be undertaken to collect a data from a representative sample of women in the Irish Army. The current survey was unable to sample a sufficient number of women due to the small number in the Army, the geographical distribution and relatively low

number of volunteers for overseas service. In order to undertake such a survey, significant buy in will be required as about half of the serving women would be required to provide sufficient statistical certainty in the results. The Army should use the women's network in the Defence Forces to seek and mobilize support. The use of mobile examination equipment would allow the dental service to provide access in regional barracks where a dental team are not available.

The causes of dental emergencies should be recorded as well as the time required for resolution of symptoms.

The systems analysis in the Army should expand to further understand the types of conditions that are responsible for dental emergencies at home and overseas. An important part of the dental service business plan is to reduce the number of dental emergencies that occur (particularly on deployment) and to return personnel with problems to duty as quickly as is possible. Dental treatments are provided to soldiers while serving on the basis that treatment of disease reduces emergencies (Chaffin et al., 2001, Chaffin and Moss, 2008) but it has not been possible to identify whether this programme is successful in the Irish Army. The collection of data from the deployed forces is particularly important as the types of emergencies seen on deployment may differ from those at home and the data collected from a single deployment of Irish soldiers in 2021 was not robust enough to allow the inference of definitive conclusions (Dept. of Defence, 2022a). The research should determine the time taken for resolution of dental emergency symptoms and the range of dental treatments required as this will inform the training needs of dentists and the breadth of specialist services required.

Research on the impacts of dental and oral disease should be undertaken to align subjective oral health with dental policy.

Further research is needed to record the impacts of oral health as dental policy is adapted and implemented to monitor the subjective experience of oral health and ensure that the changing policy does not adversely affect any subgroups or widen inequality. Self-reported oral health should be recorded using a Likert scale that can usefully dichotomize respondents into better and worse self-reported oral health for evaluation purposes (Likert, 1932). The most widely used measure of OHRQoL in use in dentistry is the OHIP-14 instrument (Slade, 1997), which was explicitly designed and used to aid in the identification of groups with higher levels of

disease (Lawrence et al., 2008, Bernabe and Marcenes, 2010, Daly et al., 2010, Jansson et al., 2014, Haag et al., 2017). As such the OHIP instrument has potential utility in the planning of care and the identification of the best approaches for the management of conditions. Two recent systematic reviews have suggested that the OHIP instrument measures only four dimensions (Mittal et al., 2019, Rener-Sitar et al., 2021) rather than the seven proposed by Locker (Locker, 1988). John *et al.* have subsequently reported a high degree of correlation between the summary scores of all variants of the OHIP instrument, with a recommendation that the short-form OHIP-5 exclusively be used in future surveys (John et al., 2022). Since the short form is easier for patients to use and can readily be incorporated into clinical practice this should be used both in clinical practice and in future surveys.

Research is required to determine the factors associated with non-attendance.

This study showed that soldiers who hadn't attended within 12 months had a higher prevalence of disease and a greater number of proximal determinants of oral health. The current data cannot determine whether the lower prevalence was due to a "healthy user" effect or the treatment to completion mandated by pre-deployment attendance. The lack of statistically significant difference between the visiting groups in the number of proximal determinants suggest that the recent attenders had no fewer behaviours that cause disease and suggests that the "healthy user" effect was not apparent. Longitudinal monitoring of personnel is required to evaluate this matter.

In addition to these data, further qualitative factors need to be explored. Differences in oral health have been described between problem-based attenders and regular users of services (Thomson et al., 2000, Richards and Ameen, 2002, Thomson et al., 2010, Yoshino et al., 2016). The reason for last attendance was not recorded in this survey and future research is needed to identify the proportion of these soldiers within each of the visiting categories. In this survey 36% of personnel who hadn't attended within two years gave no answer for the reason why they hadn't attended, which requires further investigation. Efforts to improve attendance are only possible when the drivers of non-attendance are understood. One recent systematic review concluded that free examinations, dentist communication, the relationship between the dentist and the patient and the awareness of need in the patient were important factors in changing to a regular attendance pattern from problem-based attendance (Currie et al., 2021). All of these factors are within the skillset of a routine dental practice and should be utilized by the Army dental teams, although some personnel may need communication

training to maximize the effectiveness of the implementation. Future research should include an assessment of the utility of these interventions.

A final aspect of military relevance relates to the need for contemporaneous forensic dental charts. Minimum recall periods have not been set for soldiers, which means that there may be relatively long periods between deployment and capture of the next forensic chart for some soldiers. The recall period for oversight of dental health status is different from that of the forensic chart but no research exists that provides guidance. Intraoral scans may provide a three-dimensional model that has reasonable stability and can be used over longer periods but research in this area is not available. Many soldiers stay in the Army for extended periods and would seem to offer the potential for long-term monitoring (Dept. of Defence, 2018).

7.15 Conclusion

The data captured in this survey provided important insights into the oral health of recruits and soldiers in the Irish Army. In the thirty years since the previous oral health survey (Hayden, 1995), there were marked improvements in oral health with increased retention of teeth and sound teeth, fewer dentures, a reduced caries experience and better periodontal health. The improvements reflected factors that were present in the wider community, such as lifetime access to fluoridation and a change in dental treatment from extraction to restoration of teeth. However, comparison with the results of age-matched soldiers and civilians in the TILDA survey showed that older soldiers enjoyed better oral health. A particularly important distinction in the prevalence of dentures in the civilian (31.2%) and military (6.1%) samples showed that a military effect was evident. The results suggested that the unparalleled access that soldiers had to civilian, military and specialist care afforded soldiers better outcomes than civilian peers. Overall, the outcomes indicated that the organisation of care was broadly successful in meeting the desired system outcomes. However, 7.1% of the Army had a DMFT score of zero and could not be recognized using traditional dental forensic markers. Novel methods such as scanning are required to capture a forensic dental chart in this group.

The outcomes in the Army were particularly impressive given the high prevalence of untreated caries (39.7%) and inflammatory periodontal disease (53.1%) in new entrants. The results showed that a greater proportion of recruits lived in the most deprived small areas and had “some secondary” education than occurred in the national population and that there were social gradients associated with these intermediate determinants in the experience of oral disease. By contrast, in the trained strength the differences by deprivation group disappeared but a new gradient in oral health appeared by rank. Structure, power, socio-economic class, education and rank were tightly enmeshed in the Army and confirmed the social gradient from officer to other ranks that heretofore had been subject to much anecdotal speculation. The results showed that disease experience was not uniform and that certain groups had a higher prevalence of disease, including soldiers with “some secondary” education, soldiers with phobia and those that hadn’t attended within 12 months. However, no system was in place to identify or recall these soldiers for management or for the application of preventative interventions.

Underlying these social gradients in disease experience were proximal determinants of disease that were evident in both the new entrants and the trained strength. An important difference between the new entrants and trained strength was in the attendance pattern, with

about half of new entrants and 80% of soldiers in the trained strength attending within the previous 12 months. The results suggest that at least to some degree cost and access were issues for some new entrants that impeded oral care. The data from new entrants showed that about a quarter smoked and about a third smoked or vaped in the previous month, showing that recruitment was from a subgroup of the national population. Of six behaviours associated with poorer oral health in the recruits and trained strength, about a third had two or more and another third had three or more, showing the clustering of behaviours. The results indicated that disease was being treated in a mechanistic fashion but efforts to change behaviour and reduce the number of proximal determinants that cause disease were not effective. The results highlighted the need to transform the service from the reflexive provision of dental treatments to a model that incorporates preventative practices.

The results of the subjective measures of oral health reflected the low prevalence of disease in combination with the high prevalence of proximal risk factors. The overall prevalence of pain was low, but was higher in the untreated new entrants. The prevalence of pain in the previous 12 months in the Army (15.9%) showed that soldiers continued to experience the effects of poor management of oral diseases and conditions and the need for on-going emergency dental access. The prevalence of better self-reported oral health (61.4%) was lower than the nationally reported prevalence (79%) (Dept. of Health, 2018) as was the prevalence in 50- to 64-year-old soldiers (61.3%) when compared with the TILDA cohort (81%) (Naseer, 2020), despite evidence of better oral health in soldiers. These results suggest that soldiers were aware of the behaviours that cause disease and this was factored into the answers. The gradient of normative need associated with self-reported oral health showed its potential utility in daily clinical practice. This survey was the first to report a measure of OHRQoL in soldiers. The results showed a large ‘floor’ effect and a low overall prevalence that aligned with the low prevalence of disease or symptoms (pain). However, the results also showed that certain subgroups, such as denture wearers, had a high prevalence of impacts, facts that would have been hidden by a normative need assessment. The results showed that the understanding of oral health in the Army should usefully be extended to measures such as OHRQoL on a routine basis.

This survey produced a wealth of data that had applications within dentistry and in the wider Army. The results highlight vulnerable groups with poorer oral health and groups with advantage with better oral health. The current model of care is blind to these differences resulting in inequity, ironically because of an *equal* distribution of resources. Action to

change the dental service care delivery model requires input from a broad church in the Army, including dental, medical and line management leaders.

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Appendix 1: Ethical approval



Tallaght
University
Hospital

Ospidéal
Ollscoile
Thamhlachta

An Academic Partner of Trinity College Dublin

SJH/TUH Research Ethics Committee Secretariat
email: researchethics@tuh.ie

Lieutenant-Colonel John Crotty,
Defence Forces,
Directorate Medical Branch,
Logs Base Hospital St Bricens,
Infirmary Road,
Dublin

09th May 2019

REF: An investigation into the Dental Health of the Defence Forces

REC: 2019-05 Chairman's Action (04)

(Please quote reference on all correspondence)

Date of Valid Submission to REC: 17.01.2019

Date of Ethical Review: 08.05.2019

Research and Innovation Application Number: N/A

Dear Lieutenant-Colonel Crotty,

The REC is in receipt of your recent request to TUH/SJH Research Ethics Committee in which you queried ethical approval for the above named study.

The Chairman, Prof. Richard Dean, on behalf of the Research Ethics Committee, has reviewed your correspondence and given full ethical approval for the study to proceed. The following comments were made:

- The researcher intend to collect the address of the participant, ONLY a partial address should be collected such as Tallaght, Dublin and not the entire address.

The following documents were reviewed and approved:

- Standard application form
- Patient information leaflet and Consent form

*Applicants must submit an annual report for ongoing projects and an end of project report upon completion of the study. It is the responsibility of the researcher/research team to ensure all aspects of the study are executed in compliance with the General Data Protection regulation (GDPR), Health Research Regulations and the Data Protection Act 2018. **Additionally, please note for documents submitted for GDPR purposes that the REC and the Chair are not confirming that you're documents are GDPR compliant, they are approving the document from an ethical perspective.***

Yours sincerely,

REC Officer – Dr Sadhbh O'Neill
SJH/TUH Research Ethics Committee

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Tallaght University Hospital is a registered
business name of 'The Adelaide and Meath
Hospital, Dublin Incorporating The National
Children's Hospital'.

Appendix 2: Patient information leaflet

PARTICIPANT INFORMATION LEAFLET

Analysis of the Dental Health of the Defence Forces

Principal Investigator and Co-investigator: Dr Brett Duane, Dublin Dental Hospital, 01 6127273 and Lt-Col John Crotty, Chief Dental Officer, 01 8042791

The Defence Forces provides dental treatment to enable personnel to serve at home and on overseas missions. The Dental Service intends to examine the teeth and oral cavity of serving personnel to determine the level of disease present so that appropriate funding and service delivery can be provided. Your information will be pooled into a large dataset so that you can never be individually identified.

The research is being carried out by Lt-Col Crotty, the Chief Dental Officer, in conjunction with Dr Brett Duane from Dublin Dental Hospital. Information about the study is provided below and you should read the leaflet carefully to inform yourself about the potential risks and benefits. Please take as much time as necessary and feel free to ask questions or to contact Lt-Col Crotty for further clarification.

PART 1 – THE STUDY

Why is this study being done?

Dentists inspect the teeth of people to understand whether dental health is changing. The purpose of the research is to determine the level of dental disease present in cadets, recruits and serving personnel. Information about your dental health and the information provided by you in a questionnaire will be used to assess the risk factors associated with dental disease. The data will be grouped in an anonymous dataset and your identity will not be revealed.

Why am I being asked to take part?

You are being asked to participate as you are a serving member of the Permanent Defence Forces.

Do I have to take part? What happens if I say no? Can I withdraw?

You don't have to take part in this study. If you decide not to take part it won't affect your current or future dental care. You can change your mind about taking part in the study and opt out at any time even if the study has started. If you decide to opt out, it won't affect your current or future dental care. You don't have to give a reason for not taking part or for opting out.

If you decide to withdraw from the study after your examination, you can contact Lt-Col Crotty at 01 8042791 or john.crotty@defenceforces.ie. Unfortunately, if your data has been added to a large anonymised dataset it will not be possible to identify your data so it will not be possible to remove your data at that time.

How will the study be carried out?

The study will take place in Dental Surgeries where dental treatment is provided to Defence Forces personnel. The study will take place between September 2019 and March 2020. The study will involve the routine examination of the teeth and oral cavity and the completion of an associated questionnaire. Approximately 1900 personnel will be examined during the course of the study.

What will happen to me if I agree to take part?

If you agree to take part, you will undergo a standard dental examination of your mouth, teeth and gums. The examination will take place in any of the dental surgeries where dental treatment is provided to members of the Defence Forces. The examination will be undertaken by dentists or dental hygienists.

You will also be asked to complete a questionnaire that will ask you about risk factors associated with dental disease. The questionnaire will take approximately 3 minutes to complete.

Are there any benefits to me or others if I take part in the study?

While there are no direct benefits to the participant other than those from a routine dental examination, the collated data will enable the Defence Forces Dental Service to plan for the provision of optimal dental care to personnel.

Are there any risks to me or others if I take part in the study?

No risks are involved in the dental examination as the examinations are being provided as part of routine care. All data collected will be rendered into an anonymous dataset so that your individual data cannot be identified.

Will I be told the outcome of the study? Will I be told the results of any tests or investigations performed as part of this study that relate to me?

The results of your dental examination will be communicated to you in the usual manner following your examination. The results of the research will be published on IKON and will be freely available for inspection. Certain aspects of the research involving grouped anonymised data may be published in dental journals or may be discussed at dental conferences.

PART 2 – DATA PROTECTION

What information about me (personal data) will be used as part of this study? Will my medical records be accessed?

The data collected during the examination will include standard dental examination details such as number of teeth present, presence of fillings and other dental data. This data will be transferred to anonymous grouped datasets by your dentist so that your individual records can never be identified.

What will happen my personal data?

Only dental clinical data as well as the data collected in the questionnaire will be collected in the study. The data will be made anonymous and transferred to a grouped dataset that will be archived for 7 years in line with Dublin Dental Hospital policy. The data will not leave the State. The dental teams have been trained to capture only the data needed to determine disease rates in Defence Forces personnel and it will not be processed in a way that causes damage or distress to participants.

Who will access and use my personal data as part of this study?

The only individuals who will have access to your personal data are the members of the dental health team that you are attending. The anonymised data will be sent to Lt-Col John Crotty who will collate the data into grouped anonymised datasets. These datasets will be analysed by Lt-Col Crotty and Dr Brett Duane in Dublin Dental Hospital.

Will my personal data be kept confidential? How will my data be kept safe?

Your data will be collected as part of standard dental examinations. The data will be kept in secured locked cabinets in dental surgeries or in secure, password-protected servers. A data protection assessment has estimated the risk associated with the identification of your data as low in terms of likelihood or severity. All published data will report on grouped anonymised data and it would not be possible to identify you.

What is the lawful basis to use my personal data?

The lawful basis for the use of your data derives from the processing of data as specified in Article 6 and Article 9 of GDPR.

What are my rights?

You have the following rights in relation to the data held:

- The right to access data held
- The right to restrict the use of the data held
- The right to correct inaccuracies
- The right to have information deleted
- The right to data portability
- The right to object to profiling

PART 3 – COSTS, FUNDING & APPROVAL

Will it cost me anything if I agree to take part?

No costs are associated with participation and no compensation is paid to participants. All dental personnel have appropriate State or personal indemnity in place.

Who is funding this study? Will the results study be used for commercial purposes?

The Defence Forces is funding this study and the results will be used to plan for the delivery of the most appropriate dental healthcare. The results will not be used or disclosed for commercial purposes.

Has this study been approved by a research ethics committee?

Approval to undertake the research was given by the Joint Research Ethics Committee in May 2019. Queries in relation to ethical approval can be addressed to Dr. Sadhbh O'Neill (Email: ResearchEthics@tuh.ie / Sadhbh.ONeill@tuh.ie, Phone: 01-414 2199). None of the persons carrying out the research have a link to the committee or the institution behind the committee. The lead investigators will report to the Ethics Committee via the Research Ethics Committee Officer, Dr O'Neill.

PART 4 – FUTURE RESEARCH

Will my personal data and/or biological material be used in future studies?

You will be asked to participate in this study so that current dental disease rates in the Defence Forces can be estimated. The grouped data may be used in future studies to compare disease rates in the future to current disease rates. This data will be confined to the on-going research into the dental health of Defence Forces personnel undertaken by the Chief Dental Officer, Lt-Col Crotty. You will be asked separately to consent to the use of your data in the current and future studies and you may consent to neither, one or both.

PART 5 – FURTHER INFORMATION

Where can I get further information?

Further information can be provided by the following:

- Principal Investigator(s):
 - Dr Brett Duane 01 6127273, brett.duane@dental.tcd.ie
 - Lt-Col John Crotty 01 804 2791 john.crotty@defenceforces.ie
- Data Controllers: Name / Contact details
 - Lt-Col John Crotty 01 804 2791 john.crotty@defenceforces.ie
- Data Processor(s): Lt-Col John Crotty 01 804 2791 john.crotty@defenceforces.ie
- Data Protection Officer:
 - Data Protection Officer Defence Forces, DJ1, Defence Forces Headquarters, Station Road, Newbridge, Co.Kildare. 045 49 25 72

What happens if I wish to make a complaint?

Complaints in relation to the study can be made directly to the Chief Dental Officer, Lt-Col John Crotty at john.crotty@defenceforces.ie or 01 8042791.

Will I be contacted again?

It is not anticipated that the researchers will need to contact you following your initial participation.

Appendix 3: Consent form

CONSENT FORM

Analysis of the Dental Health of the Defence Forces

To be completed by the **PARTICIPANT**:

I have read and understood the information leaflet.	YES ☐	NO ☐
I have had the opportunity to discuss the study, ask questions about the study and I have received satisfactory answers to all my questions.	YES ☐	NO ☐
I have received enough information about this study.	YES ☐	NO ☐
I understand that I am free to withdraw from the study at any time without giving a reason and this will not affect my future dental care.	YES ☐	NO ☐
I agree to allow the researchers use my information (personal data) as part of this study as outlined in the information leaflet.	YES ☐	NO ☐
I consent to take part in this research study having been fully informed of the risks, benefits and purpose of the study	YES ☐	NO ☐
I give my explicit consent to have my data processed as part of this research study	YES ☐	NO ☐

The grouped anonymised data may be used in the future for comparison to data collected at that time. All data will be anonymised so individuals cannot be identified and the data will be held in secure Defence Forces servers. The data processing will comply with current and future processing regulations.

I agree to the use of my data in future research as outlined above.	YES ☐	NO ☐

Participant's Name (Block Capitals):	
Participant's Signature:	
Date:	

To be completed by the **RESEARCHER**:

I have fully explained the purpose and nature (including benefits and risks) of this study to the participant in a way that he/she could understand. I have invited him/her to ask questions on any aspect of the study.	YES ☐	NO ☐
I confirm that I have given a copy of the information leaflet and consent form to the participant.	YES ☐	NO ☐

Researcher's Name (Block Capitals):	
Researcher's Title & Qualifications:	
Researcher's Signature:	
Date:	

Appendix 4: Risk factor questionnaire

RISK FACTOR QUESTIONNAIRE

**DO NOT WRITE ANYTHING ON THIS FORM THAT
CAN IDENTIFY YOU PERSONALLY**

Pain

P1 Do you have any problems or pain in your mouth at the moment? ☐ No pain or problem
☐ Yes pain and/or problem

P2 If you answered yes, do you think that there is pain related to your teeth? ☐ No
☐ Yes

Last dental visits

L1 About how long ago was your last visit to the dentist? (Do not include visits to a dental hygienist)

☐ Within the last 6 months	☐ More than 3, but less than 5 years ago
☐ Within the last 7-12 months	☐ More than 5, but less than 10 years ago
☐ More than 1, but less than 2 years ago	☐ More than 10 years ago
☐ More than 2, but less than 3 years ago	☐ Never

L2 Which of these, if any, are the reasons why you have not been to the dentist in the last two years?

☐ No need to go to the dentist / nothing wrong with my teeth	☐ I am afraid of going to the dentists
☐ I can't afford the charges	☐ Keep forgetting / Haven't got round to it
☐ I haven't got the time to go	☐ None of these reasons

L3 ...and which of these, if any, are also reasons why you have not been to the dentist in the last two years?

☐ It's difficult to get to / from the dentist	☐ I don't see the point in going to the dentist
☐ I've had a bad experience with a dentist	☐ None of these reasons
☐ I'm too embarrassed to go to the dentist	☐ Other reason (please specify):

Diet

D1 How often, on average, do you eat a serving of cakes, biscuits, puddings or pastries?

☐ 6 or more times a week	☐ Less than once a week
☐ 3-5 times a week	☐ Rarely or never
☐ 1-2 times a week	

D2 How often, on average, do you eat sweets or chocolate?

☐ 6 or more times a week	☐ Less than once a week
☐ 3-5 times a week	☐ Rarely or never
☐ 1-2 times a week	

D3 How often, on average do you have fizzy drinks, fruit juice, or soft drinks like squash, excluding diet or sugar-free drinks?

☐ 6 or more times a week	☐ Less than once a week
☐ 3-5 times a week	☐ Rarely or never
☐ 1-2 times a week	

D4 Do you usually have sugar in hot drinks like tea and coffee? ☐ Yes
☐ No
☐ Do not drink hot drinks

Access to fluoride

F1 Do you use toothpaste that contains fluoride? ☐ Yes ☐ No ☐ Don't know

F2 Do you mainly drink bottled or tap water? ☐ Bottled water ☐ Tap water

F3 Is your water supply: ☐ Mains water ☐ Group scheme ☐ Private well ☐ Don't know

Gum disease

G1 How many times do you brush your teeth in one day?

☐ twice a day or more often ☐ once a day ☐ less than once a day

G2 Do you think you might have gum disease? ☐ Yes ☐ No ☐ Don't know

G3 Overall, how would you rate the health of your teeth and gums?

☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor ☐ Don't know

G4 Have you ever had treatment for gum disease, such as scaling and root planing, sometimes called "deep" cleaning? ☐ Yes ☐ No ☐ Don't know

G5 Have you ever had any teeth become loose on their own, without an injury?

☐ Yes ☐ No ☐ Don't know

G6 Have you ever been told by a dental professional that you lost bone around your teeth?

☐ Yes ☐ No ☐ Don't know

G7 During the past 3 months, have you noticed a tooth that doesn't look right?

☐ Yes ☐ No ☐ Don't know

G8 Aside from brushing your teeth with a toothbrush, in the last 7 days, how many times did you use dental floss or any other device to clean between your teeth? _____ Number

G9 Aside from brushing your teeth with a toothbrush, in the last 7 days, how many times did you use mouthwash or other dental rinse product that you use to treat dental disease or dental problems?
_____ Number

Cigarette smoking

These next questions are about cigarette smoking. Then you will be asked about other products.

S1 Have you smoked at least 100 **cigarettes** in your entire life? ☐ YES
☐ NO – please go to question S11

S2 How old were you when you first started to smoke cigarettes regularly?

AGE : _____ ☐ I never smoked cigarettes regularly

S3 Do you **now** smoke cigarettes . . . ☐ every day – please go to question S6
☐ some days – please go to question S6
☐ not at all – please go to question S4

S4 How long has it been since you quit smoking cigarettes?

|__| ENTER UNIT ☐ DAYS ☐ WEEKS ☐ MONTHS ☐ YEARS

S5 At that time, about how many cigarettes did you **usually** smoke a day?
IF LESS THAN 1 PER DAY, ENTER 1

|__|__|__| ENTER NUMBER OF CIGARETTES (PER DAY)

Please now go to question S11

S6 How soon after you wake up do you smoke? Would you say . . .

☐ within 5 minutes,	☐ from more than 2 hours to 3 hours
☐ from 6 to 30 minutes,	☐ from more than 3 hours to 4 hours
☐ from more than 30 minutes to 1 hour	☐ more than 4 hours
☐ from more than 1 hour to 2 hours	

S7 On how many of the past **30 days** did you smoke cigarettes? |__|__| ENTER NUMBER OF DAYS

S8 On average, when you smoked during the past **30 days**, how many cigarettes did you smoke a day? IF LESS THAN 1 PER DAY, ENTER 1

|__|__|__| ENTER NUMBER OF CIGARETTES (PER DAY)

S9 During the past 12 months, how many times have you stopped smoking cigarettes because you were trying to quit smoking?

|__|__| ENTER NUMBER OF TIMES (1-20 TIMES)

S10 The last time you tried to quit, how long were you able to stop smoking?

|__|__|__| ENTER NUMBER (OF ☐ DAYS ☐ WEEKS ☐ MONTHS)

The next question is about e-cigarettes. These are battery-powered devices that usually contain liquid nicotine, and don't produce smoke.

S11 Have you **ever** used an e-cigarette **even one time**? ☐ YES ☐ NO

S12 During the past **30 days**, on how many days did you use e-cigarettes? |__|__|

Highest level of educational attainment – National Framework of Qualifications (NFQ)

☐ NFQ Level 3: Junior Certificate or FETAC Level 3 or NCVA foundation or FAS Introductory skills	☐ NFQ Level 7: Ordinary bachelor degree or national diploma
☐ NFQ Level 4/5: Leaving Certificate or equivalent; FETAC level 4/5	☐ NFQ Level 8: Honours bachelor degree/ professional qualification
☐ NFQ Level 6: FETAC Advanced certificate/ completed apprenticeship/ higher certificate	☐ NFQ Level 9: Postgraduate diploma or Masters degree
	☐ NFQ Level 10: PhD or Doctorate

Military experience

M1 How many years have you served in the Defence Forces? Years_____ Months_____

M2 How many overseas missions have you undertaken?

- Number of missions:
- Time in months:

Problems with your teeth, mouth or dentures

I would now like to ask you some questions about how often you experience problems with your teeth, mouth or dentures

T1 In the last 12 months, have you had trouble PRONOUNCING ANY WORDS because of problems with your teeth, mouth or dentures?

- ☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T2 In the last 12 months, have you felt that your SENSE OF TASTE has worsened because of problems with your teeth, mouth or dentures?

- ☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T3 In the last 12 months, have you had PAINFUL ACHING in your mouth?

- ☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T4 In the last 12 months, have you found it UNCOMFORTABLE TO EAT ANY FOODS because of problems with your teeth, mouth or dentures?

- ☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T5 In the last 12 months, have you been SELF-CONSCIOUS because of your teeth, mouth or dentures?

- ☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T6 In the last 12 months, have you FELT TENSE because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T7 In the last 12 months, has your DIET BEEN UNSATISFACTORY because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T8 In the last 12 months, have you had to INTERRUPT MEALS because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T9 In the last 12 months, have you found it DIFFICULT TO RELAX because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T10 In the last 12 months, have you been a bit EMBARRASSED because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T11 In the last 12 months, have you been a bit IRRITABLE WITH OTHER PEOPLE because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T12 In the last 12 months, have you had DIFFICULTY DOING YOUR USUAL JOBS because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T13 In the last 12 months, have you felt that life in general was LESS SATISFYING because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

T14 In the last 12 months, have you been TOTALLY UNABLE TO FUNCTION because of problems with your teeth, mouth or dentures?

☐ Never ☐ Hardly ever ☐ Occasionally ☐ Fairly often ☐ Very often

Dental anxiety

Many people get anxious about visiting the dentist. I would like to ask you some questions about how anxious you get, if at all, with your dental visit.

A1 If you went to your dentist for treatment tomorrow, how would you feel?

☐ Not Anxious ☐ Slightly Anxious ☐ Fairly Anxious ☐ Very Anxious ☐ Extremely Anxious

A2 If you were sitting in the waiting room (waiting for treatment), how would you feel?

☐ Not Anxious ☐ Slightly Anxious ☐ Fairly Anxious ☐ Very Anxious ☐ Extremely Anxious

A3 If you were about to have a tooth drilled, how would you feel?

☐ Not Anxious ☐ Slightly Anxious ☐ Fairly Anxious ☐ Very Anxious ☐ Extremely Anxious

A4 If you were about to have your teeth scaled and polished, how would you feel?

☐ Not Anxious ☐ Slightly Anxious ☐ Fairly Anxious ☐ Very Anxious ☐ Extremely Anxious

A5 If you were about to have a local anaesthetic injection in you gum, above an upper back tooth, how would you feel?

☐ Not Anxious ☐ Slightly Anxious ☐ Fairly Anxious ☐ Very Anxious ☐ Extremely Anxious

Appendix 5: Data return form

DATA RETURN FORM

Demographics

Service number

Age in Years

Service: Army Navy

Gender: M F

Rank grouping

1 Senior Officer (Comdt or senior)	5 Pte
2 Junior Officer	6 Cadet
3 Senior NCO (CQ/ CS or senior)	7 Recruit
4 NCO	

Home address deprivation index (Pobal HP Index 2016 by small area)	

Medical conditions affecting salivary flow: Yes No

Medical conditions affecting periodontal health: Yes No

Units of alcohol

ASA class: I II III IV

Clinical Data

No of teeth

DMFT score

Decayed score total

Primary caries Secondary caries Teeth unrestorable due to caries

Missing

Filled

Denture present Yes No

Crowns present Yes No If yes number of units

Bridges present Yes No If yes number of units

Implants present Yes No If yes number of units

PSR

PUFA
(0 to 32)

BEWE

Questionnaire attached Yes No

Appendix 6: Psychometric properties of the MDAS instrument in the Army

The psychometric properties of the MDAS instrument in the Irish Army setting were explored using Exploratory Factor analysis in SPSS. The determinant of the correlation matrix had a value of 0.017, indicating that multicollinearity between the items was not an issue. The Kaiser-Meyer-Olkin test value was 0.812, which validated the sample size. Bartlett's test of sphericity was significant and ruled out an identity matrix. The magnitude of the estimated eigenvalues was compared to the estimated random eigenvectors, as displayed in Table 0-1, and indicated that a single factor had an eigenvalue greater than the randomly generated values, with an eigenvalue of 3.7 that accounted for 74.3% of the total variance.

Table 0-1: Magnitude of randomly generated eigenvalues (Horn's technique), calculated eigenvalues and percentage of variance accounted for by each eigenvalue in factor analysis

Number	Random	Eigenvalues	% of variance
1	1.1	3.7	74.3
2	1.0	0.6	12.7
3	1.0	0.3	6.6
4	1.0	0.2	4.4
5	0.9	0.1	2.0

Unidimensionality was confirmed using Confirmatory Factor Analysis in AMOS. The initial model had a number of fit problems as displayed in Table 0-2, not least being the fit indices. Analysis of the modification indices indicated three values that could indicate large error covariances. Suitable regression paths were added to the initial model. The final model path diagram is displayed in Figure 0-1. The fit indices of the adjusted model achieved the required criteria and indicated an excellent fit of the model to the saturated model.

Table 0-2: Goodness of fit criteria for the initial and adjusted model

Model tested	χ^2	Df	NNFI	RNI	CFI	SRMR	RMSEA
Initial	528.438	5	0.832	0.663	0.883	0.1004	0.368
Adjusted	1.180	2	1.000	0.998	1.000	0.002	0.000
Criterion for goodness of fit	-	-	>0.95	>0.95	>0.95	<0.06	<0.05

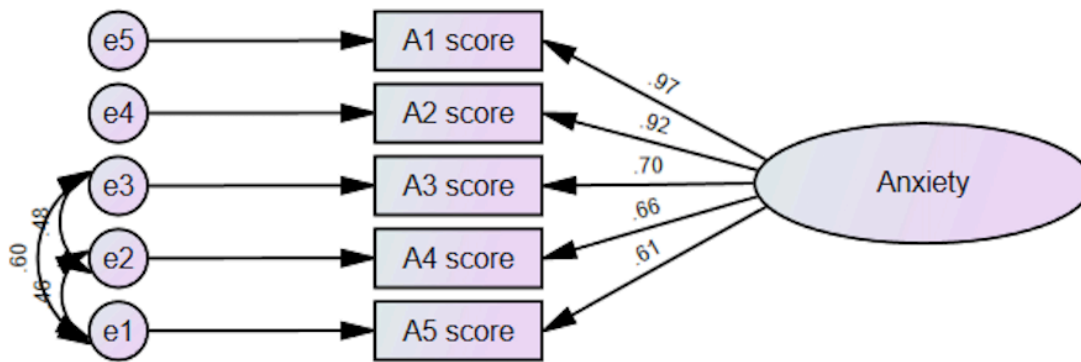


Figure 0-1: Confirmatory Factor Analysis path diagram

The Cronbach's alpha scores for the items in the questionnaire were satisfactory as demonstrated in Table 0-3 and indicate reliability in the use of the questionnaire in a single factor model. The Cronbach's alpha value decreased if any single item was removed from the questionnaire.

Table 0-3: Cronbach's alpha for the single factor model.

Factor	Items	Cronbach's alpha
1	1,2,3,4,5	0.91