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THE NUTRITIONAL STATUS OF HOSPITAL PATIENTS AND HEALTHY ELDERLY LIVING IN THE COMMUNITY

by

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A thesis for the degree of Doctor of Philosophy (Ph.D.)

at

University of Dublin, Trinity College

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April 2000

Declaration

I certify that none of the work in this thesis has been submitted for any degree or diploma at this, or any other University, and that all the work in this thesis is entirely my own. I agree that the Library may lend or copy this thesis upon request.

Clare A. Corish

Clare Anne Corish

15/8/2000

Date

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SUMMARY

Protein-energy undernutrition is known to occur in patients on admission to hospital. In a prospective study of 594 sequential hospital admissions, we assessed the prevalence of undernutrition among patients on admission to two Dublin hospitals using widely accepted anthropometric criteria (McWhirter & Pennington, 1994). We observed a significantly lower prevalence of undernutrition (11 %) than reported by McWhirter & Pennington, although pre-admission weight loss, functional impairment on admission and weight loss in hospital occurred to a similar extent. Using two popular nutrition screening instruments, the Nutrition Risk Index (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991) and the Nutrition Risk Score (Reilly *et al.* 1995), the proportion of patients at risk of nutritional deterioration was similar to that reported from other centres and was considerably higher than the level of undernutrition recorded. However, classification of the degree of nutritional risk varied depending on the screening tool used.

Patients requiring resection of a major cancer are likely to be undernourished. Undernourished patients are at higher risk for developing post-operative complications than those who are well nourished. In fifty-nine surgical oncology patients, nutritional status, physical function and quality of life were observed pre-operatively, post-operatively and for three months following discharge from hospital. Anthropometric criteria could only identify 6 % of patients as undernourished using the threshold value of a body mass index below 20 kg/m^2. The Nutrition Risk Index identified 63 % of patients as at nutritional risk. In our study, mortality was associated with the development of major post-operative complications, these in turn were associated with lower percentage body fat on admission and the severity of the surgical operation. A prolonged hospital stay was associated with the development of major infectious complications, higher alcohol intake at the time of admission and the severity of the surgical operation. We observed that major infectious complications were associated with a lower Nutrition Risk Index on admission to hospital. Three-quarters of all surgical oncology patients reassessed lost an average of 5.6 % of their admission weight in hospital, and over two-thirds of patients discharged lost an average of 5.9 % of their

discharge weight within three months. Functional status remained below baseline pre-operative levels during the three month follow-up period.

The anthropometric reference data currently used for assessing the nutritional status of patients on admission to hospital in the UK and Ireland were derived from measurements of healthy Caucasian Americans (Bishop *et al.* 1981; Frisancho, 1981) and from elderly people from South Wales in the UK (Burr & Phillips, 1984). Although anthropometric indices of fat and muscle are advocated as measures of nutritional status, their usefulness as an accurate indicator of nutritional status in the clinical setting is dependent on the availability of current age and sex related data. In a cross-sectional study of healthy Irish born elderly people, only 3 % had a body mass index below 20 kg/m^2 but approximately two-thirds (68.5 % of males and 61 % of females) were overweight or obese. Height, weight, body mass index and muscle reserves were observed to decrease with increasing age. The reduction in muscle size was associated with lower hand-grip strength. Fat reserves were observed to decline with age only in females. From the data collected, a reference set of anthropometric measurements representing the healthy elderly was established. These can be easily referred to by health professionals assessing elderly patients in various settings.

Finally, our existing data on 218 elderly patients on admission to hospital were re-analysed using the new locally derived reference data. A higher prevalence of undernutrition (28 %) was observed compared with the 10 % we had previously reported. Elderly patients on admission to hospital had significantly lower body mass index measurements than their healthy counterparts. With the secular increase in body mass index in the population, most patients need to lose considerably more than 10 % of their usual body weight to achieve a body mass index below 20 kg/m^2. Although it is useful for nutritional epidemiologists to know the proportion of different populations with a body mass index above or below 20 kg/m^2, in clinical practice we need to know how the patient on admission compares to the healthy individual in the community. This is particularly so in the elderly where early nutritional intervention appears to be of greater benefit. The results of this study suggest that with the secular increase in body mass index in the population, the thresholds for classifying patients as undernourished or as risk of nutritional deterioration should be reviewed.

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LIST OF ABBREVIATIONS

ADA	American Dietetic Association
ADL	Activities of daily living
ANOVA	Analysis of variance
BCP	Bromocresol green method
BHF	British Heart Foundation
BMI	Body mass index
Ca	Calcium
CHD	Coronary Heart Disease
cm	centimetre
COMA	Committee on Medical Aspects of Food
CRP	C-reactive protein
CSO	Central Statistics Office
Cu	Copper
CVD	Cardiovascular Disease
CVVHD	Continuous veno-venous haemodialysis
d	Day
D/C	Discharge
DCH	Delayed cutaneous hypersensitivity
EHB	Eastern Health Board
etc.	Etceteras
EU	European Union
FARA	Federation of Active Retirement Groups
Fe	Iron
GI	Gastrointestinal
HDU	High dependency unit
h	Hour
HDL	High density lipoprotein
HIPE	Hospital In-patient Enquiry
IBW	Ideal body weight
ICU	Intensive care unit

Inc.	Incorporated
INDI	Irish Nutrition and Dietetic Institute
i.v.	Intravenous
kg	Kilogram
l	Litre
LOS	Length of stay in hospital
m	month
MAC	Mid-arm circumference
MAMA	Mid-arm muscle area
MAMC	Mid-arm muscle circumference
ml	Millilitre
mm	millimetre
mmol	millimole
MNA	Mini Nutritional Assessment
n	Number of patients
N_2	Nitrogen
NBM	Nil by mouth
NHANES	National Health and Nutrition Examination Survey
NRI	Nutrition Risk Index
NRS	Nutrition Risk Score
NSI	Nutrition Screening Initiative
OWN	Older Women's Network
PNI	Prognostic nutritional index
QOL	Quality of life
RDA	Recommended Daily Allowances
RIP	Rest in peace
SD	Standard deviation
SDAT	Senile dementia of the Alzeimer type
SENECA	Survey in Europe on Nutrition and the Elderly, a Concerted Action
SGA	Subjective Global Assessment
SLAN	Survey of Lifestyle, Attitudes and Nutrition
SPSS	Statistical Package for the Social Sciences
SSF	Subscapular skinfold thickness

TNM	Tumour, Node, Metastasis
TPN	Total parenteral nutrition
TSF	Triceps skinfold thickness
UBW	Usual body weight
UK	United Kingdom
USA	United States of America
VCS	Volume, conductivity and light scatter technology
WHO	World Health Organisation
Zn	Zinc

PUBLICATIONS ARISING FROM THIS WORK

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Corish C, Flood P, Mulligan S & Kennedy NP (1998) Undernutrition in Dublin Hospitals. *Irish Journal of Medical Science* 12A.

Corish C, Flood P, Reynolds JV & Kennedy NP (1998) Nutritional characteristics of Irish patients undergoing resection of major carcinoma. *Proceedings of the Nutrition Society* **57**, 145A.

Doyle M, Corish C, Flood P & Kennedy NP (1998) Can patients' knowledge of their own weight and height be used to replace measured weight and height in the calculation of BMI. *Proceedings of the Nutrition Society* **57,** 165A.

Corish C (1999) Pre-operative nutritional assessment. *Proceedings of the Nutrition Society* **58,** 821-829.

Corish C, Flood P & Kennedy NP (2000) Nutritional status of the Irish elderly. *Irish Journal of Medical Science* 33A.

Corish C & Kennedy NP (2000) Protein-energy undernutrition in hospital in-patients. *British Journal of Nutrition* **83,** 575-591.

Corish C, Flood P, Reynolds JV & Kennedy NP (2000) Nutritional status of surgical oncology patients. *Irish Journal of Medical Science* 33A.

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1.0 Preamble

It has been widely accepted for many years that undernutrition and the risk of nutritional deterioration during the hospital stay are widespread both in the UK and in the USA. During the early 1990s, a small number of Irish undergraduate nutrition and dietetic student projects which focused on specific patient groups had reported similar results to those from the UK and USA. In late 1995, funding was obtained from Abbott Laboratories (Ireland) Ltd. to enable a postgraduate student project to be undertaken. This project aimed to characterise the problem of undernutrition in Dublin hospital patients and of those attending primary care in the community. It was also intended to evaluate the outcome of nutritional intervention in undernourished patients in both environments. The nutrition intervention to be evaluated was the standard therapy as applied by the therapeutic dietitian caring for the patient and was not a specific nutritional intervention. The benefits perceived to result from these studies included the publication of contemporary Irish data on the prevalence of undernutrition and the effects of hospitalisation on nutritional status. The effects of standard nutritional intervention on both nutritional status and clinical outcome would also become available as a result of the surveys carried out.

The first survey was established according to plan with almost 600 sequential patients being recruited from the two study hospitals, two large Dublin teaching hospitals, and approximately 70 % of those remaining in hospital for seven or more days being re-assessed before discharge from hospital. Nutritional status was assessed using anthropometry and nutritional risk using a validated questionnaire (Reilly *et al.* 1995). It was expected that the results of this survey would be similar to those reported by a group of Scottish researchers from Dundee in 1994 (McWhirter & Pennington, 1994). However, a significantly lower prevalence of undernutrition was observed in Dublin by comparison with Dundee although the deterioration in nutritional status during the hospital stay was similar. The proportion of patients at nutritional risk was also similar to that previously reported (Reilly *et al.* 1995). A small pilot study carried out in the general practices adjacent to the study hospitals (which I have not included in this thesis

(Doyle *et al.* 1998)) yielded results in keeping with those observed on admission to hospital.

As the group of undernourished patients was significantly lower than originally predicted and as the nutrition literature reports conflicting results from patients receiving nutritional support who are at risk of undernutrition only, and not undernourished per se, it was decided to assess the nutritional status of a group of patients at high risk of nutritional deterioration. These were patients admitted to hospital requiring resection of a major carcinoma. It was decided to monitor their nutritional status and the effects of their nutritional therapy both in hospital and after discharge. However, this study also showed a low prevalence of undernutrition using the criteria employed in the original survey although many of the patients obviously required nutritional intervention. It proved difficult in this study to show the advantages of nutritional intervention as the study hospital had a large and active department of clinical nutrition and patients who required nutritional management received it. The study did show however, that in spite of active nutritional management the majority of patients lose weight in hospital and continue to deteriorate nutritionally at home. Poor nutritional status was also observed to have a deleterious effect on clinical outcome.

As anthropometry, using the reference standards currently available, was found in both studies to be of limited use, it was felt at this time that the most appropriate way forward was to assess the nutritional status of the healthy Irish as a reference for those admitted to hospital. Although there is a clear need for anthropometric reference data for all age groups, it was not possible for one researcher to obtain adequate representative data to provide reference data for each age group. Currently, 35 - 40 % of all admissions to hospital are aged sixty-five years or more. This proportion is likely to increase as the proportion of elderly in the population increases. It was therefore felt most appropriate to obtain reference data from this age group and a cross-sectional study of almost 900 healthy Irish adults recruited through activity groups for the active retired was carried out. These data are presented as percentile tables which can be used as reference for nutritional assessment in clinical practice. A re-evaluation of the data collected on elderly patients in the original survey was then undertaken. Using these contemporary Irish data, a higher prevalence of undernutrition was observed.

As a result of the studies undertaken, it is hoped that a greater understanding of the problem of hospital nutrition has been obtained. Certainly issues regarding the use of anthropometry and reference data 'imported' from the UK and USA to assess the nutritional status of Irish patients have been clarified. It is hoped that this work will highlight some of the inherent problems associated with identifying those who are at highest risk of nutritional deterioration. The use of the new reference data will enable those assessing the nutritional status of the elderly to do so more reliably and accurately and should also allow for comparisons to be made between healthy elderly people living in Ireland and elsewhere.

1.1 Protein-energy undernutrition in hospital in-patients

1.1.1 Summary

Impaired nutritional status has been reported frequently in surveys estimating its prevalence among patients in hospital. There is no doubt that protein-energy undernutrition has serious implications for health, recovery from illness or surgery, and for hospital costs. However, the lack of nationally or internationally accepted thresholds and guidelines for most nutrition-related variables make nutritional assessment difficult and proper comparisons between studies impossible. In reviewing published work in which the prevalence of undernutrition has been assessed, it can be seen that each study defined undernutrition, or nutritional risk, using different criteria. This present review aims to highlight the problems which arise when deciphering these studies, and the resulting difficulty in determining the true prevalence of undernutrition and nutritional risk, among both general and specific groups of hospital inpatients. It is widely agreed that routine hospital practices can further adversely affect the nutritional status of sick patients in hospital. How this occurs, and the potential effects of impaired nutritional status on clinical outcome are examined. The methods currently available to assess nutritional status are considered in the knowledge that such assessments are difficult in clinical practice. The review concludes by emphasising that definitions of undernutrition and nutritional risk, and threshold values for the nutritional variables measured must be agreed to allow evidence-based practice. Outcome measures which allow clear comparisons between groups and treatments must be used in studies assessing the effects of nutritional interventions if we expect the medical and nursing professions to seriously consider the nutritional status of hospital patients.

1.1.2 Introduction

Undernutrition has been defined as a disorder of nutritional status resulting from reduced nutrient intake or impaired metabolism (American Society for Parenteral and Enteral Nutrition, 1995). It is used to describe a broad spectrum of clinical conditions ranging from mild to very severe. The state of impending undernutrition, or increased nutritional risk, has also been included under the umbrella of 'undernutrition' (Coats *et al.* 1993; Reilly *et al.* 1995).

In developed countries, undernutrition has been documented in hospitalised patients (Bistrian *et al.* 1974, 1976; Hill *et al.* 1977; McWhirter & Pennington, 1994) and in the institutionalised elderly (Morley, 1998).

Although the aetiology of undernutrition is complex, its development may be due to inadequate dietary intake, increased metabolic demands or increased nutrient losses. In hospitalised patients, these three situations can occur together. Severe protein-energy undernutrition results in extreme muscle wasting and loss of subcutaneous tissue. Known to clinicians as cachexia, it is similar to the nutritional marasmus seen in starving children and can be classified as 'adult marasmus'. Hypoalbuminaemia, with depressed cellular immunity and an expansion of extracellular water, resembling childhood kwashiorkor, is also observed. This condition has been defined both as 'adult kwashiorkor' (Hill, 1992) and 'hypoalbuminaemic malnutrition' (Bistrian, 1990). In hospitalized patients, 'marasmic kwashiorkor' is most commonly observed, consisting of wasting of muscle and fat with hypoalbuminaemia (Hill, 1992).

1.1.3 Prevalence of protein energy undernutrition in hospitalised patients

The prevalence of malnutrition in hospitalised patients was first reported in 1974 (Butterworth, 1974). This study was closely followed by a number of others which reported a prevalence of between 20 - 50 % in medical and surgical patients (Bistrian *et al.* 1976; Hill *et al.* 1977). Moreover, nutritional status has been shown to deteriorate over the course of the hospital stay (Weinsier *et al.* 1979; Coats *et al.* 1993; McWhirter & Pennington, 1994), a fact not recognised by medical and nursing staff (McWhirter & Pennington, 1994; Lennard-Jones *et al.* 1995; Reilly *et al.* 1995). The more recent studies examining the prevalence of protein-energy undernutrition in hospital patients have found a similar prevalence to that found in the 1970s (**Tables 1.1.1.-1.1.3**). A number of additional studies have estimated the number of patients at risk of deteriorating nutritionally in hospital (**Table 1.1.4**).

Tables 1.1.5 and **1.1.6** summarise the methods which have been used to define nutritional status in these studies. However, a careful review of the literature examining the prevalence of undernutrition, and nutritional risk in hospital patients highlights several problems. Virtually every study uses a different method of nutritional assessment and the criteria used to define undernutrition vary greatly between studies. Even where similar methods of assessment was used (e.g. anthropometric assessment), the threshold values for defining nutritional status vary and, in general, the reference data used are not derived from the population being studied. Comparison between studies and assessment of the current situation is, therefore, seriously hindered. For estimating the prevalence of undernutrition in the future, it is essential that guidelines are devised which provide guidance on which anthropometric, biochemical and functional measurements should be used to assess nutritional status in different groups of hospital patients and how the variables measured should be interpreted.

Table 1.1.1. Prevalence of undernutrition in hospitalised surgical patients

Authors	Patient group	*n*	Prevalence (%)	Method of assessment
Forse & Shizgal (1980)	General surgery	148	36	Total exchangeable potassium
Veterans Affairs Total Parenteral Nutrition Cooperative Study Group (1991)	Abdominal or thoracic surgery	2448	39	Nutrition risk index Subjective global assessment
Spiekerman *et al.* (1993)	Gastrointestinal surgery	245	44	Serum aspartate aminotransferase activity, cholesterol, total protein, albumin and transthyretin
Larsson *et al.* (1994)	General surgery	199	35	Percentage weight loss, weight index, MAMC, TSF, serum albumin and transthyretin

MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

Table 1.1.2. Prevalence of undernutrition in hospitalised elderly patients

Author	*n*	Prevalence (%)	Method of assessment
Ek *et al.* (1990)	482	28.5	Weight index, MAMC, TSF, serum albumin, transferrin, transthyretin and retinol-binding protein, delayed hypersensitivity skin testing
	482	39.5	As above, excluding delayed hypersensitivity skin testing
Lansey *et al.* (1993)	47	45	% IBW*, BMI, MAC, MAMA, TSF, SSF less than the 5th percentile using age and sex specific data†
Mowe *et al.* (1994)	311	53 (males) 61 (females)	BMI, TSF, MAMC and serum albumin in hospitalised *v.* home living elderly
Potter *et al.* (1995)	69	22	BMI less than the 5th percentile using age and sex specific data‡
Muhlethaler *et al.* (1995)	219	14	Body weight less than 80 % age and sex specific values§
Gariballa *et al.* (1998*a*)	201	31	BMI below 20kg/m^2 in elderly stroke patients
Maffulli *et al.* (1999)	119	31	BMI less than 18 kg/m^2, MAC in elderly hip fracture patients
Hanger *et al.* (1999)	66	42	Transthyretin, TSF, MAMA in elderly hip fracture patients

MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; IBW, ideal body weight; MAC, mid-arm circumference; MAMA, mid-arm muscle area; SSF, subscapular skinfold

*Simopoulos, (1985)
†Chumlea et al. (1985)
‡Burr & Phillips, (1984)
§Master *et al.* (1960)

Table 1.1.3. Prevalence of undernutrition in specialised groups of hospital patients

Authors	Patient group	*n*	Prevalence (%)	Method of assessment
Mc Whirter & Pennington (1994)	General medicine	100	46	BMI, MAMC, TSF
	General surgery	100	27	
	Respiratory medicine	100	45	
	Medicine for the elderly	100	43	
	Orthopaedic surgery	100	39	
Mc Whirter *et al.* (1994)	Gastrointestinal	100	38	BMI, MAMC, TSF
Madden *et al.* (1994)	Liver transplant	164	71	MAMC, TSF, adequacy of dietary intake compared with calculated requirement
Nightingale *et al.* (1996)	General medical	84	35	Percentage weight loss from normal, BMI, MAMC
Giner *et al.* (1996)	Intensive care	129	43	Serum albumin <35 g/l, weight : height ratio <100 %*
Naber *et al.* (1997)	Non-surgical	155	45	Subjective global assessment
			57	Nutrition risk index
			62	Maastricht Index†

MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

*Chicago Society of Actuaries (1959).

†Maastricht Index, ((20.68 - (0.24 x albumin) - (19.21 xtransthyretin) - (1.86 x lymphocytes) - 0.04 x ideal weight)). (De Jong *et al.* 1985).

Table 1.1.4. Risk of undernutrition on admission and discharge from hospital

Author	Patient group	*n*	Prevalence on admission (%)	Prevalence on discharge (%)	Method of assessment
Weinsier *et al.* (1979)	General medical	124	48	62 (*n* 44)	Likelihood of malnutrition score
Coats *et al.* (1993)	General medical	228	38	48 (*n* 48)	Likelihood of malnutrition score
Reilly *et al.* (1995)	General hospital	153	High risk: 26 Moderate risk: 24	No data	Nutrition risk score
Kovacevich *et al.* (1997)	General hospital	186	45	No data	Nutrition screening tool

Table 1.1.5. Methods of nutritional assessment in hospitalised patients

Method	Variables measured	Comment
Pre-admission weight loss	Current weight/normal weight	Lack of emphasis on routine measurement of weight; difficulties with accurate recall of weight; high prevalence of fluid balance problems in sick patients*
Anthropometry	BMI, MAMC, TSF	Confusion over appropriate cut off points for BMI and other anthropometric measurements to define undernutrition in different age and disease groups; use of outdated reference standards
Serum proteins	Serum albumin, transferrin, transthyretin, retinol-binding protein, somatamedin C and fibronectin,	All are influenced by hydration and hepatocellular dysfunction; individual proteins are influenced by factors common in sick patients (e.g. catabolism, renal failure, Fe-deficiency anaemia)†
Creatinine : height index	Urinary creatinine excretion	Need accurate 24 h urinary collections from patients on a meat-free diet
Functional status	Hand-grip strength, respiratory function	The relationship between muscle function and nutritional status has not been fully clarified
Immune competence	Delayed cutaneous hypersensitivity	Affected by disease (e. g. infection, renal and liver disease, trauma, burns and haemorrhage), drugs (e.g. corticosteroids, immunosuppressants, cimetidine, warfarin) and surgery
Bioelectrical impedance	Fat-free mass	Not useful for patients with fluid balance problems

MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

*comment referred to in **Table 1.1.6**.

Table 1.1.6. Scoring systems used for nutritional assessment in hospitalised patients

Scoring system	Variables measured	Comment
Nutrition risk index (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991)	Percentage weight loss from normal; current serum albumin	The factors which affect the components of this score affect the score result (see * in **Table 1.1.5**); designed for surgical patients
Subjective global assessment (Detsky *et al.* 1987*b*)	Percentage weight loss from normal, duration and degree of abnormal dietary intake (starvation, hypocaloric fluids, liquid diet, sub-optimal solid diet), gastrointestinal symptoms (anorexia, vomiting, diarrhoea, nausea), functional capacity (bedridden to full capacity) disease state, physical examination (loss of fat and muscle, presence of oedema or ascites)	Large subjective element to assessment; need specialised training†; technique more suitable for medical staff; designed for surgical patients
Prognostic nutritional index (Busby *et al.* 1980)	Serum albumin, transferrin, TSF, DCH	Impractical and expensive for routine pre-operative assessment; designed for surgical patients
Nutrition risk score (Reilly *et al.* 1995)	Percentage weight loss over past 3 months, BMI, food intake (appetite and ability to eat and retain food), stress factors (effect of medical condition on nutritional requirements)	Can be applied to all hospital patients, weight recall subject to error (see * in **Table 1.1.5**); validated against a sixteen item index designed to assess nutritional risk among community-dwelling elderly Americans
Nutrition screening tool (Kovacevich *et al.* 1997)	Diagnosis, nutrition intake history (< 50 % normal for > 5 d), diarrhoea, vomiting, current weight : IBW, percentage weight loss	Can be applied to all hospital patients, weight recall subject to error (see * in **Table 1.1.5**); validated against transthyretin (excluding patients with disorders known to effect transthretin)

TSF, triceps skin-fold thickness; DCH, delayed cutaneous hypersensitivity; IBW, ideal body weight.
†Lupo *et al.* (1993)

1.1.4 Relationship between nutritional status and clinical outcome

The development of undernutrition is influenced by the existing nutritional reserves independent of the disease state. Death occurs from total starvation in normal weight, healthy adults in 60-70 d (Allison, 1992). Survival beyond 50 % weight loss or BMI (weight (kg)/height $(m)^2$) below 12 kg/m^2 is unlikely (Allison, 1995). Total starvation for less than 2 - 3 d in healthy adults results in glycogen and water losses predominantly and only minor or no functional consequences (American Society for Parenteral and Enteral Nutrition, 1993). However, functional deficits are apparent in normal weight, healthy adults after 10-15d of semi-starvation. It is probable that in sick, hospitalised patients, these impairments occur more rapidly. The severity of the inadequacy and the duration of deprivation of food intake affect the rapidity with which undernutrition develops. The majority of patients who become undernourished not only lack dietary energy and protein but also micronutrients. This may accelerate the deterioration in nutritional state.

Although the pathogenesis of undernutrition in patients on admission to hospital has not been defined, the disease state itself, together with loss of appetite, pain and swallowing difficulties are likely to contribute to its development. In contrast, the consequences of undernutrition in hospital patients are widely-acknowledged. Undernutrition in sick patients is associated with impairment of every system in the body. Muscle weakness occurs (Windsor & Hill, 1988; Jeejeebhoy, 1988; Watters *et al.* 1993), particularly of respiratory muscle, resulting in reduction in vital capacity and blunted respiratory drive (Arora & Rochester, 1982). In patients with emphysema undergoing lung volume reduction surgery, 26 % of those with a low BMI required prolonged ventilatory support compared to only 4 % of the patients with a normal BMI (Mazolewski *et al.* 1999). The ability of the immune system to function effectively is reduced (Christou, 1990; Ek *et al.* 1990; Welsh *et al.* 1996; Chandra, 1997). Cellular immune function appears to be most sensitive to the effects of protein-energy undernutrition (Christou, 1990). T-cell numbers, the response to mitogen stimulation and delayed hypersensitivity reactions have all been found to be depressed. Phagocytic cell function has also been reported to be impaired and the complement system

adversely affected. Elevated titres of the immunoglobulins IgG, IgM, IgA and increased B-cell numbers are reported as a result of repeated infections. However, it is important to remember that cell-mediated immunity may also be depressed by trauma, renal and hepatic diseases, haemorrhage, steroid therapy, immunosuppressants, cimetidine, warfarin, general anaesthesia and surgery, factors common among patients in hospital. Immunoglobulin, antibody responses, complement component levels, mitogen responses and delayed hypersensitivity reactions have been found to return to normal with nutritional support. The clinical significance of these effects were observed in a study on 482 elderly patients, where 45 % of anergic patients compared with 27 % of reactive patients were undernourished as defined by anthropometric and biochemical criteria. Of the anergic patients, 28 % had pressure sores on admission or developed them during their hospital stay (Ek *et al.* 1990). In the gastrointestinal system, alterations in structure and function arise from undernutrition (Reynolds *et al.* 1996). Atrophy and impairment of the epithelial integrity occurs which may facilitate gut-derived infection. The presence of injury and infection, in turn, hasten the development of undernutrition in two ways; predominantly, metabolic changes are induced by the stress hormones (e.g. catecholamines, cortisol and glucagon) and various cytokines (e.g. tumour necrosis factor-α and interleukins 1 and 6). Insulin resistance may occur which further exacerbates the situation. The net result is inappropriate mobilisation, and substantial wastage of fat and protein which is difficult to rectify with nutritional therapy during the acute phase. The metabolic response frequently results in the development of anorexia which further decreases the dietary intake of nutrients. In addition, high levels of cytokines decrease intestinal motility and inhibit gastric emptying which may, in turn, cause nausea and vomiting (Yeh & Schuster, 1999). The situation worsens if the infection causes an increase in body temperature. Each one degree rise in temperature increases energy expenditure by elevating BMR by 13 % (Elia, 1995). Moreover, critically ill patients who develop hypoalbuminaemia as a result of chronic undernutrition have a higher incidence of diarrhoea than other critically ill hypoalbuminaemic patients (Hwang *et al.* 1994). In the cardiovascular system, myocardial atrophy, oedema and occasionally patchy necrosis of the myocardium can occur as can conduction abnormalities, reductions in cardiac output and work capacity (Heymsfield *et al.* 1978) although reassuringly, a recent study (Hill *et al.* 1997) found that, in patients who were critically ill, cardiac mass does not decrease

and function does not deteriorate after haemodynamic stability has been achieved. This was despite massive losses of N from the body. Endocrine impairments which occur as a result of undernutrition are complex, but include sick thyroid syndrome and primary gonadal dysfunction with reduced reproductive potential. Amenhorrhoea is frequently the presenting symptom in patients with anorexia nervosa. In the study by Haydock & Hill (1986) it was observed that adult surgical patients with both moderate to severe, or mild malnutrition, show an impaired wound healing response as measured by the hydroxyproline content of Gore-tex tubing implanted subcutaneously along the line of a needle track wound in the lateral aspect of the upper arm. The wound healing response was no different between the mildly undernourished, and the moderate to severely undernourished groups. This, the authors suggested, meant that the wound healing response is more dependent on the direction in which the patient is moving metabolically at the time of injury than on the degree of tissue lost. They also observed that age and the presence of malignancy did not appear to influence the wound healing response to the same degree. Additionally, impaired thermoregulation (Fellows *et al.* 1985), and impaired quality of life (Larsson *et al.* 1994; Jamieson *et al.* 1997) are observed in patients with impaired nutritional status.

Table 1.1.7 summarises some of the studies showing the effect of impaired nutritional status on clinical outcome. Despite the lack of consensus as to the optimal method of its assessment, protein-energy undernutrition is recognised to have serious implications for health and for recovery from illness or surgery. This is highlighted in recent reviews of the effects of impaired nutritional status on clinical outcome (Gallagher-Allred *et al.* 1996) and hospital costs (Tucker & Miguel, 1996).

In surgical patients, associations have been reported between poor nutritional status and higher post-operative infection risk (Busby *et al.* 1980; Detsky *et al.* 1987*a*; Bashir *et al.* 1990; Sagar & MacFie, 1994; Giner *et al.* 1996). In addition, associations have been reported between pre-operative weight loss and both increased post-operative complications (Studley, 1936; Klidjian *et al.* 1980; Meguid *et al.* 1988; Windsor & Hill, 1988; Reilly *et al.* 1988; Von Meyenfeldt *et al.* 1992) and increased post-operative mortality (Busby *et al.* 1980; Giner *et al.* 1996). The adverse effects of post-operative complications can result in longer post-operative convalescence times (Bastow *et al.*

1983; Lumbers *et al.* 1996) and increased duration of hospital stay (Bastow *et al.* 1983; Shaw-Stiffel *et al.* 1993). The average length of hospital stay is doubled in surgical patients who develop complications (McAleese & Odling-Smee, 1994).

Undernourished elderly patients have a higher risk for mortality (Sullivan *et al.* 1991), while more frequent re-admission to hospital has been reported in undernourished elderly patients who continue to lose weight after discharge from hospital (Friedmann *et al.* 1997).

Table 1.1.7. Effects of poor nutritional status on clinical outcome in hospital patients

Author	Patient group	*n*	Method of assessment	Clinical outcome in high risk group
Busby *et al.* (1980)	Elective gastrointestinal surgery	100	Prognostic nutritional index	Increased postoperative complications, major sepsis and mortality
Haydock & Hill (1986)	General surgery	66	Combination of factors including percentage weight loss from normal, BMI, MAC, TSF, serum albumin, transferrin, transthyretin	Impaired wound healing response
Detsky *et al.* (1987*a*)	Gastrointestinal surgery	202	Subjective Global Assessment	67 % suffered from major post-operative complications compared with 10 % overall
Sagar &MacFie (1994)	Cardiac valve replacement	936	BMI	Increased risk of major and septic complications
Potter *et al.* (1995)	Elderly	69	BMI, MAMA	Increased mortality and rate of discharge to residential care, decreased ability to go home
Muhlethaler *et al.* (1995)	Elderly	219	Weight, MAMA	Decreased overall survival and ability to live at home
Lumbers *et al.* (1996)	Fractured femur	60	Weight, TSF, MAMC, serum albumin and haemoglobin	Increased length of convalescence and dependence on walking frames
Giner *et al.* (1996)	Intensive care	129	Serum albumin, weight: height ratio	Increased complication rate, length of stay and "not discharged"
Giner *et al.* (1996)	Intensive care	129	Serum albumin, weight: height ratio	Increased complication rate, length of stay and "not discharged"
Naber *et al.* (1997)	Non-surgical		Subjective global assessment, nutrition risk index, Maastricht Index	Increased complication rate
Gariballa *et al* (1998*a*)	Elderly stroke	201	Serum albumin	Increased mortality rate

MAC, mid-arm circumference; TSF, triceps skinfold thickness; MAMA, mid-arm muscle area; MAMC, mid-arm muscle circumference.

1.1.5 Routine practices which affect the nutritional status of patients in hospital

A number of routine hospital practices which potentially adversely affect the nutritional status of patients were documented by Butterworth (1974) (**Table 1.1.8**). It is noteworthy, if rather depressing, to observe the prevalence of such practices in our modern hospitals (**Table 1.1.9**). If measurements (e.g. height and weight) on admission to hospital are not made, baseline nutritional status is not noted and deterioration in hospital goes undetected (Lennard-Jones *et al.* 1995).

Length-of-stay is markedly prolonged in undernourished adult patients who receive no oral intake after major gastrointestinal surgery, even in those without peri-operative complications, by comparison with those who are well-nourished (Shaw-Stiffel *et al.* 1993). Many post-operative patients have inadequate or no oral intake for more than 7 d (Townsend *et al.* 1997) and, even in well-nourished patients, this may affect the length-of-stay in hospital. In reducing length-of-stay and its associated costs, the early resumption of normal gastrointestinal function appears to be as important as the prevention of the deleterious effects of muscle wasting. Nutritional depletion, diagnosed by a decrease in mid-arm circumference by 3.6 % or more from admission to discharge occurred in 27 % of patients admitted to the geriatric and internal medicine wards of an acute care university hospital (Incalzi *et al.* 1996). Another more recent study observed that 21 % of elderly patients had an average daily in-hospital nutrient intake of less than 50 % of their calculated maintenance energy requirements (Sullivan *et al.* 1999). One of the major causes of undernutrition in institutions is not the failure to provide food, but to deliver it in a manner appropriate to the particular patient (Allison, 1995). Inflexibility imposed by economic constraints (McGlone *et al.* 1995) may result in mealtimes more suited to the hospital routine than to the patients' need for adequate nutrition. Meals are frequently unpalatable or served in a way that makes them inaccessible, either being wrapped or placed outside the reach of elderly or incapacitated patients. Portion size, the temperature of hot food and poor availability of hospital food between 18.00 and 08.00 hours have been identified as areas of patient dissatisfaction (Rushe & Moloney, 1998). If food is provided by non-nursing hospital staff, the nursing staff themselves are not always aware of patients' food intakes, nor of the physical

difficulties their patients may have in trying to eat the meals served. Unqualified nursing staff may not possess the knowledge and skill necessary to assist patients with complex chewing and swallowing difficulties and the involvement of unqualified personnel in meal selection is a matter for concern where risks of aspiration exist (McLaren *et al.* 1997). Food wastage during a 1-month period was observed to be 42 % in one ward caring for elderly patients (Stephen *et al.* 1997). The wastage of hospital food is known to have nutritional implications. In a study observing the diets of long stay elderly patients, wastage resulted in patients having inadequate intakes of vitamin C, riboflavin, vitamin B6, vitamin A, Ca, Fe, Cu, Zn and total energy although the amounts of these nutrients supplied by the kitchens and ward rations were adequate (Fenton *et al.* 1995). A comparison of wastage rates among patients choosing from the standard hospital menu and capable of independent feeding in two public, and one private hospital, showed that an average of 26 % of total energy was wasted (Heffernan & Moloney, 2000). Although there was no difference between public and private hospitals in the percentage of energy wasted, the greater provision of food in the private hospital meant that nutritional intakes were significantly greater for energy, Fe, Ca and vitamin C in the private hospital (Shirley & Moloney, 2000). To meet their nutritional requirements, patients may be dependent on receiving food from home, which may be contraindicated by the current hygiene regulations (McGlone *et al.* 1997). Finally, healthy eating guidelines, providing foods low in energy density and fat, may be in place throughout a hospital, which, although they may be appropriate for cardiac rehabilitation or coronary care wards and staff canteens, in general, are not appropriate on wards caring for elderly, surgical or cancer patients.

The provision of nutritional supplements and enteral feeds has been shown to improve nutritional status in patients in hospital (Potter *et al.* 1998*a*). The clinical and financial benefits of nutritional intervention are well documented in undernourished surgical patients (Bastow *et al.* 1983; Delmi *et al.* 1990; Beattie *et al.* 1998). More recently, beneficial effects of nutritional intervention have been observed in patients undergoing moderate to major gastrointestinal surgery, irrespective of nutritional status at time of surgery (Beier-Holgersen & Boesby, 1996; Keele *et al.* 1997; Doshi *et al.* 1998) although this has not been shown in all studies (Heslin *et al.* 1997; Watters *et al.* 1997). Improvement in functional status has also been observed but appears to apply

only to the inpatient phase of recovery (Keele *et al.* 1997; Jensen & Hessov, 1997), at least in surgical patients. The simple and inexpensive energy enrichment of normal food served to elderly patients significantly increased their energy intake (Gall *et al.* 1998*a*,*b*; Stephen *et al.* 1998) and both energy intake and body weights (Odlund Olin *et al.* 1996). Although neither of these studies sought to document clinical outcome, the provision of oral protein-energy supplements are associated not only with improvement in energy intakes and weight gain but also with a significant reduction in mortality in undernourished elderly patients (Potter *et al.* 1998*b*). Similar improvement in patient outcome may be achievable simply and inexpensively by enriching the energy content of normal foods.

Even when attempts are made to provide adequate nutrition therapy there are potential pitfalls in practice. Physiological and infectious complications (e.g. pneumothoraces and line infections) which arise from the inappropriate use of total parenteral nutrition in hospital patients have been documented (Nordenstrom & Thorne, 1994). Likewise, the results of the Veterans Affairs Study Group (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991) have been criticised, as those in whom TPN was essential were excluded from the study and those with an intact functioning gut should more appropriately have been given enteral nutrition (Moran & Jackson, 1993). The method of calculation of requirements and the quantities of substrate administered meant many patients were at risk of overfeeding or hyperglycaemia, both of which are likely to increase the incidence of complications. The discontinuation of enteral feeds because of arbitrarily defined residual volumes of gastric contents (McClave *et al.* 1992; Lin & Van Citters, 1997) decreases the likelihood of patients achieving adequate nutritional intakes. In many hospitals, nasogastric feeding is stopped if gastric residual volumes as low as 75-100 ml are observed, although it has been clearly shown (McClave *et al.* 1992) that in critically ill patients a gastric residual volume of up to 400 ml does not necessarily indicate gastric or intestinal intolerance. Close monitoring, and not discontinuation of feeding, should be the nutritional management of choice in these patients. Access to specialised nutrition support teams has been shown to eliminate many of these unsatisfactory practices with subsequent benefit to patient outcome (Martin, 1994; Wesley, 1995). However, in spite

of the evidence showing their benefit, the percentage of hospitals with a specialised nutrition team remains small (Payne-James *et al.* 1995).

The question of educating medical and nursing staff in nutrition has stimulated much interest and concern. Physicians who are specialists in nutrition remain few in number. There are, therefore, few advocates for change in medical schools' curicula (Intersociety Professional Nutrition Education Consortium, 1998). The Stratford Executive Group of the Nutrition Society proposes that nutrition should be recognised as a medical speciality, leading to structured nutrition training by various educational and clinical departments, improved structure of nutrition services and a focus on nutrition in clinical practice (Jackson, 1996). The King's Fund report (Lennard-Jones, 1992) highlights the role of nutrition screening and assessment on admission to hospital and recommends a multidisciplinary approach to it's use for all hospital patients. The study by McWhirter & Pennington (1994) observed that of fifty-five undernourished patients (defined by BMI, mid-arm muscle circumference and triceps skinfold thickness) reassessed before discharge from hospital, only ten were referred for nutritional intervention. Of those who were referred, the majority gained weight (**Table 1.1.9**). One could argue that this could have been due to careful referral with those most likely to gain weight being referred appropriately. Unfortunately, the authors of this study do not provide information on the outcome of those who gained weight compared with those who lost weight. Reilly *et al.* (1995) observed that no action to prevent further deterioration in nutritional status was taken in 64 % of patients (twenty-three of thirty-six) at moderate nutritional risk and in 30 % (twelve of forty) of those at high risk (defined by a nutrition risk score). Again, no data on patient outcome were provided. Criteria for referral for nutritional intervention need to be defined as well as the criteria to classify nutritional status. Many departments of nutrition and dietetics follow clinical standards of care which have been devised by their professional bodies or by groups such as the British and American Associations for Parenteral and Enteral Nutrition. However, the majority of medical and nursing staff who are in a position to refer patients are not familiar with these standards. A recent study, reporting the results of a questionnaire assessing knowledge about undernutrition among staff in a UK teaching hospital, concluded that current knowledge about the assessment and management of undernutrition among doctors, medical students, nurses and pharmacists is poor. The

authors recommended that teaching about undernutrition should be part of a formal curriculum with an examination, that it should be relevant to clinical practice and be taught by enthusiastic nutrition experts (Nightingale & Reeves, 1999).

In conclusion, it is vital that education about the nutritional needs of hospital patients and good hospital practice are promoted in medical and nursing schools. The beneficial effects of good practice and the detrimental effects of poor practice on clinical outcomes must be documented and incorporated into evidence based medicine.

Table 1.1.8. Common hospital practices potentially resulting in deterioration of nutritional status (adapted from Butterworth, 1974)

Diffusion of responsibility for the nutritional care of patients
Lack of interaction between medical, nursing, and nutrition and dietetic staff
Little emphasis on nutrition education in nursing and medical schools
Limited availability of methods to assess nutritional status
Failure to record patients' height and weight
Failure to observe and record patients' dietary intake
Frequent withholding of meals because of diagnostic tests
Delay in commencing nutritional support with prolonged use of glucose and saline i.v. fluids
Widespread ignorance of the physiological effects of different feeding routes and the composition of nutritional products. This results both in the inappropriate use of route of administration and the administration of enteral or parenteral feeds of uncertain composition or in inadequate amounts

Table 1.1.9. Documented practices which can potentially reduce the nutritional status of patients in hospital

Authors	Patients in whom nutrition indicators were measured (%)	Patients at nutritional risk (%)	Patients where nutritional therapy instigated (%)	Inadequate dietary intake during hospital stay	Weight change in hospital
Butterworth (1974)	Height in 44, weight in 77	No data	50	Average NBM 3d	66 % lost weight
McWhirter & Pennington (1994)	Undernourished 48	40	Undernourished 18	No data	70 % referred for nutritional intervention gained weight; 80 % not referred lost weight
George (1994)				No data	No data
1992 audit	26	60	57 of those at risk		
1994 audit	54	48	76 of those at risk		
Lennard-Jones *et al.* (1995)	63 % of nurses weigh patients, 11 % measure height 66 % doctors and nurses question recent food intake 53 % of nurses and 73 % of doctors question unintentional weight loss	No data	No data	No data	No data
Payne-James *et al.* (1992, 1995)	No data	No data	Hospital access to nutrition team: 10.5 % in 1988, 37.5 % in 1995	No data	No data
Giner *et al.* (1996)	Patients were measured for purpose of study	43	No data	In malnourished patients during 44 % of hospital stay	No data
Townsend *et al.* (1997)	No data	No data	No data	17 % of GI surgical patients	No data
Sullivan *et al.* (1999)	Patients were measured for purpose of study	No data	25 % received enteral supplements for 26 % of hospital stay; 7 % received enteral or parenteral nutrition	21 % of elderly patients	Greater weight loss in low nutrient group ($P = 0.02$)

NBM, nil-by-mouth; GI, gastrointestinal.

1.1.6 Conclusions

Although there are problems with the precise definition of undernutrition and debate about the factors which increase the risk of it's development, a significant proportion of hospital patients do have evidence of undernutrition on admission to hospital and continue to deteriorate nutritionally during their hospital stay. As a consequence, patient outcome is adversely affected in terms of increased complications and reduced quality of life. This, in turn, has cost implications for the health service and the efficient distribution of health care.

There is increasing recognition of the need for greater attention to be given to nutrition by both medical and nursing staff. This can be facilitated by routine nutritional screening and assessment on admission to hospital and at regular intervals during the hospital stay. Early identification of patients with poor nutritional status or with characteristics known to be associated with nutrition problems likely to result in nutritional depletion will enable nutritional intervention to be targeted at those who need it. The quality of care delivered to undernourished patients or those at risk of undernutrition can then be improved.

1.2 Nutritional assessment of hospital inpatients

1.2.1 Summary

While there is no consensus on the best method for the assessment of the nutritional status of hospitalised inpatients, there are a number of techniques available. These techniques can be divided into two types, those suitable for screening for nutrition risk on admission to hospital and those used to fully assess nutritional status. It is generally recognised that all techniques used in nutritional assessment have their limitations, but if these are recognised, nutritional assessment should identify the appropriate degree of nutritional intervention for an individual patient in a timely and cost-effective manner (Charney, 1995).

1.2.2 Introduction

Nutritional assessment is defined as a comprehensive evaluation to define nutrition status, including medical history, dietary history, physical examination, anthropometric measurements and laboratory data (American Society for Parenteral and Enteral Nutrition, 1995). The goals of nutritional assessment are to identify patients who have, or are who are at risk of developing, protein-energy or specific nutrient disorders, to quantify a patient's risk of developing malnutrition-related medical complications and to monitor the adequacy of nutritional therapy (Klein *et al.* 1997). Assessment of nutritional status is stated to be the first step in the treatment of malnutrition (Blackburn & Thornton, 1979). This is reiterated in a recent document published as a result of a conference sponsored by the American National Institutes of Health, American Society for Parenteral and Enteral Nutrition and American Society for Clinical Nutrition which states that 'The field of nutrition support is based on two closely related concepts: (1) nutrient depletion is associated with increased morbidity and mortality, and (2) if this association is causative, the prevention or correction of nutrient depletion can minimise or eliminate malnutrition-related morbidity and mortality' (Klein *et al.* 1997).

The need for nutritional assessment may be better understood if the deterioration in nutritional status is considered in stages. In the first stage, the availability of nutrients is inadequate due to poor diet, to increased requirements for nutrients, or to their reduced utilisation or excessive loss. This stage of undernutrition is best identified by a nutrition screening process which may be carried out by nursing or medical staff using a recognised protocol. Nutrient stores then become depleted resulting in impairment of physiological or biochemical processes. Finally, severe nutrient deficiencies result in cellular or tissue deterioration. The latter stages of undernutrition require formal nutritional assessment carried out by an individual (e.g. a dietitian) with appropriate expertise. In sick patients, the metabolic changes which occur in response to trauma, sepsis and malignancy, induced by stress hormones (e.g catecholamines, cortisol, glucagon and cytokines, tumour necrosis factor-α and interleukin 1 and 6) result in inappropriate mobilisation of fat and protein. The occurrence of insulin resistance further encourages a hypermetabolic state. Additionally, the normal passage and function of bile or pancreatic secretions may be hindered or the small intestinal mucosa may be altered quantitatively, (e.g. by intestinal resection), functionally, (e.g. by motility disorders and/or bacterial overgrowth) or histologically, (e.g. by coeliac disease) (Bettany & Powell-Tuck, 1995). Certain illnesses are associated with increased nutrient metabolism (e.g. diabetes mellitus and hyperthyroidism) while others are associated with excessive loss of nutrients (e.g. enterocutaneous fistulas).

Many of the studies which attempt to define nutritional variables that can be used to select undernourished patients do not take into account the severity of illness. If nutritional assessment focuses on physiological or biochemical function alone, it may be reflecting the severity of an illness that is not caused solely by inadequate intake or that can be reversed by nutritional supplementation (Detsky & Smalley, 1994). Systems for scoring the severity of illness should be used in clinical studies to stratify patients and in the evaluation of quality, quantity and costs of nutritional therapy in ill patients. A number of scoring systems are available which link severity of illness at presentation to outcome (Dionigi *et al.* 1986).

Severity of illness was the best discriminator for the development of nutrition-associated complications in one study of 231 elderly medical patients, who were

assessed (clinically and nutritionally) on admission to hospital and followed to 1 month after discharge. All nutritional assessment measurements (subjective global assessment, serum proteins, anthropometrics and risk indices) discriminated poorly between those with and without complications (Kinosian *et al.* 1994).

The treatment of undernutrition is best managed by using serial measurements of nutritional status to monitor the effects of therapy. More subtle degrees of undernutrition may still have an impact on outcome in seemingly well-nourished patients and the benefits of appropriate treatment for such patients need to be assessed in well designed studies.

Currently, there is no consensus on the best method for the assessment of the nutritional status of hospitalised patients. All the traditional markers of malnutrition lose their specificity in the sick adult (Jeejeebhoy *et al.* 1990). In choosing which variables to use, the reliability (sensitivity and specificity), the rapidity with which changes can be detected and the cost-effectiveness must be considered. It is generally recognised that all techniques used in nutritional assessment have their limitations, but if these are recognised, nutritional assessment should identify the appropriate degree of nutritional intervention for an individual patient in a timely and cost-effective manner (Charney, 1995).

1.2.3 Nutritional assessment techniques

The techniques used to nutritionally assess patients on admission to, or during their hospital stay can be divided into two types: nutrition risk screening and full nutritional assessment. Nutrition screening is defined as the process of identifying characteristics known to be associated with nutrition problems (**Table 1.2.1**). Its purpose is to identify individuals who are at risk of becoming malnourished or who are malnourished (Dougherty *et al.* 1995). For nutrition screening to be effective, it must use existing staff, be simple and inexpensive and be initiated early in a hospital stay. A number of techniques are in routine use (**Table 1.1.6**). A comprehensive review on screening for nutritional risk was recently published (Reilly, 1996). The main problem with using composite indices of nutritional risk, which incorporate several variables, is that nearly all patients will be found to have at least one abnormal measure (e.g. of sixty-four surgical patients assessed using a panel of sixteen variables, 97 % had at least one abnormal measure and 35 % had three or more abnormalities (Mullen *et al.* 1979)).

In a full nutritional assessment, consideration is given to both the measurement of body composition, specifically fat and muscle stores, and the effects of nutritional status on physiological function. However, in contrast to nutrition screening, a full nutritional assessment is time-consuming, requires specialist staff and is more costly. Despite the difficulties associated with nutritional assessment, the recent review of nutrition support in clinical practice from the American National Institutes of Health, the American Society for Parenteral and Enteral Nutrition and the American Society for Clinical Nutrition states that the most important goal of nutritional assessment is to quantify a patient's risk of developing malnutrition-related medical complications (Klein *et al.* 1997).

Table 1.2.1 Signs of nutritional risk in adult patients admitted to hospital (Adapted from the American Society for Parenteral and Enteral Nutrition, 1995)

Involuntary loss or gain before hospital admission of more than:
10 % of usual body weight within 6 months
5 % of usual body weight in 1 month
A weight of 20 % over or under ideal body weight
The presence of chronic disease
Disease induced increased metabolic requirements.
Alterations to the normal diet required as a result of recent surgery, illness or trauma
Receiving artificial nutrition support as a result of recent surgery, illness or trauma
Inadequate nutritional intake including not receiving food or nutrition products due to impaired ability to ingest or absorb food adequately for greater than 7 days

Table 1.2.2. Nutrition risk screening in hospitalised patients

Screening tool	Variables measured	Comment
Nutrition risk index (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991)	Percentage weight loss from normal; current serum albumin	The factors which affect the components of this score affect the score result (see * in **Table 1.1.5**); designed for surgical patients
Nutrition risk score (Reilly *et al.* 1995)	Percentage weight loss over past 3 months, BMI, food intake (appetite and ability to eat and retain food), stress factors (effect of medical condition on nutritional requirements)	Can be applied to all hospital patients, weight recall subject to error (see * in **Table 1.1.5**); validated against a sixteen item index designed to assess nutritional risk among community-dwelling elderly Americans
Subjective global assessment (Detsky *et al.* 1987*b*)	Percentage weight loss from normal, duration and degree of abnormal dietary intake (starvation, hypocaloric fluids, liquid diet, sub-optimal solid diet), gastrointestinal symptoms (anorexia, vomiting, diarrhoea, nausea), functional capacity (bedridden to full capacity) disease state, physical examination (loss of fat and muscle, presence of oedema or ascites)	Large subjective element to assessment; need specialised training†; technique more suitable for medical staff; designed for surgical patients
Prognostic nutritional index (Busby *et al.* 1980)	Serum albumin, transferrin, TSF, DCH	Impractical and expensive for routine pre-operative assessment; designed for surgical patients
Likelihood of malnutrition index (Coats *et al.* 1993)	TSF, MAMC, serum albumin, packed cell volume, total lymphocyte count, vitamin levels	Impractical and expensive for routine use; designed for use in all hospital patients
Instant nutritional assessment (Seltzer *et al.* 1979)	Serum albumin and total lymphocyte count	Neither of these measures are sufficiently sensitive to measure nutritional status in sick patients; designed for surgical patients

TSF, triceps skin-fold thickness; DCH, delayed cutaneous hypersensitivity; MAMC, mid-arm muscle circumference.
†Lupo *et al.* (1993)

1.2.4 Methods for nutritional risk screening

An effective nutritional screening tool will generally use a combination of objective and subjective factors. A number of methods are in routine use including the nutrition risk index (NRI), the nutrition risk score (NRS) and the subjective global assessment (SGA) among others (**Table 1.2.2**).

Probably, the best known of these methods is the NRI, developed by the Veterans Affairs Total Parenteral Nutrition Cooperative Study Group (1991) for use in their clinical trial evaluating the efficacy of perioperative total parenteral nutrition in malnourished patients undergoing major abdominal or thoracic surgery. The NRI relies on serum albumin concentration and percentage usual weight (**Table 1.2.3**). The NRI has been used to define nutritional risk in a number of recent studies where the effects of undernutrition (Reynolds *et al.* 1996) or nutritional intervention were investigated (Heslin *et al.* 1997; Keele *et al.* 1997). As a nutrition screening tool, a drawback of the NRI is the reliance on measurements of current and previous body weight, limiting its usefulness where there is a relative increase in body weight due to an increase in total body water, (e.g. in patients with hepatic, renal or cardiac disease). The use of patient recall for determining usual weight needs to be treated cautiously (Morgan *et al.* 1980; Rowland, 1990; DelPrete *et al.* 1992; de Fine Olivarius *et al.* 1997). Undernourished (BMI < 20 kg/m^2) and obese (BMI ≥ 30 kg/m^2) Irish patients attending their general practitioner were observed to report current weight incorrectly (Doyle *et al.* 1998). They may also be unable to report usual weight accurately. A BMI of under 18 kg/m^2 indicates the patient is at nutritional risk regardless of the NRI score. In these patients the NRI should not be used alone to assess nutrition risk (Stack *et al.* 1996). The NRI is open to further criticism as a nutrition screening tool for including serum albumin in its formula. Protein-energy malnutrition causes a decrease in the rate of synthesis of albumin, but this decreased synthesis has little impact on plasma concentrations, the metabolic response to stress being of greater importance (Klein, 1990; Doweiko & Nompleggi, 1991; Vanek, 1998). Despite these problems, the NRI on admission was shown to predict post-operative complications in surgical patients (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991).

Table 1.2.3. Nutrition Risk Index (NRI; Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991)

NRI = 1.519 x serum albumin (g/l)

+ 0.417 x (current weight/usual weight) x 100.

No nutritional risk: NRI score > 100

Borderline nutritional risk: NRI score > 97.5 - 100

Mild nutritional risk: NRI score 83.5 - 97.5

Severe nutritional risk: NRI score < 83.5

The NRS (**Table 1.2.4**) was developed in 1992 by the Department of Nutrition and Dietetics in Birmingham Heartlands Hospital to assess patients' risk at admission for nutritional deterioration in hospital (Reilly *et al.* 1995). Incorporated into the NRS are the variables weight loss (amount and duration over the previous three months), BMI (kg / m^2), food intake (appetite and ability to eat and retain food) and stress factors (effect of medical condition on nutritional requirements). The score is intended to be completed within 24 hours of admission, and repeated weekly during a hospital stay if the patient's condition has changed. Patients are categorised as at low, moderate or high risk for the development of undernutrition. Guidance for appropriate action is provided as a poster on each ward (Reilly, 1996), with nursing staff encouraged to provide nutritional supplements and monitor weight for patients at moderate nutritional risk. Patients deemed to be at high nutritional risk are highlighted for dietetic referral to enable more detailed nutritional assessment and for the provision of appropriate nutritional support. In a validation study (Reilly *et al.* 1995) the NRS correlated well ($P < 0.001$) with a sixteen-item nutrition risk index designed to assess nutritional risk among community dwelling elderly Americans (Wolinsky *et al.* 1990) and with the dietitian's clinical impression of the degree of risk of undernutrition ($P < 0.001$). Reproducible scores were produced between dietitians ($P < 0.001$) and between dietitians and nursing staff ($P < 0.001$). The NRS has been adopted as a national standard in the United Kingdom (Sizer *et al.* 1996) despite some criticisms that the age and mental status of the patient are not considered. It has also received some criticism

for not considering a greater number of objective factors. A number of screening tools based on the NRS have been developed for different patient groups (Davison, 1996; Bryan *et al.* 1998; Cooper, 1998; Goudge *et al.* 1998; Ward *et al.* 1998; Pattison *et al.* 1999). However, a version adapted for use in surgical patients has not yet been developed.

A third well known and respected method of assessing nutritional risk is SGA. SGA is a clinical technique with subjective elements, and assesses nutritional status based on features of the patient's history and physical examination. The history includes assessment of weight loss in the previous six months, dietary intake in relation to usual pattern, presence of gastrointestinal symptoms, and functional capacity. The physical examination assesses loss of subcutaneous fat, muscle wasting and loss of fluid from the intravascular to the extravascular compartments. The basis for the assessment is to determine whether there is a true restriction of food intake and/or absorption, and whether there are associated effects on function and body composition (Jeejeebhoy *et al.* 1990). SGA divides patients into three classes, well nourished, moderately (or suspected of being)-malnourished and severely-malnourished (Detsky & Smalley, 1994). The pattern of weight loss, more than the underlying diagnosis, appears to be the most important factor in determining outcome (Detsky *et al.* 1987*b*). SGA has been shown to be 78 % sensitive and 70 % specific in predicting infection in surgical patients (Baker *et al.* 1982). Clinicians can therefore detect abnormalities that place patients at high risk. Interobserver reproducibility was found to be 81 % between two physicians, while a high degree of interobserver agreement was found between trained clinicians and trained nurses (κ 0.78, $P < 0.001$; Detsky *et al.* 1987*b*). Using receiver operating characteristic curves SGA was found to have the best combination of sensitivity (0.82) and specificity (0.72) when compared with six other methods of nutritional assessment in the prediction of risk in surgical patients (Detsky *et al.* 1984). SGA has been criticised, however, as it has been found that untrained operating surgeons could not globally assess patients at high risk for the development of complications beyond those who were quite obviously at very high risk (Lupo *et al.* 1993). Abnormal nutritional variables could not be detected clinically. Discordance occurred in the classification of patients as mildly- or moderately-malnourished. This subjective weighting is seen as one limitation of a technique more suitable for clinicians than for nursing staff.

In an attempt to improve the sensitivity and specificity of individual tests used for pre-operative nutritional assessment, a number of other indices have been developed which incorporate several variables. However, almost all tests rely on serum proteins for their power, and do not use additional methods to evaluate the severity of illness. Among these formulas are the prognostic nutritional index (Mullen *et al.* 1980) which constructs anthropometry, including measurement of triceps skinfold, delayed hypersensitivity skin testing, serum albumin and transferrin, into a formula intended for pre-operative use to identify patients at increased risk of post-operative complications who may benefit from nutritional intervention. The likelihood of malnutrition index (Coats *et al.* 1993) is another formula which considers anthropometrics, including triceps skin-fold and mid-arm muscle circumference, serum albumin, packed cell volume, lymphocyte count and vitamin levels. Neither of these formulas have been shown to have advantages over the simpler methods of assessment of nutritional risk, and are too impractical and expensive for routine pre-operative use. Finally, the instant nutritional assessment (Seltzer *et al.* 1979) considers serum albumin and total lymphocyte count only, neither of which have been shown to be sufficiently sensitive in measuring the nutritional status of sick patients.

Table 1.2.4. The Nutrition Risk Score (Reilly *et al.* 1995)

Patient's Name:_____

Hospital Number:_____ **Ward:**_____

Date of Birth:_____ **Date:**_____

Weight :_____ **Height/Length:**_____

Please circle relevant score. Only select one score from each section.
Select the highest score that applies.

	SCORE
1. WEIGHT LOSS IN LAST 3 MONTHS(Unintentional).	
No weight loss	0
0 - 3 kg weight loss	1
> 3 - 6 kg weight loss	2
6 kg or more	3
2. BMI (Body Mass Index)	
20 or more	0
18 or 19	1
15 - 17	2
Less than 15	3
3. APPETITE	
• Good appetite, manages most of 3 meals / day (or equivalent)	0
• Poor appetite, poor intake, leaving > half of meals provided (or equivalent)	2
• Appetite nil or virtually nil, unable to eat, NBM (for > 4 meals)	3
4. ABILITY TO EAT / RETAIN FOOD	
• No difficulties eating, able to eat independently. No diarrhoea or vomiting.	0
• Problems handling food, e.g. needs special cutlery. Vomiting / frequent regurgitation / mild diarrhoea	1
• Difficulty swallowing, requires modified consistency. Problems with dentures affecting food intake. Problems with chewing affecting food intake. Moderate vomiting and / or diarrhoea. Needs help with feeding.	2
• Unable to take food orally. Unable to swallow (complete dysphagia). Severe vomiting and / or diarrhoea. Malabsorption	3
5. STRESS FACTOR	
• No stress factor (includes admission for investigations only)	0
• Mild — Minor surgery / minor infection	1
• Moderate — Chronic disease. Major surgery. Infections. Fractures. Pressure sores / ulcers. CVA. Inflammatory bowel disease. Other gastrointestinal disease.	2
• Severe — Multiple injuries. Multiple fractures / burns. Multiple deep pressure sores / ulcers. Severe sepsis. Carcinoma / malignant disease.	3

TOTAL ☐

1.2.5 Methods of nutritional assessment

In a formal nutritional assessment, the assessment measures used when a patient is admitted to hospital include pre-admission weight loss, anthropometry, serum proteins and functional status (**Table 1.1.5**). Attention must also be given to the disease state, duration of symptoms, nutrient intake and the presence of anorexia, dysphagia or gastrointestinal symptoms (American Society for Parenteral and Enteral Nutrition, 1995).

Pre-admission weight loss as a determinant of outcome and treatment

Weight loss at the time of hospital admission reflects the energy deficit over the period before admission to hospital. Although the pathogenesis of pre-admission weight loss has not been precisely defined, the clinical disease state, depression, loss of appetite, pain and swallowing difficulties are likely to contribute to its development. The degree of weight loss believed to be clinically significant was defined by Blackburn *et al.* (1977) (**Table 1.2.5**). It is generally believed that more than 10 % weight loss in the 6 months, or more than 5 % in the 1 month, before admission to hospital is clinically significant. When more than 20 % of body weight has been lost, accompanying physiological impairment (e.g. reduced respiratory function) is invariably present (Hill, 1992). Many patients with weight loss between 10 % and 20 % are undernourished to a degree that may affect clinical outcome significantly. The rate and timing of weight loss is postulated to be a more important predictive factor for the development of post-operative complications than the underlying diagnosis (Detsky *et al.* 1987*b*).

Table 1.2.5. The influence of duration on severity of weight loss (adapted from Blackburn *et al.* 1977)

Duration	Clinically significant weight loss	Severe weight loss
1 week	1 - 2 %	> 2 %
1 month	5 %	> 5 %
3 months	7.5 %	> 7.5 %
6 months	10 %	> 10 %

Only patients with both clinically significant weight loss (i.e. more than 10 % over 6 months) and measurable physiological impairment (e.g. reduced hand-grip strength and respiratory function) were shown to have an increased incidence of post-operative complications (e.g. intra-abdominal sepsis, septicaemia, anastomotic leakages, wound dehiscence or infection, pulmonary emboli, pneumonia, myocardial infarction, cerebrovascular accidents, urinary tract infection and death) (Windsor & Hill, 1988). These patients were older (mean age 69 (SD 2.3) years) and had smaller muscle reserves. In the elderly, post-operative mortality worsens as nutritional status deteriorates (Bastow *et al.* 1983; Muhlethaler *et al.* 1995). The authors (Windsor & Hill, 1988) conclude that only those patients who have impairment of important bodily functions (e.g. respiratory function) in addition to more than 10 % weight loss should be considered for pre-operative nutritional repletion. Improvement in a number of functional indices (e.g. hand-grip strength and respiratory function) has been shown with pre-operative nutritional support (Church *et al.* 1984; Haydock & Hill, 1987).

In patients with chronic obstructive airways disease, weight loss in the preceding year correlated significantly with the need for in-patient treatment (Braun *et al.* 1984) while wasting was shown to be an independent risk factor for mortality in patients with chronic heart failure (Anker *et al.* 1997). Moreover, a prospective study which examined percentage weight loss on admission to hospital, serum albumin, total lymphocyte count, total Fe-binding capacity and serum cholinesterase activity concluded

that pre-admission weight loss of 10 % is the only index with a prognostic performance worth evaluating in the pre-operative nutritional assessment (Gianotti *et al.* 1995).

Anthropometric assessment of nutritional status

Anthropometry is defined as the scientific study of the measurements of the human body (Fowler & Fowler, 1991). There is currently no anthropometric measurement considered to be completely accurate and practical for use in the clinical setting although recent studies suggest that measures such as BMI, mid-arm muscle circumference and triceps skinfold thickness can be used (McWhirter & Pennington, 1994; Edington *et al.* 1996, 1997). Anthropometric data can be used in two ways when assessing a patient's nutritional status: (1) to compare the measured values with standard values derived from population surveys. The standards routinely used in most hospitals are derived from measurements made in the early 1970s of healthy Caucasian Americans (Bishop *et al*, 1981; Frisancho, 1981) while reference data derived from people in South Wales in the UK, published in 1984, are frequently used for defining the nutritional status of those aged 65 years or more (Burr & Phillips, 1984), particularly in the UK and Ireland. A major problem occurs when the patient's measurements start out well above the normal range but he deteriorates nutritionally for some time and so measurements now classify the patient as normal (Smith & Mullen, 1991). Anthropometric measurements can also be used (2) to compare serial measurements over time in the same patient. If anthropometry is used to define malnutrition, it has been recommended that at least three different anthropometric criteria should be observed (e.g. height, weight, mid-arm circumference) in classifying the subject's nutritional status (Jeejeebhoy *et al.* 1990).

BMI is the simplest technique for assessment of nutritional status, and requires the measurement of height and weight (for calculation of BMI, knee height (Chumlea *et al.* 1985; Han & Lean, 1996) and demi-span (Kwok & Whitelaw, 1991; Reeves *et al.* 1996) can be used as surrogates for height in adults if height cannot be measured). A small survey of Irish patients attending their general practitioner showed most patients reported height with reasonable accuracy (Doyle *et al.* 1998). However, the same survey reported that although normal and overweight Irish patients report weight

accurately for the purpose of estimation of BMI, those who are undernourished or obese do not do so.

Knowledge of weight loss alone does not reveal the changes in body composition with loss of weight. Body reserves of fat can be estimated by measuring skinfold thickness over the triceps and biceps muscle or by measuring fat at the subscapular and supra-iliac sites. Percentage body fat can be calculated from these four measurements and compared to normal ranges (Durnin & Womersley, 1974). Muscle mass can be calculated from muscle circumferences, measured at the mid-point of the upper arm and at the maximum circumference of the calf. The minimum muscle mass compatible with survival was established as an arm muscle area of between 900 and 1200mm^2. Muscle mass can predict clinical outcome when the target is death secondary to fuel depletion, but provides only a background index in the trauma or surgical patient who is prone to infection or wound dehiscence (Heymsfield *et al.* 1982*a*).

It is vitally important that anthropometric measurements are carried out following recognised guidelines (World Health Organisation, 1995). The physiological changes that occur with ageing mean that the usual anthropometric assessment parameters used in younger patients may not be appropriate in assessment of nutritional status of the elderly (see **Chapter 1.4.8**). The redistribution of body fat with age renders skinfold thickness measurements less valid in the elderly compared to younger persons (Taren & Schler, 1990). Although there have been attempts to derive anthropometric tables of normal values for the elderly (Chumlea *et al.* 1986; Falciglia *et al.* 1988; Burr & Phillips, 1984; Rea *et al,* 1997), there are as yet no universally accepted 'gold standard' measurements for this population. This may well be impossible, because population reference norms may differ between countries, both for young and elderly populations and make accurate comparisons impossible (World Health Organisation, 1995; Launer & Harris, 1996). Normal values may need to be established, therefore, that are age, sex and population specific.

Since the publication of the paper by McWhirter &Pennington (1994), a widely accepted definition of undernutrition in clinical practice is a BMI below 20 kg/m^2 with a

mid-arm muscle circumference or triceps skinfold thickness less than the 15th percentile, using reference data from the USA (Bishop et al. 1981) for those aged under 65 years, and from South Wales (Burr & Phillips, 1984) for those aged 65 years or more. However, the prevalence of obesity is known to be increasing worldwide, including in Ireland (Lee & Cunningham, 1990; Kilkenny Health Project, 1992), the UK (Prentice & Jebb, 1995; Jebb, 1999) and the USA (Galuska *et al.* 1996; Van Itallie, 1996; Flegal *et al.* 1998). An even greater prevalence of obesity in surgical patients than in the general population has been documented (Riley & Burke, 1997). Many patients with weight loss or other clinical or nutritional problems will not be detected if a BMI below 20 kg/m^2 is the sole determinant of patients who require nutritional intervention to prevent undernutrition-related complications. Landi *et al.* (1999) associated a BMI below 22 kg/m^2 with 1-year survival in older people living in the community. Further confusion may be caused by the recent reclassification of BMI (World Health Organisation International Obesity Task Force, 1998). A normal or ideal BMI is now defined as 18.5 - 24.9 kg/m^2 (Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults, 1998) based on assessment of risk of a number of chronic diseases (e.g. hypertension, dyslipidaemia, type 2 diabetes, CHD, stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and endometrial, breast, prostate and colon cancers). Schols *et al.* (1993) showed that depletion of fat-free mass could occur in patients apparently maintaining weight, and that it was depletion of fat-free mass that was important functionally. In addition, the anthropometric reference data routinely used in clinical practice in the UK and Ireland were derived from measurements taken over 20 years ago and no longer accurately define our current nutritional status (Finch *et al.* 1998). New reference data detailing the normal anthropometric distribution of all population age groups may be required so that thresholds suitable for nutritional assessment in clinical practice can be agreed. A number of recent studies in the UK (Paul *et al.* 1998; Savage *et al.* 1998) which have examined the current anthropometric status of babies, and compared it with the reference data used routinely (Tanner & Whitehouse, 1975) have drawn attention to this problem in that age group.

Biochemical assessment of nutritional status

A number of comprehensive papers have assessed the impact of disease on the biochemical markers of both macro- and micronutrient status in hospitalised patients (Shenkin *et al.* 1996; Shenkin, 1997, 1998). The 'ideal' protein to measure would have a rapid rate of synthesis, a small total pool, a short half-life, a rapid catabolic rate and few factors that alter its distribution or catabolism (Fischer, 1982) and a number of serum proteins have been extensively investigated to determine their validity in the assessment of nutritional status. These include serum albumin, transferrin, transthyretin, retinol-binding protein, somatamedin C and fibronectin. In hospitalised patients, however, no single marker or group of tests can be recommended to reliably assess nutritional status (Young *et al.* 1990). In Western society, low plasma protein levels usually do not usually mean a lack of nutrients but reflect an inflammatory response (e.g. acute or chronic infection or inflammation). Serum protein levels vary in response to medical conditions (e.g. serum transferrin is reduced in liver disease, protein-losing enteropathy and nephropathy, chronic infections, uraemia and acute catabolic states, and increase under other conditions (e.g. pregnancy, oestrogen therapy and Fe-deficiency anaemia); serum transthyretin is increased in patients with chronic renal failure, serum retinol-binding protein is low in vitamin A deficiency and both serum transthyretin and serum retinol-binding protein are reduced by acute catabolic states, surgery and hyperthyroidism). If we define undernutrition using anthropometric criteria, not all undernourished patients have low serum protein levels. For example, many patients with anorexia nervosa, although severely undernourished (i.e. they may have a BMI below 16 kg/m^2 and muscle and fat stores below the 5th percentile) do not necessarily have a low serum albumin.

A large proportion of patients admitted to hospital are elderly. Many of the biochemical and haematological measurements used in assessing nutritional status also change with age and medication (Taren & Schler, 1990). It is now also realised that ageing is characterised by increasing concentrations of glucocorticoids and catecholamines and decreasing production of growth and sex hormones, a pattern similar to that seen in patients with chronic stress (Yeh & Schuster, 1999). These

changes that occur with ageing need to be fully reviewed in order to use biochemical measures to accurately assess the nutritional status of elderly patients.

When biochemical measurements are used, patient outcome may relate to disease severity as opposed to nutritional status (e.g. although immune function is depressed in undernourished patients, it is also depressed in ill patients who are not undernourished (Dwyer *et al.* 1993)). The measurement of an acute-phase reactant, such as C-reactive protein as an assessment of acute infection or inflammation, can assist in the interpretation of blood protein measurements in the sick patient admitted to hospital (Benjamin, 1989), although there is some evidence now that C-reactive protein can be used as a marker for chronic inflammation, at least in type 1 diabetic patients (Schalkwijk *et al.* 1999). A post-operative reduction in albumin has been observed to be linked to the surgery-induced increase in C-reactive protein (Reynolds *et al.* 1997) and may predict those patients likely to have a turbulent recovery and a possible need for nutritional intervention. The measurement of α-1-acid glycoprotein as a marker of chronic inflammation has been discussed in the literature and a proposal made that it should be used with C-reactive protein, albumin and transthyretin as a prognostic inflammatory and nutritional index (Inglenbleek & Carpentier, 1985). Correlations with other acute phase proteins have been reported (Thurnham, 1997). However, mean serum α-1-acid glycoprotein levels in elderly subjects were observed to be higher than in a younger reference group (Kawerk *et al.* 1991). As approximately 40 % of patients currently admitted to hospital are elderly, more research is required on the use of α-1-acid glycoprotein as an index of chronic inflammation in this age group before it could be recommended for routine use as a marker of chronic inflammation in patients in hospital.

Despite the problems associated with biochemical measurements, a review of a number of studies of between fifty and 2060 patients has related low levels of the serum proteins albumin and transferrin, and the failure of nutritional support to increase serum albumin, with poor outcome (Dempsey *et al.* 1988). Measurement of the other proteins have not been shown to be superior to albumin in predicting outcome in sick patients or in identifying those who might benefit from nutritional support (Klein *et al.* 1997; Vanek, 1998) and are, in general, more expensive to measure. Albumin, therefore,

remains the most widely used biochemical marker to predict outcome in sick patients, with decreased levels generally representing one component of the metabolic response to stress or illness.

Functional status as a determinant of nutritional status and clinical outcome

The objective markers of nutritional assessment (e.g. weight loss and anthropometric measurements) are sometimes criticised as they do not always reflect physiological function. These functional effects include muscle weakness, particularly of respiratory muscle, loss of immune function, poor wound healing, impaired thermoregulation, depression, irritability and fatigue. Physiological dysfunction may be due to undernutrition and may improve with re-feeding. Metabolic and functional (e.g. muscle cell membrane potential) changes occur earlier on initiation of energy and protein restriction and they respond more quickly than anthropometric parameters to re-feeding (Jeejeebhoy *et al.* 1990). Hypoenergetic feeding results in a fall in muscle membrane potential and in the concentration of intracellular ionic K, not reversible by K supplementation (Pichard *et al.* 1991). It has been proposed that the functional effects of undernutrition (e.g. impaired respiratory function) are more important than subnormal measurements of serum proteins as an index of surgical risk (Windsor *et al.* 1988). Functional deficits are evident in healthy normal-weight adults who voluntarily restrict their food intake after about fifteen days of semi-starvation (American Society for Parenteral and Enteral Nutrition, 1993). It is probable that in sick, hospitalised patients, functional impairments occur more rapidly.

Muscle function may be assessed by voluntary hand-grip, by electrical stimulation of the adductor pollucis muscle or by pulmonary function testing. Voluntary hand-grip has been shown to be more sensitive than other measurements of nutritional status (weight loss, weight related to height, skinfold thickness, arm-muscle circumference, and plasma proteins) in the prediction of post-operative complications and mortality (Klidjan *et al.* 1980). Values below 85 % of standard for age and sex were found to be 74 % sensitive as a prognostic indicator for post-operative complications (e.g. chest infection, local sepsis, wound infection or dehiscence,

prolonged ileus, obstruction, thromboembolism, renal failure) and mortality in a study of ninety patients undergoing major surgery on the gastrointestinal tract (Webb *et al.* 1989). The authors conclude that a grip strength below the recommended cut-off for age and sex suggests that the patient is in a high-risk group and demands further investigation of nutritional status. A recent study (Keele *et al.* 1997) showed that post-operative gastrointestinal surgical patients given oral nutritional supplements (Fortisip, Numico Nutritional Healthcare, Zoetermeer, The Netherlands) *ad libitum* in hospital, maintained hand-grip strength in comparison with those patients who did not receive nutritional supplements. This applied only to the in-patient phase of the study with no effect noted during the out-patient phase; this finding was confirmed in a Danish study (Jensen & Hessov, 1997) where, in a group of gastrointestinal surgical patients given nutritional intervention during the post-operative convalescent period, small changes in weight and lean body mass did not appear to affect physiological function or fatigue (measured by a visual analogue scale (Christensen *et al.* 1982)). However, the relationship between nutritional status and hand-grip strength requires further clarification as significant changes in body composition were not reflected in improvement or deterioration in hand-grip strength in a study of general surgical patients which aimed to evaluate a combination of anthropometric (weight/height, mid-arm muscle area, triceps skinfold thickness), biochemical (serum albumin, total protein, creatinine/height) and functional (hand-grip strength) variables to assess nutritional status (Forse & Shizgal, 1980).

As with the anthropometric reference data, a need for reference data for grip strength appropriate to the population being studied may be required. The reference data currently in use were derived from healthy patients (Klidjian *et al.* 1980) and from staff at a British hospital and self-caring volunteer residents at two institutions, judged by the authors to provide nutritious food for their patients (Webb *et al.* 1989). If hand-grip strength is to be reliably used to determine nutritional status or post-operative risk, age and sex specific data derived from healthy members of the population being studied may be required. Furthermore, the effects of medication (e.g. opiates, sedatives, etc.) and disease on hand-grip strength should be fully evaluated before it is routinely advocated as a measure of functional status in all patient groups.

Much work on lung function and the strength of intercostal muscles has been carried out in patients with chronic obstructive pulmonary disease. These studies were recently reviewed (Congleton, 1999). The studies of respiratory muscle strength and malnutrition in chronic obstructive pulmonary disease have given conflicting results. Some groups have shown reduction in inspiratory and expiratory muscle strength in underweight patients (Donahoe *et al.* 1989; Gray-Donald *et al.* 1989; Schols *et al.* 1991). However, other groups have shown that body weight makes only a small contribution to respiratory muscle strength, which is more affected by the degree of mechanical disadvantage of the respiratory muscles due to hyperinflation (Lewis *et al.* 1986; Knowles *et al.* 1988; Sauleda *et al.* 1998). However, even in this patient group, it is recognised that peripheral skeletal muscles are functionally affected. Efthimiou *et al.* (1988) showed a significantly reduced hand-grip strength in underweight chronic obstructive pulmonary disease patients. Schols *et al.* (1991) showed a correlation between the percentage ideal body weight and walking distance.

Finally, a number of more subjective methods have been recommended to assess physiological function (Hill, 1992). These include observing the patient's activity around the ward, asking the patient to squeeze the doctor's index and middle fingers for at least 10 s and getting the patient to blow hard holding a strip of paper 100 mm from the lips to assess respiratory muscle function. Patient's self-assessment of fatigue, using a visual analogue scale has also been recommended (Christensen *et al.* 1982), and recently used as a measure of function in a number of studies assessing the effects of post-operative nutritional intervention (Jensen & Hessov, 1997; Keele *et al.* 1997; Watters *et al.* 1997). Another measure of physiological function is a modified version of the Norton scale (Ek & Bjurulf, 1987) which consists of seven subscales: mental condition, activity, mobility, food and fluid intake, incontinence and general physical condition. This scale has been used in recent intervention studies examining the effects of nutritional supplements (Unosson *et al.* 1992) and energy enriched foods (Odlund Olin *et al.* 1996) on clinical outcome.

1.2.6 Conclusions

Impaired nutritional status affects outcome in hospital inpatients. This relationship has been shown in numerous studies. There is increasing recognition of the need for greater attention to be given to nutrition by both medical and nursing staff. This can be facilitated by routine nutritional screening and assessment on admission to hospital and at regular intervals during the hospital stay. Nutrition risk screening on admission is useful to detect those patients most likely to have increased post-operative infectious complications, greater weight loss in hospital, a prolonged stay in hospital and reduced ability to return to their own home. Early identification of patients with poor nutritional status or with characteristics known to be associated with nutrition problems likely to result in nutritional depletion will enable nutritional intervention to be targeted at those who need it. The quality of care delivered to undernourished patients or those at risk of undernutrition can then be improved. A full nutritional assessment should be carried out early in the hospital stay in patients found to be at high risk on nutrition screening. The nutritional assessment should include a number of assessment measures. Details of weight, particularly acute weight loss, appetite, ability to eat, serum albumin are important indicators of the risk of post-operative complications and probable need for nutritional intervention.

For the future, there is an urgent need for honest discussion on the methods of nutritional assessment and the variables used to classify nutritional status in specific groups of patients. Clear distinction must be made between undernutrition, and those at risk of nutritional deterioration. Guidance must be provided on what reference data are appropriate for comparative purposes. Should we all use a cut-off BMI of 20 kg/m^2 to define undernutrition, regardless of how this compares with the anthropometric profile of the normal healthy population? Is there a need for comparison to the current nutritional status of the healthy population in every study? Should we use different anthropometric and biochemical cut-off values for different age groups? Should we consider weight loss, and what degree of weight loss should we accept as detrimental? Should we consider functional status? How can we truly distinguish between measurements that reflect disease state and nutritional status? What criteria should be

used to decide if referral for dietetic management is necessary? All these questions need to be fully discussed in an open and honest way, taking clinical outcomes into consideration. The current confusion over appropriate assessment criteria impedes both the recognition and provision of nutritional support to those who would most benefit from it. Furthermore, unless this problem is addressed, it will remain impossible to monitor the problem of undernutrition using criteria which allow for comparison between centres and for changes over time. Undernutrition will continue to be both unrecognised and untreated, resulting in reduced clinical outcomes and increased hospital costs.

1.3 Nutritional status of the elderly

1.3.1 Summary

A major challenge facing society is how we can maintain health and quality of life in an ageing population. Although maximum life expectancy has not changed substantially, average life expectancy has increased greatly in the past century. This reflects improvements in mortality in infancy and young adulthood, resulting in a much greater proportion of people surviving to older age. Optimal nutritional status is a critical component of good health at any age but requires particular attention in the older age group. A variety of age-related morbidities and dysfunctions may interfere with the maintenance of good nutritional status. The detection and treatment of nutritional disorders in older persons is an issue of major concern and a number of primary and secondary preventative strategies have been developed to identify undernutrition or the risk of undernutrition in older persons. These involve the process of nutrition screening which is complicated by the heterogeneity of the health status of the older population and the impact of both acute and chronic illness on nutritional assessment.

Despite the availability and usage of nutritional screening methods in free-living, hospital and nursing home populations, no method has yet been demonstrated to have test characteristics sufficient to justify its universal use. Data linking undernutrition identified at earlier stages to adverse health outcomes are few and usually have not considered other factors (e.g. diseases) that may contribute to these outcomes, nor is there good evidence that these outcomes are nutritionally mediated. Furthermore, there is only scanty evidence to suggest that persons identified early as being nutritionally at risk will benefit from intervention although there are many who advocate this view. The goal of attempting to develop nutritional screens should be pursued however, as further investigation will benefit populations and help elucidate the mechanisms by which undernutrition confers adverse outcomes.

1.3.2 Introduction

Many Western societies, including Ireland, have experienced a considerable increase in the number of elderly in the population. This has created a need for additional knowledge of age-related changes relevant to nutrition, which has importance in the treatment and prevention of disease and in maintaining good health and quality of life in an ageing population (Gariballa & Sinclair, 1998). Ageing, disease, lifestyle and environmental factors account for many of the changes observed in older individuals. It is well recognised that with advancing age there is a high incidence of chronic diseases, and evidence points to the importance of nutrition in the development, susceptibility and outcome of these diseases. There is no doubt that good nutrition contributes to the health and well-being of the elderly and to their ability to recover from illness (UK Department of Health, 1992). There are, however, problems in recognising undernutrition in the elderly because of physical and biochemical changes which take place as part of normal ageing.

The heterogeneity of the older adult population present very real difficulties in carrying out research in this population group. Ideally they should be divided into three groups; old (65 - 75 years), old, old (75 - 85 years) and oldest, old (over 85 years). The recently published Recommended Dietary Allowances (RDA) for Ireland (1999) state that 'there is no evidence that the nutrient requirements (as distinct from the energy requirements) of the elderly (over 65 years) differ from those of adults, and except for vitamin D, no different values are given'. However, there is need for further studies on the nutrient requirements of sub-groups within the elderly population, in particular those aged over eighty-five years. There is also a need for normative data and for longitudinal studies of healthy elderly persons to determine fully which changes are truly associated with ageing and which are due to pathological conditions or disease states. In addition, greater effort should be made to educate health professionals on the complexities of nutritional assessment and management in the older adult.

1.3.3 Healthy ageing

A major challenge facing society is how we can maintain health and quality of life in an ageing population. In general, older adults in good nutritional status and free from disease should show haematological, electrolyte and serum protein levels within the normal reference range (Granieri, 1990). Maximum life expectancy has not changed substantially, but the average life expectancy has increased greatly in the past century (Khaw, 1997). This reflects profound improvements in mortality in infancy and young adulthood, resulting in a much greater proportion of people surviving to older ages. The rise in the numbers and proportion of older people has led to concern about societal, including health consequences. Increasing age is associated with increasing disability and loss of independence, with functional impairments such as loss of mobility, sight, and hearing. It has been estimated that at age sixty, about a quarter of the remaining years must be lived with some disability (Murray & Lopez, 1997*a, b*). If the average onset of ill-health is unchanged, increased life span means more years of ill health before death for an individual and a greater proportion of people with disability. However, some believe that the onset of ill health may be delayed to a greater extent than the increase in life span (Fries, 1980, 1996). This is confirmed in reports from Japan, the United States and Europe which show that people are living not only longer but more healthily (Butler, 1997). However, it seems to occur most frequently in those of higher socio-economic status, with more education or who are more physically active (Fries, 1996). Healthy life expectancy is determined by a relatively limited number of chronic conditions that become more common with increasing age. These include cardiovascular disease, such as coronary heart disease and stroke; musculoskeletal diseases, such as arthritis and osteoporosis leading to fractures; neurodegenerative disorders, such as memory loss and dementia; neuropsychiatric disorders, such as depression; cancers and other degenerative conditions, such as visual loss from cataracts, macular degeneration and glaucoma, and hearing loss. Reduction or postponement of these conditions may not only reduce premature death and increase longevity but, may also decrease the period of illness so that people can remain healthy until near death. The great variation in rates of chronic diseases in different communities shows that a substantial proportion of the chronic diseases associated with

ageing can be prevented, or at least postponed. Secular trends and changes with migration show that these differences are likely to be due mainly to environmental rather than genetic factors. Wide regional and social class variations exist for total mortality, with British men in social class V having about twice the mortality of those in social class 1 (Khaw, 1997).

Many of the diseases that are associated with ageing reflect deterioration in physiological functions. The biological process of ageing and its clinical manifestations reflect the interaction between genetic inheritance and the environment. It is well recognised that huge variation in phenotype exists in people with the same genes and that gene expression and function is modified by environmental factors. Thus, while the maximum life span is probably genetically determined, the likelihood of reaching that life span in good health seems to be largely determined by environmental and lifestyle factors (**Tables 1.3.1** and **1.3.2**). Nutrition clearly has a key role in health throughout life -from maternal nutrition and foetal metabolic programming, to childhood nutrition affecting growth and development, to diet in later life influencing maintenance of health. Although it is not known precisely which nutrients are responsible for which particular actions, the evidence is overwhelming that particular dietary patterns do relate to good health. The 1994 recommendations of the UK Committee on Medical Aspects of Food Policy emphasise the importance of adequate intake of nutrients such as vitamins and minerals and of n-3 fatty acids, which can be achieved by diets high in fruit, vegetables, and complex carbohydrates or plant polysaccharides such as rice, bread and pulses. Reduction in dietary sodium and saturated fat or trans fatty acid intake can be achieved by reductions in intakes of certain processed foods or replacement with low fat foods or oils rich in unsaturated fatty acids. The Rotterdam Elderly study (Hofman *et al.* 1991) is a longitudinal population study designed to investigate determinants of the incidence and progression of four major diseases in the elderly, neurogeriatric diseases, cardiovascular diseases, locomotor diseases and ophthalmologic diseases, the results of which should provide data from which preventive strategies can be developed.

It is known that dietary restriction can slow the ageing process and prolong life span in animals, and until recently, it was believed that this could also apply to man. However, a recent review on the topic (Sayer & Cooper, 1997), concluded that newer

evidence supports the existence of adverse effects of undernutrition in very early life. Early undernutrition seems to be associated with faster ageing changes and decreased life span and may predispose to a variety of age-related diseases.

Obesity is a risk factor for many chronic diseases. Although studies give varying values for ideal weights in older people, extremes of weight [very high (BMI > 30 kg/m^2) or very low (BMI < 18.5 kg/m^2)] body mass indices are adversely associated with health in most populations. To maintain adequate nutrition while keeping body mass index within the desirable range requires regular physical activity. Physical activity seems to protect against many diseases, such as cardiovascular disease, osteoporosis and fractures, diabetes, and breast and colon cancer (Khaw, 1997). The particular effects of exactly how much, and what sort of physical activity at different ages is still unclear, but even moderate activities such as walking, gardening, and keeping generally mobile seem to promote physical and mental functioning and well-being. The Fels Longitudinal Study (Guo *et al.* 1999) has shown that low fat free mass can be improved by increased physical activity. However, in women these changes were not apparent either by measuring weight or by calculating BMI. However, it is also known that ageing is associated with a reduction in efficiency, so that standard tasks (e.g. walking, may account for up to 20 % more energy expenditure in older individuals and, therefore, may contribute to negative energy balance (Durnin & Lean, 1992)).

Prevention of cognitive loss poses a particular challenge in elderly people. Some deterioration can be attributed to atherosclerotic disease and may be prevented by medical interventions or dietary patterns that reduce cardiovascular risk. High educational status early in life and continued mental stimulation also seem protective (Khaw, 1997).

For many diseases, the general environmental and lifestyle patterns that help prevention are known. However, individuals' ability to make changes to improve their health is determined by their social and cultural circumstances. Successful ageing encompasses social as well as physical and psychological well-being. Therefore, the social policies that may enable individuals to attain their potential and optimal health are

crucial. Sustaining a growing older population is the responsibility of everyone, the government, the private sector and the individuals themselves.

Table 1.3.1. Potential health interventions at different stages of life (Adapted from Khaw, 1997)

Period	Process	Potential interventions
Intrauterine	Metabolic programming	Maternal nutrition
Childhood and adolescence	Growth and development	Nutrition, physical activity,
	Building reserves	cognitive stimulation
	Reduce damage	no smoking, reduce exposure to pollution and infection
Adult	Increase protection	Nutrition
	Prevent disuse	Physical and mental activity

Table 1.3.2. Interventions to improve health in later life (Adapted from Khaw, 1997)

Intervention	Potential effects
No smoking	Smoking increases risks of many cancers including lung, stomach, larynx, colon; cardiovascular disease and thereby vascular dementia; respiratory disease; osteoporotic fractures; stomach ulcers
Diet	
High fruit and vegetable intake (5 or more servings daily)	Protective for cardiovascular disease; respiratory function; macular degeneration and cataracts; cancers including breast, prostate, colorectal and stomach; diverticular disease; diabetes
High complex carbohydrates, non-starch polysaccharides	Protective for cardiovascular disease; cancers including breast and colorectal
Reduced saturated fat (<15% food energy intake) and total fat (<35% food energy intake)	High saturated fat intake increases risk of coronary heart disease; cancers including colorectal, prostate and breast; large bowel disease; osteoarthritis
Reduced sodium	high sodium intake increases risk of stroke, stomach cancer, osteoporosis, respiratory disease
Physical activity	Protective for cardiovascular disease; diabetes; osteoporosis; cancers including colorectal and breast; depression

1.3.4 Undernutrition in the elderly

The term failure to thrive is frequently used to describe older adults whose independence is declining. The clinical picture or symptom complex in the elderly person with failure to thrive presents as a mirror image of the infant with failure to thrive. The older person loses weight, declines in physical and cognitive function and often exhibits signs of hopelessness and helplessness (Braun *et al.* 1988). This general failure of the old person is all too often accepted as due to 'old age' or senility or is regarded as a dementing process and the physical basis is overlooked (Hodkinson, 1973).

Smaller degrees of weight loss in the elderly may assume a higher clinical significance. Body composition changes in the elderly. There is loss of lean body mass (Fisher & Johnson, 1990). Total body water intracellular volume and basal metabolic rate decrease while total body fat and plasma volume increase (Granieri,1990). The range of weight loss cited in the literature as clinically significant in the elderly includes 4.5 kg over two years (Dwyer *et al.* 1987), 10 % over six months (Morley *et al.* 1988), 2 kg / year (Rajala *et al.* 1990), 7.5 % over six months (Thompson & Morris, 1991), 4 % (Wallace *et al.* 1995) and 5 % annually (Beck & Ovesen, 1998). Mortality was reported to be significantly greater in elderly patients with low weights than in those with normal weights (Agarwal *et al.* 1988). The common belief that most geriatric patients with persistent weight loss have an occult malignancy is not necessarily true (Thompson & Morris, 1991) who found malignancy in only 16 % of forty-five patients with significant unexplained weight loss (7.5 % over six months). In 24 % of the patients, however, the cause of the weight loss remained unknown after at least twenty-four months of clinical investigation and observation. Depression occurred in 18 % of these geriatric patients and deserves greatest attention, being potentially reversible. A review on the topic (Fischer & Johnson, 1990) cites alterations in the gastrointestinal tract, functional disabilities, lowered socio-economic status, social isolation and polypharmacy as contributing factors to weight loss in the aged. A more recent review (Vetta *et al.* 1999) details the conditions associated with weight loss in elderly people (**Tables 1.3.3** and **1.3.4**).

Table 1.3.3. Conditions associated with weight loss in elderly people (Adapted from Vetta *et al.* 1999)

Social	Poverty
	Functional impairment influencing activity of daily living
	Social isolation
	Low instruction level
	Institutionalisation
Psychological / Neurologic	Dementia
	Parkinsonism
	Mood disorders
	Alcoholism
	Anorexia tardive or nervosa
	Sociopathy
Medical	Drugs
	Oral and gastro-intestinal tract pathologies
	Hepatic failure
	Renal failure
	Diabetes
	Metabolic disorders causing increase of energy expenditure
	Trauma and chronic immobilisation syndrome
	Chronic obstructive pulmonary disease
	Cardiac cachexia
	Cancer

Table 1.3.4. Determinants of frailty in the elderly (Adapted from Vetta *et al.* 1999)

Pathophysiologic	Chronic inflammations
	Age related inability to down regulate stress response
	Immune senescence
	Altered cytokines' network
	Gonadal failure
	Modifications in neuroendocrine axis
	Muscle phenotype modifications
Health habits	Poor nutrition
	Sedentary life
	Smoking
	Alcohol consumption
Comorbid disease	Congestive heart failure
	Renal or liver dysfunction
	Chronic pulmonary disease
	Metabolic disorders
	Osteoporosis
	Arthritis
	Parkinson's disease
	Mood and cognitive disorders
Major life events	Loss of partner
	Recent retirement
	Extreme dependency
	Social isolation
	Falls / fear of falling
	Institutionalisation
Multipharmacotherapy	

An association between low BMI (< 20kg/m^2) and poor health and performance was confirmed by the results of the SENECA (Survey in Europe on Nutrition and the Elderly, a Concerted Action) project, a European Union Community project which studied about 2600 subjects aged 70 to 75 years old (Van Staveren *et al.* 1995). This study reported that a low BMI appeared to be more prevalent in women, in subjects living with others, in smokers, in subjects with a high ADL (activities of daily living) score and with poor subjective health. This study also reported, however, that the relationship between health and BMI in women is unlike that found in men. In women, reduced mobility hardly affects energy intake or BMI whereas both are reduced in men. It has recently been argued (Beck & Ovesen, 1998) that the optimal range of BMI for elderly people is from 24 - 29 kg/m^2 different to that in younger individuals where the optimal range is 20 - 25 kg/m^2. It appears that a high percentage of the elderly, particularly those who are initially undernourished, will not benefit from nutritional intervention. Therefore, a BMI less than 24 kg/m^2 or any degree of weight loss should be used to classify those at nutritional risk to allow for the initiation of nutritional support in time to reduce nutrition-related complications. A BMI less than 22 kg/m^2 was observed to be a significant predictor of mortality in older Italian people living in the community (Landi *et al.* 1999). Significantly more elderly patients with an average BMI of 20.9 kg/m^2 who were undergoing lung volume reduction surgery required ventilatory support and had significantly longer hospital length of stay than those patients with an average BMI of 26.1 kg/m^2 (Mazolewski *et al.* 1999).

In elderly patients, the validity of skinfold thickness measurements must be questioned (Fischer, 1982). There is an increase in the percent of body fat with increasing age in both men and women, in part because of a loss of lean body mass and consequent loss of total body water. A redistribution of fat from the extremities onto the trunk appears to occur along with the loss of lean body mass (Taren & Schler, 1990). Skinfold thickness measurements on the trunk (subscapular and supra -iliac) in males and at the triceps and biceps area in females have been postulated as being the most accurate in the elderly (Morley, 1986). However, a more recent study compared the use of percent ideal body weight and anthropometry in the elderly for the assessment of malnutrition. The anthropometric measurements taken were mid-arm circumference, triceps skinfold thickness and mid-arm muscle area. The authors concluded that

anthropometry, when used in conjunction with albumin and / or total lymphocyte count, provides a more sensitive indicator of malnutrition (Lansey *et al.* 1993). The use of anthropometry and it's associated problems in the elderly are fully discussed in **Chapter 1.4.8**.

Age itself was shown to account for a decline in weight of 2.5 kg per decade in men and 3.5 kg per decade in women (Lehmann *et al.* 1991). A four year follow-up study on weight changes in 629 elderly men and women living in their own homes confirmed that ageing, in old age, is associated with loss of body weight, but with a large intra-individual variation. This study reported that neither initial body weight nor the change, was associated with mortality or morbidity over the four year period (Lehmann *et al.* 1996).

With ageing, changes in the biochemical indicators of nutritional status occur. Serum copper, liver iron stores in females, and serum ferritin levels rise. Hair and serum zinc levels, serum calcium, selenium, silicon, tocopherol, 1,25-dihydroxyvitamin D, iron, thiamin, chromium, ascorbic acid, pyridoxine and vitamin B_{12} levels fall. There appear to be no significant changes with age in liver iron in men, or in folic acid, vitamin A, carotene, riboflavin, biotin, panthothenate, leukocyte zinc or blood vessel calcium levels (Taren & Schler, 1990). Routine haematological and biochemical measurements are unhelpful in identifying undernutrition in elderly patients admitted to a geriatric unit from their own homes (Potter *et al.* 1995). In a study of elderly nursing home patients, 99 % had hypoalbuminaemia and 79 % had hypoprealbuminaemia. Both predicted increased mortality and extended hospitalisation (Fergusan *et al.* 1993). However, in a study of 219 elderly patients followed up over a 4.5 year period, although serum prealbumin less than 150 mg/l was strongly associated with increased mortality, serum albumin and transferrin were not (Muhlethaler *et al.* 1995). A mortality risk index using serum cholesterol and haemocrit predicted death with a sensitivity of 90 % and a specificity of 85 % in the elderly (Rudman, 1989). Those elderly most likely to die soonest were older, more dependent, and had lower serum albumin, cholesterol, body mass index, triceps skinfold, haemocrit and haemoglobin. However, not all studies report the same predictive variables. A study by Gariballa *et al.* (1998*b*) reported that in elderly stroke patients, of a number of anthropometric, haematological

and biochemical measures, only serum albumin concentrations showed a significant association with outcome in hospital and mortality at three months after acute stroke. A Spanish study (Alarcon *et al.* 1999) reported that the variables on admission to hospital predicting mortality within six months of discharge included a Barthel index below sixty-five, presence of pressure sores, malnutrition (although how this was measured was not defined) and polypharmacy. Older hospitalised medical patients who were malnourished (defined by Subjective Global Assessment (Detsky *et al.* 1987)) were observed to have a higher mortality rate, delayed functional recovery and higher rates of nursing home use independently of illness severity, comorbidity or functional dependence on admission to hospital (Covinsky *et al.* 1999). However, yet another recent study (Maffulli *et al.* 1999) examining the nutritional status of patients admitted with proximal femoral fractures reported that although 31 % of patients were classified as undernourished, nutritional status as measured by anthropometry was not related to post-operative complications. Other studies have observed a direct relationship between the degree of malnutrition and length of stay, treatment costs, failure to return to usual life (Delmi *et al.* 1990; Sullivan *et al.* 1990) and re-admission rates (Friedmann *et al.* 1997). In addition, poor nutritional status is one of four variables (with impaired physical function, depression and cognitive impairment) that predict an adverse outcome in the elderly (Sarkisian & Lachs, 1996).

While no correlation between dietary iron intake and haemoglobin, or between protein intake and albumin could be found in a study comparing the nutritional status of elderly long-stay hospital patients and fit community elderly (Lipski *et al.* 1993), it would appear that many elderly European people have inadequate intakes of one or more nutrients, iron and riboflavin accounting for most of the inadequacies studied (de Groot *et al.* 1999). The current situation in Ireland may be better than that reported from Europe. The 1990 Irish National Nutrition Survey (Lee & Cunningham, 1990) was the last large dietary survey carried out in Ireland. Overall, the diets of the healthy elderly assessed were nutritionally adequate (Hurson *et al.* 1997). Macronutrient intakes were in keeping with the recommended guidelines and intakes of micronutrients lower than recommended were observed only for Vitamin D and Folate. If it can be presumed that the current diet of the elderly in Ireland is similar to that of the elderly in the UK (Finch *et al.* 1998), where only a small proportion of the elderly population have sub-optimal

intakes of most nutrients (Buttriss, 1999), the majority of healthy Irish elderly are adequately nourished. However, sub-optimal nutritional status has been observed in elderly Irish people mainly living in geographically isolated rural areas around Galway (Fogarty & Nolan, 1992). Except in cases of obesity, the UK Department of Health report *The Nutrition of Elderly People* (1992), recommends that energy intake should 'tend to be generous'. This increases the likelihood of older people obtaining sufficient intakes of vitamins, minerals and micronutrients and to support this, the report recommends that older people should try and remain physically active (Jones, 1999). In elderly patients in hospital, a different situation may be observed. Elderly in-patients in the UK who are 'eating normally' have a dietary intake well below their estimated energy requirements (Marshall *et al.* 1994). Food intake decreases with mastication and swallowing problems which may affect up to 64 % of elderly in-patients (Mowe *et al.* 1994). In addition, if dysphagia is a major problem and tube feeding has not been instituted, daily unsupported intake may be as low as 275 kcalories (Brynes *et al.* 1998). Food wastage on wards for the elderly in the UK is documented as being greater than 40 % (Stephen *et al.* 1997). This has been documented as having nutritional implications for elderly patients (Fenton *et al.* 1995). This situation is no better in the USA (Sullivan *et al.* 1999) and unlikely to better in Ireland (Heffernan & Moloney, 2000; Shirley & Moloney, 2000).

In the elderly loss of strength associated with ageing is not accounted for entirely by a loss of muscle mass (Welle *et al.* 1996). The age-associated loss of muscle fibres is related to a loss of α-motoneurons. The force generating capacity of residual contractile material is, however, unaltered. There are normally no signs of degenerated fibres in ageing muscle and the fibre content is relatively constant, independent of age (Astrand, 1992). By age seventy years, it is estimated that muscle strength is about 35 - 45 % lower than its peak value in youth. Muscular strength affects nutritional status by its impact on mobility, physical activity levels and energy expenditure. Evidence of a nutritional association with psychomotor function in elderly people has not been established. No published study directly assessing nutritional status and functional ability in free-living elderly exists (Manandhar, 1995). A recent Italian study (Giampaoli *et al.* 1999) reported that in males aged seventy-seven years or older, poor muscular strength as measured by hand-grip dynamometry could predict disability. In

those aged seventy-six years or younger, only a lower concentration of high-density lipoprotein cholesterol could predict disability.

A recent review (Vetta *et al.* 1999) has focused on the impact of malnutrition on quality of life in the elderly. They highlight social, psychological and medical factors as being the main reasons for weight loss in the elderly and conclude that there is evidence for a correlation between undernutrition, quality of life and changes in biochemical and functional indices that characterise 'failure to thrive', a pathological condition destined, if not reverted, to progress into homeostatic balance failure syndrome and finally multiple organ failure.

1.3.5 Undernutrition in elderly patients in long term care hospitals and nursing homes

The prevalence of undernutrition in long term care hospitals and in nursing homes for the elderly has been considered in several studies. In the United States of America, 5 % of people aged over sixty-five years and 20 % of those aged over eighty-five years live in nursing homes. When elderly patients are transferred between long term facilities and acute care hospitals, continuity of care may be lost (e.g. up to 30 % of nursing home residents develop decubitus ulcers during an acute hospital admission). Patients require monitoring of food intake, weight changes and serum biochemistry. Eating dependency is associated with several impairments and early mortality. Nursing home patients at greatest risk of developing dehydration are elderly women with several chronic diseases, with limited mobility, and who are receiving multiple medications. Prior to the use of a nasogastric feeding tube, patients with eating problems should receive a thorough evaluation for depression, poor dentition, faecal impaction, drug toxicity, malignancy, malabsorption and thyroid disease. If indicated, additional calories should be provided, the diet should be altered mechanically, and / or the patient should be assisted with feeding (Starer & Libow, 1992). In the USA, the Omnibus Reconciliation Act which provides the basis for the federal survey process for long term care facilities defines unintentional weight loss as a 5 % loss in actual body weight in 30 days and a 10 % loss in six months (Posthauer & Russell, 1997).

A comparison of BMI in elderly subjects attending day centres and in hospital reported that 24 % were underweight, 54 % of those in hospital and 12 % of those attending day centres (Kwok & Whitelaw, 1991). In a Canadian study of elderly patients in long-term care, nutritional status was determined by weight, percentage weight loss, BMI, triceps and subscapular skinfold thicknesses, mid-arm circumference, arm muscle circumference and area and percentage body fat (Keller, 1993). Severe undernutrition was present in 18 % and mild / moderate undernutrition in 27.5 %. Some uncontrollable factors were found to be highly associated with the level of malnutrition such as primary diagnosis, mental state, presence of a terminal diagnosis and total number of health problems. Length of residence, sex, age and medication use were not associated with malnutrition in the population studied. Factors significantly associated ($P < 0.05$) with malnutrition that may be amenable to intervention included dependency for feeding, poor appetite, slow eating / feeding, dysphagia, number of feeding impairments and energy and protein intake. When twenty-six department of veterans affairs nursing homes in the USA (*n* 2811 residents) were surveyed to determine the prevalence of undernutrition (Abbasi & Rudman, 1993), underweight (defined as body weight less than 80 % of standard (Hamwi, 1964)) occurred in 11.8 %, and hypoalbuminaemia (defined as serum albumin less than 35g/l) in 27.5 % of the patients. A survey of tube feeding in three American nursing homes showed 5, 11 and 14 % respectively of residents were being fed by tube. About half the tube-fed residents were below the desired threshold in their body weight and about half were below the desired threshold in their serum albumin level. Using a method to give the lowest estimate for maintenance caloric requirement, actual intakes were below this in more than 50 % of residents, averaging only 70 % of the maintenance requirement (Abbasi *et al.* 1994). This is similar to that observed among elderly hospitalised patients where 21 % had an average daily nutrient intake in hospital of less than 50 % of their calculated maintenance energy requirements (Sullivan *et al.* 1999). This results in nutritional depletion, reported to occur in 27 % of patients admitted to the geriatric and internal medicine wards of an acute care university hospital who were observed to undergo a decrease in mid-arm circumference of 3.6 % or more from admission to discharge (Incalzi *et al.* 1996). The UK National and Nutrition Survey (Finch *et al.* 1998) reported that 16 % of men and 15 % of women living in institutions were underweight (defined as a BMI of 20 kg/m^2 or less). Although 46 % of men and 47 % of women

living in institutions were overweight or obese, these proportions were significantly lower than those in the free-living group for men ($P < 0.05$) but not for women.

In comparison to fit community elderly (*n* 92), the nutritional status of elderly long-stay hospital female patients (*n* 92) had significantly lower values for triceps skinfold thickness, mid-arm muscle circumference, corrected arm muscle area and arm-fat area (Lipski *et al.* 1993). As assessed by seven day weighed dietary records, 68 % of the long-stay patients compared to 15 % of those in the community had a diet deficient in energy. Mid-arm circumference and arm-fat area were the measurements which distinguished differences between fit and long-stay geriatric subjects for both sexes.

In Ireland, only a small amount of work assessing the nutritional status of elderly people has been carried out. In one study, the nutritional status of 196 institutionalised and non-institutionalised elderly subjects living in Belfast was assessed (Vir & Love, 1979). Dietary intakes and biochemical status were recorded. Those institutionalised in long stay wards of geriatric hospitals had the lowest energy intakes. The occurrence of biochemically-deficient levels of iron, folate, thiamin, riboflavin and vitamin B_6 was highest in subjects living in sheltered dwellings, reflecting the failure of this type of institution to meet the nutritional needs of the elderly. However, no anthropometric measurements were carried out in this study.

1.3.6 Undernutrition in community-living elderly

A review of the studies on the prevalence of undernutrition in elderly people in the community show a prevalence of between 2 - 82 % (Lehmann, 1989). In the UK the Department of Health Committee on Medical Aspects of Food (1979) defined 7 % of a sample of the elderly population in the community as suffering from malnutrition (Department of Health (UK), 1979). The more recently published UK National Diet and Nutrition Survey (Finch *et al.* 1998) reported that among the free-living group, 3 % of men and 6 % of women were undernourished (defined as a BMI of 20 kg/m^2 or less) while 67 % of men and 63 % of women had a BMI greater than 25 kg/m2. In a comparison of a hospitalised group of elderly with a home control group subjects, 86 %

of the group living at home showed no signs of undernutrition (Mowe *et al.* 1994). A small Irish study, which assessed the nutritional status of a group of rural (*n* 46) and urban (*n* 24) elderly living at home, reported that 25 % of elderly males in both groups had a BMI of less than 20 kg/m^2 and almost 20 % of elderly females a BMI less than 19 kg/m^2 (Fogarty & Nolan, 1992). However, this was a small selected group.

Poor nutritional status was found to be an important predictor of mortality in 758 elderly community living people (Campbell *et al.* 1990). BMI, corrected arm muscle area and tricep skinfold thickness were all associated with a significant increase in the relative risk of death. Poor nutritional state associated with chronic disease only partly explained the increased mortality in those with low body weight and the authors concluded that it is possible that poor nutritional state contributes directly to increased mortality. Similar findings have been more recently reported when Vellas *et al.* (1997) noted higher patterns of morbidity in malnourished subjects. However, a four year longitudinal study on weight changes in elderly men and women (*n* 629) living in their own homes in the UK, reported that although ageing, in old age, is associated with loss of body weight, there is large intra-individual variation. In this study, neither initial body weight, nor the change, was observed to be associated with increased mortality or morbidity over the four year period (Lehmann *et al.* 1996) although age itself was shown to account for a decline in weight of 2.5 kg per decade in men and 3.5 kg per decade in women (Lehmann *et al.* 1991).

However, differences in nutritional status can be observed within sub-groups of elderly within the population. When the nutritional intake, functional status and muscle strength of elderly subjects attending a local day centre (*n* 51) and a local day hospital (*n* 41) was assessed (Mowat *et al.* 1992), males attending the day centre had higher lean body mass while females had significantly greater triceps skinfold thickness and mid-arm circumference by comparison with those attending the day hospital although both groups were community-based. It could be presumed that those who attended the day hospital had had a more recent episode of acute illness or a more chronic illness which adversely affected nutritional status. Assessment of weight changes in 362 non-institutionalised patients with Alzheimer's disease over a two year period showed weight gain in some subjects with periods of acute weight loss and increased weight fluctuation

compared to cognitively normal controls (White *et al.* 1996). This suggests that nutritional intervention during periods of weight loss may be beneficial. Alzheimers disease subjects were two and a half times more likely to lose a clinically significant amount of weight, defined as 5 % or more of their initial weight. Increasing severity of illness correlated with greater weight loss and the likelihood of weight loss occurring increases over the duration of the illness. In a small Irish study (O' Neill *et al.* 1990) examining the dietary, haematological, biochemical and immunological indices of nutrition in patients with mild to moderate senile dementia of the Alzeimer type (SDAT), the SDAT patients were noted to have lower body weight, triceps skinfold thickness, body mass index and mid-arm muscle circumference.

Using the same criteria as McWhirter and Pennington (1994), the prevalence of malnutrition in patients with cancer of the lung, gastrointestinal tract or prostate (*n* 213) and chronic diseases of the lung, gastrointestinal tract or nervous system (*n* 228), randomly selected from general practice registers was assessed (Edington *et al.* 1996). Of these patients, 9 % were malnourished, 5% mildly, 3% moderately and 1% severely Malnutrition occurred in 10 % of patients with cancer and 8 % of patients with chronic disease. Malnutrition was commoner in social classes III manual, IV and V (12 %) than people in social classes I, II, and III non-manual (3 %). The proportion of the group who were elderly was 68 %, of whom 9 % were classified as malnourished, 4 % mildly, 3 % moderately and 1 % severely. In the under-65 year age group, BMI alone correlated well with criteria for malnutrition. When only BMI was used to determine undernutrition, 14 % of elderly patients were malnourished, 7 % mildly, 5 % moderately and 2 % severely. Of the malnourished patients, 35 % reported involuntary weight loss during the six months immediately preceding the survey. However, 88 % reported their appetite to be good or reasonably good at the time of the survey.

1.3.7 Nutritional screening in the elderly

Screening for malnutrition focuses on the identification of risk factors and warning signals. A risk factor is a major identifiable biological or environmental circumstance or event that increases the risk of malnutrition. Warning signals are single or groups of observable circumstances that, if left unchecked, might directly cause an

individual at risk of malnutrition to become malnourished (Davies & Knutson, 1991). A long-standing nutritional deficiency can be present for some time before it is apparent clinically. However, marginally nourished, or even well nourished individuals, particularly those who are elderly, can quickly become undernourished if they become acutely ill or if they experience a change in their social circumstances. It has been recommended that a two step process to screen for malnutrition in the general population be implemented (Elmore *et al.* 1994). First the population is screened and this is followed by a full nutrition assessment of the at-risk group. It is necessary, therefore, to develop an initial screening tool that is easy to use, is of reasonable cost and has sufficient sensitivity and specificity. A number of such screening tools have been developed (**Table 1.3.5**).

To address the nutrition needs of older individuals, the American Academy of Family Physicians, the American Dietetic Association (ADA) and the American National Council on Ageing have taken a leading role in the development of the Nutrition Screening Initiative (NSI). The NSI is committed to increased public awareness of the nutritional problems of older persons, the promotion of optimal nutrition in advancing age and the development of strategies for nutritional risk assessment and intervention planning. It recognises that the potential risk factors for undernutrition in the elderly include inappropriate intake, poverty, social isolation, dependency / disability, the presence of acute / chronic diseases or condition, chronic medication use and advanced age (White *et al.* 1991). It suggests a tiered approach to screening for poor nutritional status (Lipschitz *et al.* 1992; Wellman, 1994). The first level of screening is a checklist to be completed by elderly individuals or their caregivers. It is anticipated that individuals will approach their physicians on the basis of the scores on the checklist. The fourteen items considered for inclusion were selected on the basis of associations found with the nutritional well-being of older people in previous research. The reverse side of the checklist form contains educational information which is intended to highlight the nutritional vulnerability of older people. This is followed by a level I screen which is completed by a healthcare or other trained professional and its goal is to identify individuals who may be candidates for preventive interventions. The level II screen is also completed by a healthcare or other trained

professional and includes more specific diagnostic information that can be used in the clinical setting.

The frequency with which risk factors occur and their order of importance is known since the application of the NSI. The New Jersey NSI project (Garofalo & Hynak-Hankinson, 1995) found that the most common nutritional risk factor was eating alone. The second most common was taking three or more prescribed or over-the-counter medicines daily and the third was having an illness or condition which caused a change in the kind or amount of food eaten. In Nevada, the most common problem was polypharmacy, the second in equal numbers was eating alone and having an illness or condition requiring changes in diet. Nearly one-quarter of the elderly screened consumed inadequate amounts of fruits and vegetables (Wilson & Benedict, 1996). Posner *et al.* (1993) showed that lack of monetary resources, eating fewer than two meals daily and eating few fruits and vegetables were the strongest predictors of an inadequate dietary intake. Jensen *et al.* (1997) adapted the NSI by adding the measurement of height, weight and serum cholesterol and albumin concentrations, to try and characterise the nutrition screening items that could identify subjects at potential risk for limitation of function and for increased health care charges. Age greater, or equal to, seventy-five years, use of three or more medications and a serum albumin concentration below 35 g / L were significant predictors of both functional limitation and health care charges. Poor appetite, eating problems, low income, eating alone and depression were significant predictors of functional limitation but not of health care charges. Being male, weight loss, overweight (BMI > 27 kg/m^2), both low (< 4.14 mmols/L) and high cholesterol (> 6.2 mmols/L) and functional limitation were significant predictors of health care charges. In addition, the ADA published a list of risk factors and risk categories in agreement with the NSI list but also included food and nutrient intake patterns, psychological and social factors, physical conditions and diseases and disorders and medications (Posthauer *et al.* 1994). The ADA in a position statement on nutrition and ageing (ADA, 1993) stresses that certain nutrition services within the continuum of care should be emphasised (**Table 1.3.6**).

However, the NSI has been criticised for poor test characteristics. It was originally tested in a sample of non-institutionalised individuals aged seventy years and

over in New England, USA, 96 % of whom were white. This sample is considered by many to be non-representative. Moreover, when used as a screening tool, the NSI identified only 45.8 % of those who reported bad health and only 36.2 % of those who reported low nutrient intakes (Rush, 1993).

Another American initiative, the Nutrition Risk Index (NRI) is a sixteen item questionnaire designed for use with older persons to screen those at risk of developing nutritionally related disabilities who could benefit from interventions to maintain their health status while reducing health service utilisation (Wolinsky *et al.* 1990). The NRI examines nutritional risk under mechanics of food intake, prescribed dietary restrictions, illness affecting food intake, problems caused by food intake and changes in dietary habits. However, it is difficult to differentiate whether the nutritional deficiencies are a cause or an effect of the associated health outcomes.

Yet another screening instrument, including screening items for malnutrition / weight loss was developed for use by non-medical staff to screen elderly people seen in community physicians' offices (Moore & Siu, 1996). The nutrition screen was comprised of two parts, a 'yes' answer to the question 'have you lost 10lbs over the past 6 months without trying to?' or a weight of less than 100lbs. When compared to blinded and unblinded physicians' assessments, the sensitivity of the screen to assess malnutrition was only 0.65 % and 0.70 % respectively. The specificity was 0.87 % and 0.88 % respectively. The actual prevalence of malnutrition was 21 %, the screening tool only providing a positive predictive value of 0.62 and a negative predictive value of 0.92.

The Mini Nutritional Assessment (MNA) test is a rapid and simple tool for evaluating the nutritional status of the frail elderly, which allows, if necessary for nutritional intervention (Guigoz *et al.* 1996). It is composed of eighteen simple and rapidly measured items and can be performed in less than fifteen minutes. The test involves anthropometric assessment (weight, height, arm and calf circumferences and weight loss), general assessment (lifestyle, medication and mobility), dietary assessment (number of meals, food and fluid intake, and autonomy of feeding), subjective assessment (self-perception of health and nutrition). Patients are categorised into well-

nourished, at risk of malnutrition or malnourished. Validation of the MNA has been carried out on six hundred elderly subjects in three successive studies and has been shown to identically classify 92 % and 89 % of subjects with the clinical status determined by two physicians trained in nutrition. The authors propose to integrate the MNA into geriatric assessment programs and that it is appropriate for use at hospital admission, admission into nursing homes, or by general physicians for early detection of risk of malnutrition. When used to assess the pre-operative nutritional status of elderly patients, the MNA was found to be well suited for pre-operative assessment during the anaesthesia consultation (Cohendy *et al.* 1999). However, a recent evaluation of both the NSI and mini nutritional assessment checklists as tools to identify nutritional problems in elderly Europeans concluded that both assessment tools were of limited value. Using cross-classification, based on both instruments, only 1 % of subjects were classified as at high nutritional risk, 11 % at moderate risk and 10 % as well-nourished. Average biochemical, anthropometric and dietary evaluation criteria did not differ between NSI categories or between MNA categories (de Groot *et al.* 1998).

In the UK, the Nutritional Advisory group for the Elderly of the British Dietetic Association designed a checklist for use by health professionals which measures intakes of specific nutrients. However, it can take up to fifteen minutes to complete, which for use in general practice, where the average consultation is ten minutes, is impossible. An assessment list for use by social workers to assess nutritional neediness among the homebound elderly was found to agree with the NSI consensus (Reuben *et al.* 1995). Another more recent UK nutrition screening tool specifically designed for screening elderly patients admitted to the geriatric assessment unit has been published (Pattison *et al.* 1999).. This tool includes the variables of medical condition, mental condition, weight, dietary intake and ability to eat and was validated against physical markers of nutritional status. However, comparison of scores obtained by dietetic and nursing staff showed that over 40 % of patients at nutritional risk were not correctly identified by the nursing staff. This highlights a problem inherent in all screening forms in that the classification of risk depends on a score given. The different professions carrying out the nutritional screening may believe in the contribution of fundamentally different factors to the development of undernutrition.

However, despite the problems associated with nutrition screening, by achieving consensus on risk factors, public awareness is heightened and ease of recognition of those at risk is developed. Much of the research to date, and the screening tools developed, have been aimed at the elderly population and their developers do not attempt to claim that they are valid when used in other age groups. Although each screening tool has had some success, none can be deemed sufficiently valid or practical to implement on a routine basis. Screening by questionnaires would obviously be the favoured approach, self-administered questionnaires being ideal as they are simple, inexpensive and can be administered to large numbers. However, a question hangs over the validity of the information obtained from self-administered questionnaires and further investigation into this is warranted. It may also be that screening tools with different emphasis are required for community and hospital use. Although intervention studies have shown an overall positive effect of nutritional support in elderly patients, there seems to be a high percentage, especially those initially malnourished who will not benefit from support (Beck & Oveson, 1998). It would seem sensible to suggest that greater awareness of malnutrition, early recognition of its signs, and effective intervention might reduce hospital admissions and length of stay, reduce the financial burden on the health service and most importantly improve patients' quality of life.

Table 1.3.5. Nutrition screening instruments used for the elderly

Screening tool	Users	Author
Nutrition screening initiative checklist	Self-administered	White *et al.* 1991
Nutrition screening initiative level I	Social service or health care professional	White *et al.* 1991
Nutrition screening initiative level II	Health care professional in medical setting	White *et al.* 1991
Nutrition risk index	Health professionals	Wolinsky *et al.* 1990
Nutritional advisory group for the elderly checklist	Health professionals	British Dietetic Association (1990)
Mini nutritional assessment	Health professionals	Guigoz *et al.* (1994)
Nutrition screening instrument	Non-physician office staff	Moore & Siu, (1996)
Qualitative screening tool	Nursing staff	Pattison *et al.* 1999

Table 1.3.6. Position of the American Dietetic Association: nutrition, ageing and the continuum of health care (American Dietetic Association, 1993)

Promoting health and functional independence of older individuals
Reducing the risks and complications associated with chronic diseases through improved nutrition-related management
Lowering the prevalence of protein-calorie malnutrition, particularly in the institutionalised and homebound older population
Eliminating nutrient deficiencies that may accompany drug therapies or acute or chronic illnesses
Screening and referral for appropriate nutrition services throughout the health care continuum
Containing health care costs
Improving and maintaining physical and cognitive functioning with advancing age
Enhancing the quality of life

1.3.8 Effects of nutritional intervention on outcome in the elderly

The only way to ascertain the benefit of nutritional supplementation on undernourished elderly patients is to carry out prospective randomised controlled-intervention trials. There have been positive results of trials of nutritional support given enterally or orally. Bastow *et al.* (1983) studied the effect of overnight nasogastric feeding supplements (1000kCals / 4200 kJ) in a randomised controlled trial of elderly women with a fractured neck of femur and showed that treatment was associated with improvements not only in anthropometric and plasma protein measurements but also in clinical outcome, mainly in shortened rehabilitation time and hospital stay. Delmi *et al.* (1990) were able to demonstrate a clinical benefit of oral supplements in a randomised controlled group of elderly patients with a fractured femur which persisted six months after injury. In a randomised controlled trial, Woo *et al.* 1994 demonstrated a clinical benefit of oral supplements on a group of elderly patients suffering from chest infection. The study of Larsson *et al.* (1990) on 501 elderly in-patients randomly allocated to receive oral supplements or ward meals only, demonstrated clear benefit of nutritional supplements in terms of mortality, hospital stay, mobility and probability of pressure sores. Another study of elderly patients receiving high protein supplements reported that pressure sore surface area was reduced. The change in ulcer surface area correlated with protein intake (Breslow *et al.* 1993). Similar beneficial results may be obtained less expensively from the use of fortified foods. A study of thirty-six elderly patients (aged 52 - 96 years) who were given six weeks of regular hospital food followed by six weeks of high energy food using a crossover study design reported that the high energy food led to a 40 % increase in energy intake resulting in a 3.4 % increase in body weight, the costs of the high energy food being less than 15 % of that of the same energy given as an oral supplement (Odlind Olin *et al.* 1996).

A review of the literature on nutritional interventions in nursing homes concluded that protein energy undernutrition is a frequently preventable and potentially treatable common problem in the institutionalised elderly. Enteral nutrition support, aggressive oral feeding with high calorie foods (e.g. sweets and chocolate), the use of tasteless calorie supplements and the discontinuation of restrictive diets have been

shown to improve daily energy intake, serum albumin and transferrin levels and nitrogen balance (Abbasi *et al.* 1993). In a survey of tube feeding in three American nursing homes which showed 5 %, 11 % and 14 % of residents respectively, were being fed by tube, about half the tube fed residents were below the desired threshold in their body weight and about half were below the desired threshold in their serum albumin level. Using the method which gives the lowest estimate for maintenance caloric requirement, actual caloric intakes were below this in more than 50 % of residents, averaging only 70 % of the maintenance requirement. When during a twelve week intervention period, the volume of feed infused was increased by 30 %, all patients gained weight (mean = 3.56 kg) but no significant change in the serum albumin was found (Abbasi *et al.* 1994). No adverse reaction to the increased volume of feed was observed.

A randomised prospective study of thirty in-patients with persistent dysphagia 14 d following acute stroke, compared percutaneous gastrostomy and nasogastric tube feeding. Patients fed via the gastrostomy tube had significantly lower mortality and a greater improvement in nutritional status at 6 weeks (Norton *et al.* 1996). However, a study (Quill, 1992) on patterns of use and the attitudes of physicians to nasogastric feeding tubes in elderly patients with severe chronic illness, reported that the nasogastric tube was removed because of medical improvement in only two of the fifty-five patients. There was no formal comparative assessment of quality of life with and without the use of nasogastric feeding. The author recommends that if the medical situation is unclear, a trial of nasogastric feeding can be initiated which should be discontinued if the initial indications for its use are no longer valid.

In a double-blind placebo-controlled trial, ninety-six independently living, healthy men and women over sixty-five years of age were randomly assigned to receive nutritional supplementation. Nutrient status and immunological variables were assessed at baseline and at 12 months, and the frequency of illness due to infection was ascertained. Subjects in the supplement group had higher numbers of certain T-cell subsets and natural killer cells, enhanced proliferation response to mitogen, increased interleukin-2 production, and higher antibody response. Supplementation with micronutrients significantly improved immunity and decreased the risk of infection

(Chandra, 1992). Another randomised placebo-controlled trial (Fiatarone *et al.* 1994) compared progressive resistance exercise training, multi-nutrient supplementation, both interventions and neither intervention in 100 frail nursing-home residents over a 10-week period. High-intensity resistance exercise was found to be a feasible and effective means of counteracting muscle weakness and physical frailty in very old subjects. In contrast, multi-nutrient supplementation without concomitant exercise did not reduce muscle weakness or physical frailty.

However, a number of studies (Williams *et al.* 1989; Hankey *et al.* 1993; Hogarth *et al.* 1996) have not shown a clear benefit from nutritional supplementation. These studies had problems with compliance to the supplements which, indeed, seems to be a problem in all studies assessing the use of supplements. In routine clinical practice the situation is probably worse because the nutritional state of many patients is not recognised, and only a small percentage are referred for dietetic assessment. If supplements are prescribed they may not be given to the patients or are given but not consumed (Peake *et al.* 1998). A new research project established in the UK will assess the use of feeding assistants on wards who will provide extra support and encouragement to patients to eat the normal food provided in hospital. This study will also investigate if this is a more effective approach to increasing nutritional intake than relying solely on supplements (Hickson *et al.* 1999).

1.3.9 Conclusions

Physical, mental, social and environmental changes which take place with ageing may affect the nutritional status of elderly people. There is evidence that undernutrition is relatively common in elderly people and may influence clinical outcome during disease, and that nutritional supplements can improve outcomes in some settings, but differences in the methodology, variability of dietary habits with time, prevalence of disability and selective survival may be part of the reasons for the conflicting results obtained by different researchers. To enable better recognition of undernutrition and distinction between the signs of undernutrition and those due to disease and / or the processes of ageing and to be able to intervene both appropriately

and effectively, further research is required. Appropriate reference data need to be established for well-defined populations of elderly using sound experimental design and adequate sample size. Better understanding of the changes in body fat distribution and lean mass in the elderly and their influence on the well-being of the elderly are required. The value of clinical assessment as an effective measure of nutritional status as opposed to objective measurements deserves more scientific study. Energy requirements and expenditure in elderly people during health, and particularly during acute and chronic illness and disability, are of particular concern.

However, based on the present knowledge, firm recommendations to maintain and improve nutritional status in elderly people can be made. Health professionals should have access to the necessary basic training which will enable them to assess and meet the nutritional demands of elderly patients at risk of undernutrition. Simple clinical assessment of nutritional status, such as asking people about unintentional weight loss, should be a routine part of history taking and clinical examination when a patient is admitted to hospital. A quick and simple screening tool for the detection of early undernutrition could be integrated into geriatric assessment programmes. Elderly people should be advised to eat a balanced diet containing a variety of nutrient-dense foods, more fruits, vegetables and grains and foods containing adequate amounts of Calcium and vitamin D. Finally, elderly people should be encouraged to lead an active life, especially after episodes of intercurrent illness.

1.4 Anthropometric assessment of nutritional status

1.4.1 Summary

Anthropometry provides the single most portable, universally applicable, inexpensive and non-invasive technique for assessing the size, proportions, and composition of the human body. It reflects both health and nutritional status and predicts performance, health and survival. As such, it is a valuable, but currently underused, tool for guiding public health policy and clinical decisions.

1.4.2 Introduction

Anthropometry provides the single most portable, universally applicable, inexpensive and non-invasive method available to assess the size, proportions, and composition of the human body. Since growth in children and body dimensions at all ages reflect the overall health and welfare of individuals and populations, anthropometry reflects both health and nutritional status and may also be used to predict performance, health and survival. These applications are important for guiding public health policy and clinical decisions that affect the health and social welfare of individuals and populations. Although, traditionally, anthropometry had been focused largely on infants and young children, advances over the past decade have demonstrated the relevance of anthropometry throughout life, not only for individual assessments but also for reflecting the health status and social and economic circumstances of population groups. The report published in 1995 by the World Health Organisation attempted to re-evaluate the value of anthropometric indices and indicators at different ages in assessing health, nutrition and social well-being and provided guidelines to different needs and applications through the life cycle. This report identified reference data for anthropometric indicators and provided guidance as to how the data should be used. It also identified unresolved issues and gaps in knowledge that required further research.

Low height and/or weight relative to reference data have been used as classic indicators of undernutrition for individuals and groups; similarly, elevated body weight and thickness of subcutaneous fat have become common indicators of overnutrition or obesity. Recent research has expanded the applications of anthropometry to include predicting those who will benefit from interventions, and evaluating the response to the intervention, and identifying social and economic inequity. It is now clear that appropriate applications and interpretations of anthropometric indicators may be different for individuals and populations.

1.4.3 Body composition

Full understanding of the use of anthropometry requires an understanding of body composition. A five-level model of body composition has recently been developed (Wang *et al.* 1992). These five levels include atomic (level I), molecular (level II), cellular (level III), tissue system (level IV) and whole body (level V). Whole body measurements of the chemical elements at the atomic level can provide valuable data (e.g. nitrogen balance is an indicator of protein turnover). At level II, anthropometric methods of assessing total body fat and fat-free mass have been developed using indirect techniques that rely on assumptions that relate measurable aspects of body composition to the constituent of interest. At level III, a widely used model considers the total cellular mass to be composed of two components, fat and body cell mass. Several equations based on anthropometry have been developed to predict body cell mass at the cellular level, although their accuracy is debatable and none is widely used. The tissue system consists of the major tissues, organs, and systems; body weight is equal to adipose tissue + skeletal muscle + bone + blood + residual (visceral organs, etc.). A steady state relationship exists between the various body-composition compartments. This permits information about body composition at various levels to be derived from anthropometric measurements made at the whole body level. Both ageing and disease affect the relationships between the body-composition compartments. Anthropometry provides a means of detecting the resultant changes (World Health Organisation, 1995).

1.4.4 Anthropometric measurements, indices, and indicators

Anthropometric measurements

The main anthropometric measurements are height and weight. Measurements of fat and muscle circumferences can also be made. The recommended methods for carrying out these measurements are described in **Chapter 2**.

Anthropometric indices

Anthropometric indices are combinations of measurements that are essential for the correct interpretation of measurements (e.g. body weight must be related to either height or age). Measurements of height and weight can be combined to produce BMI (kg/m^2), or weight may be related to height through the use of reference data. Different indices are used in different age and physiological groups (e.g. weight-for-height, height-for-age, weight-for-age in children, and pregnancy weight gain in pregnant women).

Anthropometric indices can be expressed in terms of Z-scores, percentiles, or percent of median, which can then be used for comparison with a reference population.

A Z-score (or standard deviation score) is the deviation of the value for an individual from the median value of the reference population, divided by the standard deviation for the reference population:

$$\textit{Z-score or SD score} = \frac{\textit{(observed value)} - \textit{(median reference value)}}{\textit{standard deviation of reference population}}$$

A fixed Z-score implies a fixed height or weight difference at a given age. A major advantage of this is that, for population based applications, it allows the mean and standard deviation to be calculated for a group of Z-scores.

A percentile is defined as the rank position of an individual on a given reference distribution, stated in terms of what percentage of the group the individual equals or exceeds (e.g. an individual of a given age whose body mass index falls in the 10th percentile has the same, or a greater, BMI than 10 % of the reference population of the same age). Percentiles are commonly used in clinical settings because their interpretation is straightforward. However, because the same interval of percentile values corresponds to different absolute values, it is inappropriate to calculate statistics such as means and standard deviations for percentiles. Moreover, towards the extremes of the reference distribution, there is little change in percentile values, when there may be large changes in absolute values.

Percent of median is the ratio of a measured value in an individual to the median value of the reference data for the same age, expressed as a percentage. The main disadvantage of this system is the lack of exact correspondence with a fixed point of the distribution. In addition, cut-offs to classify risk are different for the different anthropometric indices (e.g. the usual cut off for low height-for-age is 90 %, but for low weight-for-height and low weight-for-age 80 %, of the median).

The main characteristics of the three reporting systems are summarised in **Table 1.4.1.**

If the distribution of reference values follows a normal distribution, percentiles and Z-scores are related mathematically. The -3, -2, and -1 Z-scores are, respectively the 0.13th, 2.28th, and 15.8th percentiles. Similarly, the 1st, 3rd and 10th percentiles correspond to, respectively, the -2.33, -1.88, and -1.29 Z-scores.

Table 1.4.1. Comparison of the characteristics of three anthropometric data-reporting systems (adapted from World Health Organisation, 1995)

Characteristic	Z-score	Percentile	Percent of median
Adherence to reference distribution	Yes	Yes	No
Linear scale permitting summary statistics	Yes	No	Yes
Uniform criteria across indices	Yes	Yes	No
Useful for detecting changes at extremes of the distributions	Yes	No	Yes

Anthropometric indicators

Depending on the circumstances, an anthropometric index may be influenced equally by nutrition and health, or more by one than by the other. It may then be referred to as an indicator of nutrition, or of health, or of both. In some cases, the index may be used as an indirect indicator of socio-economic status. An anthropometric indicator is open to erroneous interpretation (e.g. BMI reflects energy reserves in sedentary, but not in highly trained athletes; low birth weight reflects maternal malnutrition in mothers who are too thin, but not in those who are overweight). Factors, other than anthropometric, need to be considered (e.g. providing nutritional supplements to mothers on the basis of low birth weight will not succeed if smoking is the predominant cause of the low birth weights). Therefore, other factors must always be considered when assessing the nutritional status of populations from indicators thought to be nutritional.

Anthropometric indicators can be classified according to the objectives of their use, which include the following:

Identification of individuals or populations at risk

This requires data based on indicators of impaired performance, health, or survival. The anthropometric indicators must reflect past or present risk, or predict future risk. Indicators of this type are used to identify health problems and potential interventions (e.g. malnutrition may increase risk of mortality and, therefore, should be identified and treated).

Selection of individuals or populations for an intervention

This should predict the benefit to be derived from an intervention.

Evaluation of the effects of changing nutritional, health, or socio-economic influences, including interventions.

These indicators must reflect response to past and present interventions. There may be a possible lag between the start of an intervention and the time when a response becomes apparent.

Excluding individuals from high-risk treatments, from employment, or from certain benefits.

These indicators predict lack of risk and may not always be identical to indicators that predict risk.

Achieving normal standards

This requires indicators that reflect 'normality'. This may, or may not be warranted (e.g. moderate obesity among the elderly is not associated with poor health or increased risk of mortality, and weight control in this age group is based solely on normative distributions).

Research purposes that do not involve decisions affecting nutrition, health or well-being

The need to build appropriate biological, behavioural, and epidemiological models into the analyses often means that some of the simpler indicators may be inadequate for research purposes.

A good indicator is one that reflects the issue of concern or predicts a particular outcome. Choosing a particular indicator generally focuses on risks to health. A screening test identifies individuals at risk on the basis of an indicator and a specific cut-off point. Sensitivity and specificity need to be considered when establishing the most appropriate cut-off points. Values for sensitivity and specificity are unaffected by the prevalence or incidence of the condition of interest. Other screening tests (e.g. positive

predictive values, are affected by prevalence, and, therefore, inappropriate for use in comparing indicators in different populations). Screening should be seen as simply a first step in a sequence of increasingly specific screens leading to effective intervention.

In clinical practice, change can be assessed from two or more serial anthropometric measurements in the individual. Anthropometry may also be used for deciding to discontinue an intervention in individuals who fail to respond.

Anthropometry provides some of the most important indicators used in nutritional surveillance. Prevalence estimates often play an important role in the assignment of priorities to health problems. However, a problem arises in that a 'gold standard', that is, appropriate nutrition is difficult to define. It is of greatest importance to identify those amenable to intervention.

1.4.5 Reference data

A *reference* is defined as a tool for grouping and analysing data and provides a common basis for comparing populations (World Health Organisation, 1995). No inferences should be made about the meaning of the observed differences. A *standard*, on the other hand, embraces the notion of a norm or desirable target. Concern has been expressed that, because reference data embody certain characteristics or patterns of normality, they have been widely used to make inferences about the health and/or nutrition of individuals and populations. A BMI cut-off of ≥ 30 kg/m^2 is applicable to all adults, because data on risks of morbidity and mortality support this. For most other anthropometric data, however, there are insufficient data to permit the specification of standards. It is recommended (World Health Organisation, 1995) that care should be taken to choose references that resemble, as far as possible, true standards, so that the same deviation from the reference data has the same biological meaning. The choice of sample for developing references or standards thus raises the question of what constitutes a healthy population. At least four definitions exist (World Health Organisation, 1995):

The population lives in a healthy environment.

The population lives in a healthy environment and contains no overtly sick or very few clinically sick individuals.

The population lives in a healthy environment and contains only individuals whose present good health will be demonstrated by longevity or at least by survival for some years after the measurements are taken.

The population lives in a healthy environment and contains only individuals who live healthily according to present prescriptions.

A further refinement could exclude, for example, those who die within a specified period after measurement, or those who smoke. Another question concerns the extent to which different standards should be used to approximate the ideal. It is generally believed that, when reference data are used to make decisions about populations, it is better to use statistical methods to control for differences within or across populations than to use different standards (e.g. intrauterine growth in smokers and non-smokers). On the level of the individual, the utility of developing different standards for screening individuals depends on the prevalence of the condition being screened. If reference data are to be used as standards, the following criteria have been established as desirable (World Health Organisation, 1995):

The sample should include at least 200 individuals in each age and sex group.

A sample of this size provides the 5th percentile with a standard deviation of about ± a 1.54 percentile, and is considered acceptable for individual-based applications (e.g. screening). This size of sample will also allow for differentiation between environmental and genetic effects of growth.

The sample should be cross-sectional since the comparisons that will be made are of a cross-sectional nature.

This is no longer considered essential, since longitudinal data can be presented cross-sectionally with minor adjustments. Cross-sectional data should not be used to monitor longitudinal data, but continues to be widely misused for this purpose.

Sampling procedures should be defined and reproducible.

Measurements should be carefully made and recorded by observers trained in anthropometric techniques, using equipment of well tested design and calibrated at frequent intervals.

References should include data on reliability and precision. Inter-observer variability and instrument error should be documented. It is useful, though not essential, to have estimates of within and between observer components of reliability. Methods by which missing data were derived and any 'cleaning' of data should be clearly documented.

The measurements made on the sample should include all the anthropometic variables that will be used in the evaluation of nutritional status.

The various measurements taken from an individual should be compared with reference data taken from a single population.

The data used from which reference graphs and tables are prepared should be available for anyone wishing to use them, and the procedures used for smoothing curves and preparing tables should be adequately described and documented.

1.4.6 Anthropometry in thin adults in developed countries

Analysis of mortality data is appropriate when attempting to define a level of weight or BMI below which impairments become apparent. Mortality is increased in adults with a relatively low BMI. However, a systemic analysis of twenty-five major studies showed two sources of bias in this relationship (Manson *et al.* 1987). The first was failure to control for smoking, and the second, the failure to eliminate early mortality from the analysis of thin adults, many of whom may have already been ill when measured and, therefore, more likely to have lost weight. It may be, that after the exclusion of smokers and individuals dying early, the relationship between low BMI and increased mortality is invalid. In addition, all the mortality studies were carried out in economically developed countries and involved predominantly white, middle-class adults, generally men. It is, therefore, unknown whether the results are applicable to other racial or ethnic groups. What is known, however, is that unintentional weight loss has a profound effect on subsequent morbidity and mortality, shown in a number of clinical studies (Braun *et al.* 1984; Windsor & Hill, 1988; Gianotti *et al.* 1995; Anker *et al.* 1997).

In developed countries, prevalence of undernutrition is common in hospitals (Butterworth, 1974; Bistrian *et al.* 1976; Hill *et al.* 1977; McWhirter & Pennington, 1994) and nursing homes (Morley & Silver, 1995). Two forms of malnutrition may be seen, firstly, adult marasmus, and, secondly, the malnutrition associated with low serum albumin, analogous to kwashiorkor in children. Both conditions are almost invariably secondary to disease. Hypoalbuminaemic malnutrition usually results from the metabolic effects of injury, inflammation, or infection, rather than from dietary protein deficiency, and the cause is usually clinically obvious. Marasmic individuals or those with significant weight loss also react badly to injury and infection, and have a poorer outcome than normal individuals (Haydock & Hill, 1986; Windsor & Hill, 1988; Jeejeebhoy, 1988; Watters *et al.* 1993; Ek *et al.* 1990; Sullivan *et al.* 1991; Larsson *et al.* 1994; Gallagher-Allred *et al.* 1996; Welsh *et al.* 1996; Giner *et al.* 1996; Friedmann *et al.* 1997).

In the clinical setting, the preferential loss of lean tissue that results from tissue catabolism and gluconeogenesis in both acute and chronic infections is of particular significance. Patients may lose substantial amounts of lean tissue during illness which will be a major determining factor for survival at low body weight. Not only does muscle mass fall, so also does muscle power as measured by hand grip strength (Windsor & Hill, 1988; Webb *et al.* 1989). Muscle mass should be assessed in these individuals using mid-arm circumference and mid-arm muscle circumference (World Health Organisation, 1995). Functional tests (e.g. hand grip strength) can also be used for assessing an acute deterioration in health. Appropriate nutritional intervention should elicit an improvement in grip strength within days; the anthropometric measurements usually take longer to improve (Jeejeebhoy *et al.* 1990).

In developed countries, there are no recognised reference standards that satisfactorily define the lower limit of desirable body weight except in terms of mortality (World Health Organisation, 1995). As the proportion of the population with a low BMI decreases, there is almost a symmetrical increase in the proportion with a BMI over 25 kg/m^2. This indicates a tendency for a population-wide shift as socio-economic conditions improve. Finding an appropriate society where adults in general are not inactive, not on a high-fat diet, and not subject to severe intercurrent infections or food shortages is difficult. A normal or ideal BMI is now defined as 18.5 - 24.9 kg/m^2 (Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults, 1998) based on assessment of risk of a number of chronic diseases (e.g. hypertension, dyslipidaemia, type 2 diabetes, CHD, stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and endometrial, breast, prostate and colon cancers).

The World Health Organisation Report (1995), describes the condition of low BMI as thinness, with the following three grades:

Grade 1: BMI 17.0 - 18.49 (mild thinness)

Grade 2: BMI 16 - 16.99 (moderate thinness)

Grade 3: BMI < 16.0 (severe thinness)

Body fat can be predicted from measurement of skinfold thickness at various sites. The measurement most frequently used is the triceps skinfold thickness. However, this measurement in itself is not particularly useful as it correlates poorly with physiological function (Bistrian, 1977), hospital morbidity and mortality (Mullen *et al.* 1979; Harvey *et al.* 1981). The principal value of the triceps skinfold thickness measurement is for calculating mid-arm muscle circumference or arm muscle area. Corrective formulas for bone area for both males and females have been devised (Heymsfield *et al.* 1982*b*). Reference data for triceps (Bishop *et al.* 1981) and subscapular skinfold thickness (Grant *et al.* 1981), and mid-arm muscle circumference (Bishop *et al.* 1981) have been compiled for adults aged 18-74 years in the United States of America based on data from the National Health and Nutrition Examination Survey (NHANES I). Data from both NHANES I and NHANES II were used to provide reference data for weight, triceps skinfold thickness, subscapular skinfold thickness and bone-free upper arm muscle area for Americans with small, medium and large frame sizes. Frame size was determined by elbow breadth (Frisancho, 1984). However, few data are available that relate mid-arm circumference and arm muscle area to health.

An alternative method proposed is to relate arm measurements to the BMI cut-off, which then could be used as practical alternatives to BMI (James *et al.* 1994). From a regression of BMI versus mid-arm circumference, it was estimated that the average mid-arm circumference is about 24 cm in people with a BMI below 18.5 kg/m^2. It is likely that, at a BMI of less than 18.5 kg/m^2, individuals with mid-arm circumference greater than 24 cm, thin but healthy people, will fare better than those with a smaller mid-arm circumference (World Health Organisation, 1995). Mid-arm muscle

circumference is of greater significance in dealing with sick patients, because its reduction is directly related to the severity of the disease.

Because low adult weight relates to impaired physical capacity and health, adult height and weight should be routinely measured in the population, and particularly in groups who are known to be at risk for undernutrition. However, the validity of anthropometric cut-offs needs to be established.

1.4.7 Anthropometry in overweight adults in developed countries

When intake of energy exceeds energy expenditure, the excess is stored as triglycerides in adipose tissue. The practical definition of overweight and obesity is based on BMI. However, because BMI does not measure fat mass or fat percentage and because there are no clearly established cut-off points for fat mass or fat percentage that can be translated into cut-offs for BMI, the different high levels of BMI are expressed in terms of degrees of overweight rather than degrees of obesity which would imply knowledge of body composition (World Health Organisation, 1995). For adults, the classification of BMI has cut-off points of 25 kg/m^2, 30 kg/m^2 and 40 kg/m^2, based principally on the association between BMI and mortality. However, a number of points are highlighted by the World Health Organisation Expert Committee on Physical Status: the use and interpretation of anthropometry:

> *The recommended cut-offs are appropriate for identifying the extent of overweight individuals and populations, but do not imply targets for intervention.*
>
> *The broad ranges of BMI do not imply that the individual can fluctuate within this range without consequence. Weight gain in adult life may be associated with increased morbidity and mortality independently of the original degree of overweight.*
>
> *The cut-off points for degrees of overweight should not be interpreted in isolation but always in combination with other determinants of morbidity and mortality.*

The method used to establish BMI cut-off points has been largely arbitrary. It is based upon the relationship between BMI and mortality and it may be necessary to revise the classification of overweight in terms of BMI based on health risk. Most studies have been conducted among people living in western Europe or in the USA where BMI appears to be a good indicator of the deposition of excess energy as fat. It is probably less appropriate in other populations who differ in body build and body

proportions. Similar problems may occur in the classification of body fat distribution by abdomen: hip circumference ratio. Different contributions of muscle mass and bone structure as well as stature and abdominal muscle tone may lead to different associations between abdomen: hip ratio and visceral fat accumulation. Abdominal fatness may imply different health risks for different racial groups (Dowling & Pi-Sunyer, 1993) and at different ages (Seidell *et al.* 1994). These issues complicate the future development of universal cut-off points for abdomen: hip circumference ratio.

Secular trends in the prevalence of overweight show it to be increasing worldwide, for example, in Ireland (Lee & Cunningham, 1990; Kilkenny Health Project, 1992;), the UK (Prentice & Jebb, 1995; Jebb, 1999) and the USA (Galuska *et al.* 1996; Van Itallie, 1996; Flegal *et al.* 1998). The determinants of overweight include biological (age, sex, pregnancy and lactation), socio-cultural (socio-economic status, educational level and marital status) and behavioural (smoking habits, physical activity and alcohol consumption) determinants. It has been widely concluded that the relationship between BMI and mortality is U-shaped or J-shaped. The causes of death at different ends of the U or J-shaped curve are very different. The high mortality at low BMI is dominated by digestive and pulmonary disease, but at high BMI it is related predominantly to cardiovascular disease, diabetes mellitus, and gallbladder disease. It is sometimes argued that the high mortality at low BMI is related to the confounding presence of smoking and disease and that the relationship between BMI and mortality may in fact be linear (Lindsted *et al.* 1991).

In prospective studies where fat distribution is assessed by skinfolds or circumferences, abdominal fatness is a risk factor for CHD, stroke, hypertension, non-insulin dependent diabetes mellitus, gall-bladder disease, independently of BMI. It may also be implicated in a number of other diseases (e.g. endometrial and breast cancers) and disorders (e.g. some endocrine disorders and infertility, reflux oesophagitis and hiatus hernia, and sleep apneas). It may also result in psychosocial problems. Abdominal fatness is associated with increased levels of insulin and triglycerides and decreased levels of HDL-cholesterol. In addition, abdominal fatness may be associated with haemostatic and fibrinolytic factors, which also contribute to an increased risk of myocardial infarction.

The magnitude of the problem of overweight in populations and its geographical, sex, racial, ethnic, and socio-economic distribution can be identified by the stratification of sufficiently large random population samples according to age, sex and race. Details of urbanisation, ethnicity, and socio-economic status should also be recorded, and it is important to document other risk factors such as hypercholesterolaemia, hypertension, and smoking habits in the sample population. In women, menopause influences both weight and fat distribution as well as their health consequences, and this too should be documented. In many populations, lifestyle and nutrition have undergone radical changes over a relatively short period of time; different birth cohorts may therefore have developed differently in terms of anthropometric indicators, which may complicate interpretation. Increases in abdominal fatness in populations undergoing such changes may provide a sensitive indication of an emerging public health problem of overweight and its consequences. Cross-sectional data on height and body weight are available for most adult populations, but data for other indicators are limited. Monitoring of overweight in a population should be performed using independent cross-sectional surveys, either continuously or at regular intervals. However, participation rates in surveys vary markedly with a recognised bias resulting to lesser participation among lower socio-economic groups, smokers and heavy alcohol drinkers. People with chronic diseases are often less interested in taking part in population risk factor surveys. This will have an effect on the distribution of anthropometric variables and on prevalence estimates of overweight. Mean values of anthropometric variables, plus 95 % confidence intervals and standard deviations, medians, percentiles, and proportion of subjects in the ranges of 25 - 29.99 kg/m^2, 30 - 39.99 kg/m^2 and 40 kg/m^2 or more should be reported by sex, age and race. Ideally population data on anthropometric variables should be presented by sex and 5-year age groups. Any other stratification (e.g. geographic, socio-economic, ethnic) used in the sample selection should also be used in the presentation of data. Summary statistics will require proper adjustment for age and other variables used in sample selection. An analysis of the primary data (weight, height, circumferences) must be provided where indices (e.g. BMI and abdomen: hip circumference) are used for assessing the functional outcomes of overweight. Because selective mortality is associated with both overweight and

underweight, it is important to supplement cross-sectional data with longitudinal data on the health effects of overweight in different populations.

The use of reference data for assessment of overweight

Because the prevalence of overweight varies widely between countries, and because there are no indications that different populations with the same distributions of BMI have similar relative and attributable risks of morbidity and mortality associated with different degrees of overweight, there is currently no obvious need for reference data for BMI (World Health Organisation, 1995). In order to obtain the distribution of BMI values in a healthy population, it is important that data are derived from people without nutrition problems, chronic or acute disease and who do not smoke. The recommended cut-off points for BMI refer to cross-sectional data only. It is believed that weight fluctuations, weight gain and weight loss, are themselves indicators of risk. However, it is not currently possible to recommend cut-off values for such weight changes which would allow for the identification of high risk groups (World Health Organisation, 1995). Anthropometric data for the potential development of reference data or standards should cover at least weight and height, age, sex, race, socio-economic status, presence of disease, and smoking habits.

In the future, it may be possible to develop better anthropometric indicators of fatness and distribution in adults; indicators that would monitor change in visceral fat distribution would be particularly important.

1.4.8 Anthropometry in elderly adults in developed countries

The term 'elderly' is generally applied to those aged 65 years and over. This group represent the fastest growing segment of population throughout the world, with particularly pronounced growth in developed countries. In Ireland, people aged 65 years and over make up 11 % of the total population (Central Statistics Office, 1996). Elderly people account for 44 % of all Irish people living alone (Central Statistics Office, 1996), and 35 - 38 % of all hospital admissions (HIPE, 1995; St James's and Meath Hospitals). Other demographic changes that accompany population ageing are sex differences in longevity, urbanisation, and the composition of the labour force. In most countries, older women outnumber older men and the percentage in this age group is steadily increasing. Urbanisation results in migration of younger people to cities, resulting in a disproportionately larger older population in rural areas. In rural areas, elderly people frequently continue to work in contrast to elderly urban people who must retire at 60 or 65 years. These changes have an enormous impact on the health services demanded and required.

Anthropometry and ageing

Height

Decline in height with age has been noted in studies throughout the world. The rate of decline is 1 - 2 cm/decade and is more rapid at older ages (World Health Organisation, 1995). It is particularly apparent in sitting height and is the result of vertebral compression, change in height and shape of the vertebral discs, loss of muscle tone, and postural changes. Results of cross-sectional studies may be confounded by the secular increases in height among younger cohorts (Eveleth & Tanner, 1990). Height-related differences in survival rates may also affect results of cross-sectional studies but this needs further investigation and may vary between populations depending on various environmental and genetic factors. It is important that measured, not reported height is always used in the elderly. An overestimation of height by an average of 4.85 % was found in the 49 % of elderly inpatients who claimed to know their height (Haboubi *et al*, 1990). The average maximum lifetime loss of height is known to be 2.9 cm in men and

4.9 cm in women (Taren & Schler, 1990). If stated height is used to calculate BMI, this loss of height may introduce inaccuracy into the calculated index although a small survey of Irish patients attending their general practitioner observed that most patients reported age with reasonable accuracy (Doyle *et al.* 1998). No differences were observed between the younger and older age groups in the accuracy of reporting.

A number of methods are available to estimate height in the elderly. These include knee height and arm span measurements. Knee height is the distance from the sole of the foot to the anterior surface of the thigh with the ankle and knee each flexed to a 90 degree angle. It can be measured more accurately if the patient is recumbent rather than in a seated position (Chumlea *et al.* 1985). Knee height can be used to estimate the stature of an elderly person who is bed-bound or who has such spinal curvature or chest deformity that an accurate stature measurement cannot be made. Knee height changes little with age. A 90 % confidence limit that true stature for elderly men and women can be estimated within $\pm$ 6cm from a recumbent measure of knee height in men and knee height and age in women has been shown (Chumlea *et al.* 1985). The knee height measurements gave essentially the same degree of accuracy in a group of 165 elderly Welsh people when compared to the group of 236 elderly Americans previously assessed (Chumlea *et al.* 1985). The measurement of knee height in large scale epidemiological studies, without difficulty and with a precision of $\pm$ 0.2 cm in repeat measurements by a single observer has been confirmed (Roubenoff & Wilson, 1993). Their study supports the use of knee height rather than height in comparing body composition across age groups. However, another study concluded that the measurement of knee height was superior to that of arm span in elderly patients (Sullivan *et al.* 1989). A comparison of height and knee height measurements made on a group of thirty-four 'healthy' non-institutionalised individuals (Bannermann *et al.* 1996) showed that for the group no significant difference between measured height and estimated stature was observed and that 95 % confidence limits of agreement were achieved. However, the authors postulate that potential inaccuracies in estimating stature at an individual level could result in the inaccurate calculation of BMI which could have implications in terms of identification of individuals at risk of malnutrition. Another study (Haboubi *et al.* 1990) reported that measured height was found to correlate best with supine total arm length (R^2=0.69), although knee height and erect

forearm length were also closely correlated, (R^2=0.63 and R^2=0.61) respectively. The study by Kwok & Whitelaw (1991) confirmed that that arm-span can be readily estimated by demi-span and that it approximates to height. However, considerable individual variation was shown to occur. When arm-span was used in an equation to calculate BMI in this group of 101 elderly people, significant overestimation of undernutrition occurred, 24 % versus 9 % when measured height was used. Demispan has been used in two large British surveys on the elderly living in their own homes. (Lehmann *et al.* 1991, 1996). However, no comparison of demi-span to measured height was made in either of these studies.

Weight

Weight also declines with age but the pattern of change is reported to be quite different from that of height and varies by sex. Weight gains in men tend to plateau at around 65 years and weight generally declines thereafter; in women, however, the weight increases are frequently greater and the plateau occurs about 10 years later than in men (World Health Organisation, 1995). Changes accompanying the weight loss include a decline in muscle cell mass, and in cell mass in general, which is more pronounced in men (Fischer & Johnson, 1990; World Health Organisation, 1995). Reduction in body water content has been described in a Swedish longitudinal study (Steen *et al.* 1985), while a decrease in total body intracellular volume with a simultaneous increase in total plasma volume has been reported (Granieri, 1990). The decline in weight was observed to be 2.5 kg per decade in men, and 3.5 kg per decade in women (Lehmann *et al.* 1991). A four year follow-up study on weight changes in 629 elderly men and women living in their own homes confirmed that ageing, in old age, is associated with loss of body weight, but with a large intra-individual variation. However, neither the initial body weight nor the change, was associated with mortality or morbidity over the four year period (Lehmann *et al.* 1996). As a clinical goal, however, it is reasonable to set maintenance of weight (within 10 % of usual body weight) (World Health Organisation, 1995).

Smaller degrees of weight loss in the elderly by comparison with younger adults may assume higher clinical significance. Involuntary weight loss of greater than 4 %

annually appears to be clinically important as an independent predictor of increased mortality in the elderly (Wallace *et al.* 1995). The range of weight loss cited in the literature as clinically significant in the elderly includes 2 kg / year (Rajala *et al.* 1990), 4.5 kg over two years (Dwyer *et al.* 1987), 5 % over six to twelve months (Marton *et al.* 1981), 7.5 % over six months (Thompson & Morris, 1991) and 10 % over six months (Morley *et al.* 1988). Mortality is significantly greater in elderly patients with low weights than in those with normal weights (Agarwal *et al.* 1988). A common belief that most geriatric patients with persistent weight loss have an occult malignancy was not substantiated in the study by Thompson & Morris (1991). Malignancy was found in only 16 % of forty-five patients with significant unexplained weight loss (7.5 % over 6 months). In 24 % of the patients, however, the cause of the weight loss remained unknown after at least 24 months of clinical investigation and observation. Depression occurred in 18 % of these geriatric patients and deserves greatest attention, being potentially reversible. A review on undernutrition in the elderly cites alterations in the gastrointestinal tract, functional disabilities, lowered socio-economic status, social isolation and polypharmacy as contributing factors to weight loss in the aged (Fischer & Johnson, 1990). However, despite its clinical and nutritional importance, body weight is frequently not recorded for elderly people receiving nutritional support because of mobility problems, illness, or the unavailability or unreliability of equipment.

Body mass index

Like weight, average body mass index in developed countries tends to increase in middle age and stabilises somewhat earlier in men than in women. In men, the plateau may begin at 50 - 60 years or even at 70 years of age; in women it starts at 70 years or later. Both sexes generally show a decrease in average BMI after 70 - 75 years of age (World Health Organisation, 1995). The relationship between BMI and fat and muscle mass changes with age. Data from NHANES I and II have shown that BMI is more highly correlated with subcutaneous fat (estimated by subscapular skinfold) in younger than in older men and women, and with muscle mass in older than in younger adults (Micozzi & Harris, 1990). Thus, a young person with a high BMI is likely to have more subcutaneous fat than a person with a relatively low BMI. However, BMI may have different significance in elderly individuals and young adults, because of the

reduction in height , and it is uncertain whether current height or young adult height is the better for deriving BMI.

It should be emphasised that BMI may not decline with increasing age; indeed, it may be higher at age 70 and above than at younger ages because of the age-related changes in both height and weight and morphological changes in the vertebral column that result from osteopaenia and increased curvature. Morphological changes in the spine influence mobility, balance, and sometimes respiration. With extensive vertebral changes, height measurement cannot be accurate and has little value.

The recommended cut-off point for low BMI of 18.5 kg/m^2 for adults may be relevant for the elderly, at least from 60 - 69 years, but whether different cut-offs are more appropriate in individuals of 70 or more years is uncertain (World Health Organisation, 1995). For individuals classified as overweight, the BMI cut off of 30 kg/m^2 recommended for adults may also be considered as a health risk marker, at least in those under the age of 70 years, who may be considered for nutrition counselling. When there is no pre-existing chronic disease, older individuals who have remained overweight are probably best advised to maintain their weight; for individuals with pre-existing disease, however, weight control associated with overall clinical treatment is recommended. All groups should be encouraged to increase both physical activity and nutrient density in order to maintain or augment lean body mass (World Health Organisation, 1995).

Body composition

Significant changes in fat-free mass and patterns of fat distribution occur with ageing. Cross-sectional studies show a slow, progressive redistribution of fat in the elderly, with subcutaneous fat on the limbs tending to decrease and intra-abdominal fat to increase. The former is reflected in a decline in calf, thigh, triceps, and biceps skinfolds (World Health Organisation, 1995) and the latter by an increase in the abdomen: hip circumference ratio. Women accumulate more subcutaneous fat than men and lose it at a later stage. Computed tomography scans have shown that fat weight is similar in middle-aged and older men but that there is less subcutaneous fat and

significantly more intra-abdominal fat in older men (Borkan *et al.* 1983). The same investigators also reported more fat between and within muscles in older men.

The Baltimore Longitudinal Study of Ageing in the USA measures a large sample of volunteer adults every two years. A number of indices have been computed, including the ratio of subscapular skinfold to triceps skinfold; this index compares subcutaneous fat at a trunk site with that at an extremity site. There are large sex differences in the ratio, which is greater for men at all ages than for women, and increase with age in men but not in women (Shimokata *et al.* 1989).

Using underwater weighing of 200 healthy Swedish men and women aged 45 - 78 years, Bjorntorp & Evans (1992) reported changes in the percentage of weight that is represented by body fat. At 45 - 49 years, men averaged 25 % fat and women 30 %. At 60 - 65 years, men had stabilised at 38 % fat. Women stabilised at 43 % fat at 55 - 59 years. Between 60 and 78 years, neither men nor women showed much change in percentage body fat.

Body circumferences and skinfold thicknesses are useful in clinical practice for the initial classification of patients, but are generally not sufficiently precise for short-term follow-up and monitoring. It is unlikely that these measurements will really change if weight does not, and the simplicity of measuring and interpreting a change in weight makes body weight the measurement of choice for short-term follow-up. However, if there is an increase in weight due to oedema or ascites, the clinician may wish to assess somatic protein stores, in which case calf circumference is probably the most useful measurement, being independent of any changes in the abdomen (World Health Organisation, 1995).

Assessment of functional ability in the elderly

Assessment of functional ability is important in the evaluation of older people; it is generally rated in terms of daily routine activities such as, walking, dressing, and eating. A variety of simple functional tests are available, including hand grip strength, 10-metre walking time, time to rise from a chair, and ability to stand on one leg. These tests are good predictors of function, and generally correlate with lean body mass and muscle mass (Vellas *et al.* 1992).

Some evidence suggests that loss of lean body mass predicts functional status, especially in the elderly. Muscle strength is one of the best predictors of independence and mobility (Fiatarone *et al.* 1990) but by age 70 years, it is estimated that muscle strength is about 35 - 45 % lower than its peak value in youth. That strength is directly determined by the amount of muscle mass is less clear, with some authors arguing that it is (Frontera *et al.* 1991), and some reporting that in the elderly, loss of strength associated with ageing is not accounted for entirely by a loss of muscle mass (Welle *et al.* 1996) who conclude that the age-associated loss of muscle fibres is related to a loss of α-motoneurons and that the force generating capacity of residual contractile material is unaltered. This conclusion is supported by Astrand (1992) who observed that there are normally no signs of degenerated fibres in ageing muscle and that the fibre content is relatively constant, independent of age.

Poor nutritional status and changes in body composition are believed to be associated with increasing problems of balance and gait in the elderly and thus with risk of falls (Vellas *et al.* 1990).

Variation in anthropometry in the elderly population

In any given population, individual variation is increased because of variable rates of ageing. Most studies show that the distribution of BMI among those reporting poor health extends further to the left than it does among those reporting very good/excellent health. However, some studies show considerable overlap in the left-

hand side of the distribution of those reporting poor health and those reporting excellent health (World Health Organisation, 1995).

Anthropometry as an indicator of nutritional and health status in the elderly

Although the anthropometric characteristics of individuals and populations are simple and strong predictors of future ill health, functional impairment, and mortality in the elderly, anthropometry is a relatively new tool and thus difficult to evaluate (World Health Organisation, 1995). The comparative analysis of world populations suggests that the predictive power of anthropometric indicators relative to a specific outcome is likely to vary with a number of factors such as age-related biological changes, illness, secular changes, childhood diseases, lifelong practices (smoking, diet, exercise), and socio-economic factors. For individuals aged over sixty-five years the health risk of overweight is unclear; in fact, population data indicate that moderate overweight at older ages is associated with lower mortality (Andres, 1985). Among those older than eighty years, thinness and loss of lean body mass may be a more significant problem than overweight. Whether a high abdomen: hip ratio is a significant risk factor among the elderly is unclear.

Height, weight and BMI are good indicators for risk of morbidity and mortality in young and middle-aged adults. The situation is less clear in the elderly since a given BMI does not necessarily imply the same amount of fat and muscle (Micozzi & Harris, 1990) as in younger individuals. In a Finnish study (Rissanen *et al.* 1989) lowest mortality occurred at somewhat higher BMI among men aged over seventy-five years than among younger men. Overweight did not reduce life expectancy in Finnish women aged 65 - 79 years (Rissanen *et al.* 1991); indeed a moderate degree of overweight seemed to be protective against death, with the most favourable BMI being 27 - 31 kg /m^2. A follow-up study in Finland of ninety-five men and 431 women aged over eighty-five years showed that low BMI was a more important predictor of risk of death than high BMI (Mattila *et al.* 1986). Highest five year mortality was reported in the group with BMI below 20 kg/m^2 and the lowest in the group with BMI above 30 kg/m^2. It was concluded that overweight ceases to be a risk factor for death in this age group. Similar results from a follow-up to the NHANES I in the USA revealed that the moderate

additional risk of death associated with weight apparent in older men was not apparent in older women (Tayback *et al.* 1990). When analysis was controlled for poverty, smoking, and elevated blood pressure, high BMI was associated with somewhat increased mortality risk in older white men and no increased risk in older white women. Other analyses of these data suggested that, compared with older people of moderate BMI, heavier and very thin white older women and non-smoking white older men were at increased risk of death (Cornoni-Huntley *et al.* 1991). In the Framingham Heart Study in the USA, there was a positive relationship between BMI and mortality in non-smoking men and women over sixty-five years of age in follow-up studies of from one to twenty-three years (Harris *et al.* 1988). Survival was lower among individuals in the 70th percentile for BMI (28.5 kg/m^2 for men, 28.7 kg/m^2 for women) than among thinner individuals with moderate BMI. Those who were overweight at sixty-five but not at fifty-five years of age were at lower risk of death than those who gained 0 - 9 % BMI, and those who lost 10 % of BMI were at almost twice the risk.

Both overweight and thinness appear to carry risk for mortality, but in the elderly thinness carries a greater risk than overweight. Weight change, especially involuntary weight loss, also poses considerable risk, which may interfere with the interpretation of the data from large studies.

Interpretation issues in the elderly

Differences between young people and the elderly in the relationship between body weight and other variables are due, in part, to the influence of on body size and fatness of the normal physiological effects of ageing. There is considerable lack of understanding of the functional and health-related implications of anthropometric indicators in older people. Moreover, the redistribution of body fat from the extremities to visceral areas in the elderly hampers the adequate estimation of body composition when anthropometric models based on younger adults are applied. Data derived from magnetic resonance imaging or computerised tomographic scanning of the elderly reveal not only a progressive redistribution of fat from the extremities to the visceral area but also the replacement of muscle tissue by intramuscular fat (Fiatarone *et al.* 1990); this is not reflected in anthropometric measurements of subcutaneous fat. It should therefore

be kept in mind that use of anthropometry in the elderly may well result in the underestimation of body fat, and this phenomenon is absent from the young healthy reference population so often used to validate scientific methodology. The use of anthropometric techniques in older adults must be validated on individuals of the appropriate ages. It is unlikely that present methods can avoid this bias.

Traditional measurements of body size may also fail to provide adequate estimates of nutritional status or the effects of nutritional intervention in the elderly. In elderly women, there is significant negative correlation between abdominal circumference and sitting height (Chumlea *et al.* 1984). In elderly men, increased time spent in sedentary activities in retirement may explain some of the age-related loss of lean body mass. A significant negative correlation between age and calf circumference is noted in elderly men, but not in women, and may be due to general loss of muscle in response to the greater reduction in physical activity among men than women. Calf circumference is considered the most sensitive measure of muscle mass in the elderly (World Health Organisation, 1995).

Limitations with the use of anthropometry in the elderly

A number of intrinsic limitations are common to the use of anthropometry in all age groups; these include the effect of body fluid changes on weight, skinfolds, and circumferences, and the inability of sick people to stand for height measurements. In the elderly, there are additional constraints, such as the difficulty of obtaining measurements of weight, height, and other anthropometric variables when a large proportion of the population of interest is unable to walk or stand. From a clinical standpoint, however, the elderly are often the most important target population for intervention. However, when using anthropometry in individual elderly patients, there is lack of agreement on its clinical usefulness for prognosis and for evaluating the response to treatment. The anthropometric measurements that may be useful in classifying individuals according to their initial nutritional status often differ from those that are useful for following people over time or for assessing their response to an intervention. The differences arise from the greater importance of accuracy and appropriate reference data for initial

classification, in contrast to the precision that is essential for repeat measurements in follow-up studies (World Health Organisation, 1995).

In addition, problems in the interpretation of anthropometric data in the elderly may arise from selective survivorship in cross-sectional studies. It should be noted that any alteration in the distribution of BMI in the elderly may be due to a cohort effect. When assessing the determinants of thinness and overweight in the elderly, prevalence of depression, institutionalisation, injury resulting from falls, poverty, solitary living, illness, and social support networks must all be considered.

Nutrition surveillance in the elderly

Population surveys have often failed to include the elderly, and this situation may be worsened by the reluctance of older people to be measured or interviewed. It is recommended not only that the elderly be included in nutritional surveillance, but that they be specifically targeted since they may be prone to hidden deficiencies that can be corrected by nutritional and health programmes. The elderly should be recognised as a group at risk and efforts should be made to maintain or improve quality of life for the elderly. For nutrition surveillance of those aged sixty years and more, anthropometric data should ideally be presented by five-year age groups, but ten-year age grouping is more realistic (World Health Organisation, 1995). Biological age groups would be even more appropriate since different organ systems age at different rates and there are no reliable biomarkers of ageing. Because anthropometry varies markedly according to gender in the elderly, all data must be analysed by gender.

Reference data for the elderly

Appropriate use of anthropometry requires the comparison of data from individuals of the same age, sex, and, as far as possible, genetic and environmental background. Currently available normative data rarely include the very old. Even the data from NHANES II, the most comprehensive data set for anthropometry does not include people aged over seventy-four years (Bishop *et al.* 1981; Frisancho *et al.* 1984). Canadian normative data cover people up to the age of seventy years, Japanese data

cover those over eighty years and UK data from South Wales cover those aged over sixty-five years (Burr & Phillips, 1984).

The World Health Organisation Expert Committee (1995) considered the validity of various data sets of anthropometry in the elderly for use as references, applying the criteria that data should be presented by ten-year age groups and by sex; that means, standard deviations, and percentiles should be available for each anthropometric variable and age group; and that data for people over eighty years of age should be included. It was felt that data from people in their sixties should not be extrapolated to those in their eighties. Moreover, the population sample should be free from major disabilities and living in a healthy environment, although it would be likely to contain some unhealthy individuals, since most elderly people probably have one or more disease conditions. The definition of health used to select the sample has a major influence on the reference data. The high prevalence of disease in the elderly means that very few are completely free of disease. There may also be significant cohort effects in the elderly: the elderly of today grew up under quite different conditions from those who will be elderly in twenty or forty years time.

Recognising the limitations of available reference data, the World Health Organisation (1995) did not recommend universal reference data at this time but, rather, the collection of data to describe local levels and patterns. The use of the available reference data is pertinent only to compare means and standard deviations across populations. They should not be used as standards. Different populations show large geographical and ethnic variations in height, weight and BMI, much of which reflects differences in lifestyle and environment throughout life, genetic differences, and to an uncertain extent, differences in health status. All countries are encouraged to collect anthropometric data on elderly adults, to monitor the health of this sector of the population through anthropometric surveys at regular intervals and to seek to fill the numerous gaps in knowledge of the use of anthropometry to assess physical status in the elderly (see **Appendix 1**).

Chapter 2
General Methodology

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2.0 Introduction

The study design and method of patient selection for each study is described in the relevant chapter (i.e. **Chapter 3:** Prevalence of undernutrition on admission to hospital; **Chapter 4:** Assessment of nutritional risk on admission to hospital; **Chapter 5:** Nutritional status of Irish surgical oncology patients; **Chapter 6:** Development of anthropometric reference data for the elderly Irish population; **Chapter 7:** Assessing nutritional status of elderly patients admitted to hospital). With the exception of a small number of subjects in **Chapter 6**, the work reported in this thesis, including the anthropometric measurement of patients and healthy elderly, all patient assessments, data entry and analysis was carried out by the author (C. Corish).

The methods common to all three studies are described in this chapter.

2.1 Ethical approval

Ethical approval for each study was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals. In the hospital studies written informed consent was obtained from each patient or, from a relative if the patient was unable to give informed consent, before the measurements were made. Copies of the approval and consent forms for each study can be seen in **Appendix 2.**

2.2 Anthropometry

2.2.1 Height

Height was measured to the nearest mm with a Leicester portable stadiometer (Chasmors Weighing Equipment Ltd, London, UK) (see **Figure 2.1**). All subjects removed their shoes. If the subject had a hairstyle which would make the reading inaccurate, they were asked to alter it. The stadiometer was placed on a hard flat surface and the subject stood facing forward with feet flat on the base plate, heels against the rod, back as straight as possible and arms hanging freely at the sides. The headplate was lowered to just above the subject's head which was then carefully positioned so that the Frankfort Plane was horizontal, in order to extend the participant to maximum height. To achieve this, the head was tilted forward until the top of the external ear canal and the top of the lower bone of the eye socket were on a plane parallel to the floor. Once in this position, the subject was instructed to focus on a point straight ahead and to breathe in and stretch to their fullest height while maintaining the head in the Frankfort position. The subject remained in position while the reading was recorded. For consistency with methods used to collect reference data, no additional upward pressure was exerted on the mastoid processes. Although there is a well-recognised diurnal variation in height (Werther, 1998); a person is tallest on rising in the morning, and shrinks by 0.5 - 1.5 cm during the day (as the spine becomes compressed and the spinal muscles tire), it was impossible to measure all subjects in these studies at the same time of day. It is unlikely that these small differences in height affected the classification of BMI in all but the occasional subject. In the studies on patients in hospital, the height recorded on admission to hospital was used for calculating BMI throughout the study. In the first survey (see **Chapter 3**), if height could not be measured on admission to hospital but was measured on discharge, this measurement was used to calculate BMI both on admission and on discharge. Where height could not be measured, knee height was measured and stature calculated.

2.2.2 Knee height

At present there are no guidelines regarding the degree of spinal curvature that would invalidate the measurement of height (World Health Organisation, 1995) but there are obviously individuals whose height should not be measured because of kyphosis or other postural problems. In hospitalised patients, it may be impossible to measure height on admission if the patient is very ill or badly injured. In such cases, knee height should be used as a surrogate (World Health Organisation, 1995). Arm span has also been used as a surrogate for height, but may be less satisfactory than knee height because of joint stiffness in the elderly and because the number of joints involved can reduce the accuracy of measurement. Arm span is also believed to yield young adult height rather than the current (reduced) height of the older individual, since there is little reduction in the length of the long bones with ageing (World Health Organisation, 1995). The average maximum lifetime loss of height is 2.9 cm for men and 4.9 cm for women (Taren & Schler, 1990). In addition, the reliability of knee height measurements has been shown to be superior to that of arm span measurements in elderly patients (Sullivan *et al.* 1989).

In bed bound individuals, knee height can be measured more accurately if the patient is recumbent rather than in a seated position (Chumlea *et al.* 1985). A 90 % confidence limit that true stature for elderly men and women can be estimated within ± 6 cm from a recumbent measure of knee height in men and knee height and age in women has been shown (Chumlea *et al.* 1985). In bed-bound patients in the first survey (*n* 95) (see **Chapter 3**), knee height was measured as the distance from the sole of the foot to the anterior surface of the thigh with the ankle and knee each flexed to a ninety degree angle. It was measured with a sliding broad-blade calliper (Chasmors Weighing Equipment Limited, London, UK). The fixed blade of the calliper is placed under the sole of the foot, and the shaft positioned so that it passes over the lateral malleolus and just posterior to the head of the fibula. The moveable blade is placed over the anterior surface of the thigh, above the condyles of the femur, about 4 cm proximal to the patella. The shaft of the calliper is held parallel to the shaft of the tibia and pressure is applied to compress the tissues. The measurements were recorded to the nearest 0.1 cm.

Stature was then calculated using the equations developed by Chumlea *et al.* (1985) (see **Appendix 3**).

The measurement of knee height in large scale epidemiological studies, without difficulty and with a precision of ± 0.2 cm (1 SD) in repeat measurements by a single observer has been confirmed (Roubenoff & Wilson, 1993). Their study supports the use of knee height rather than height in comparing body composition across age groups.

2.2.3 Weight

Weight was measured using a high specification portable Seca 870 weighing scales with a weighing range of 10 - 150 kg (Chasmors Weighing Equipment Limited, London, UK) (see **Figure 2.2**). This scales contains a built-in, long-life solar cell which lasts for 100,000 weighing operations. The scales was regularly checked against two others of similar make. No re-calibration of the scales was required during the study period.

The weighing scales were placed on a level, fixed surface in a room with adequate lighting. The solar cell was then briefly covered to automatically zero the scales. All subjects were weighed standing facing forwards in the middle of the scales with arms hanging by their sides. Once the weight reading was displayed, weight was recorded and the subject stepped off the scales. All subjects were weighed once on each weighing occasion.

Any hospitalised patient who could not stand was weighed on mechanical chair scales, calibrated against the Seca 870 weighing scales. In those patients in the first survey who could not be weighed (*n* 50) (see **Chapter 3**), weight was calculated using calf circumference, knee height, mid-arm circumference and subscapular skinfold thickness using the equations of Steinbaugh (Steinbaugh *et al.* 1986). (see **Appendix 4**).

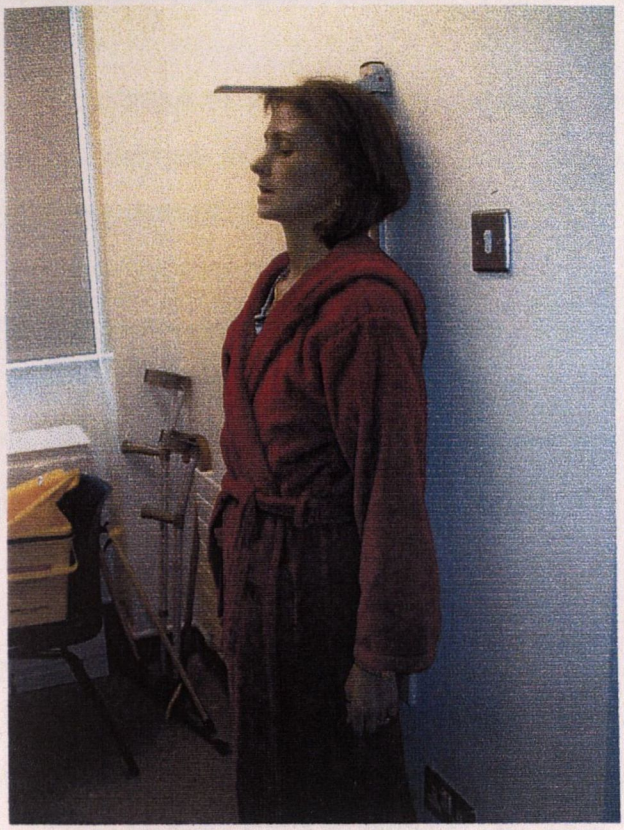


Figure 2.1.
Measurement of height



Figure 2.2.
Measurement of sitting weight

2.2.4 Percentage weight loss

Information on weight loss and duration over which it occurred was collected by patient interview and was expressed a percentage loss of pre-illness weight using the following formula:

Percentage weight loss = [(usual weight* - current weight ÷ usual weight] x 100.

*usual weight was determined from patient recall or from the weight recorded on a previous hospital visit.

2.2.5 Skinfold thickness measurements

A Holtain skinfold thickness callipers was used which provided a standardised pressure of 0.01 kg/min^2 (0.098 N/mm^2)+ 10 % at all jaw openings. Each division on the dial was 0.2 mm, but the instrument could be easily read to 0.1 mm by the interpolation between the markings. Three consecutive measurements were made at each site with the subject in the standing position and recorded to 0.1 mm. The mean of these three measurements was used as the skinfold thickness measurement of the site.

Triceps skinfold

For consistency with the reference data, measurements were taken on the right arm in patients aged under sixty-five years (Bishop *et al.* 1981) (see **Figure 2.3**) and on the left arm (Burr & Phillips, 1984) in those aged sixty-five years or more. The triceps skinfold was measured in the mid-line of the posterior aspect of the arm, over the triceps muscle at a level midway between the lateral projection of the acromion process at the shoulder and the olecranon process of the ulna (at the point of the elbow). With the elbow flexed to 90 degrees, the lower arm across the body and the palm facing upwards, the mid-point was determined by measuring the distance between the two landmarks with a tape measure. Where possible, the subjects was measured standing, with the arm hanging loosely at the side. A vertical fold of skin was picked up gently with the left

thumb and index finger, approximately 1cm proximal to the marked level, and the tip of the callipers applied perpendicular to the skinfold at the marked level. Where the patient was bed-bound, the triceps skinfold thickness was measured with the individual lying on the opposite side to that to be measured. The trunk was positioned in a straight line, the legs bent and tucked up slightly and the arm to be measured laid along the trunk, palm down. The triceps skinfold measurement was made at the mid-point between the lateral projection of the acromion process at the shoulder and the olecranon process of the ulna. A double fold of skin and subcutaneous tissue was taken between the fingers and the thumb, about 1 cm from the marked level. The fold of skin was on the back of the arm, in the mid-line and parallel to the long axis of the upper arm. The measurements were made with the jaws of the callipers placed perpendicular to the length of the skinfold at the level of the marked mid-point. The measurement was read with the observer bending down to read the calliper to avoid errors due to parallax.

Biceps skinfold

Measurements of biceps skinfold thickness were taken on the right arm in patients aged under sixty-five years (Bishop *et al.* 1981) and on the left arm (Burr & Phillips, 1984) in those aged sixty-five years or more. Where possible, the measurements were made with the subjects standing upright with the arms hanging by the sides. The measurement was made over the biceps muscle following the same procedure as for the measurement of triceps skinfold thickness. In bed-bound patients, the measurements were made in the same manner as the triceps skinfold thickness measurements in this group of patients.

Subscapular skinfold

The subscapular skinfold was picked up gently on a diagonal, inclined infero-laterally at approximately forty-five degrees to the horizontal plane in the natural cleavage lines of the skin, just inferior to the inferior angle of the scapula. Where possible the measurement was made with the patient standing erect, with the arms relaxed at the sides of the body with the calliper jaws applied 1 cm infero-lateral to the thumb and finger raising the fold. In bed-bound patients, the measurement was made

with the patient in the same position as for the measurement of triceps skinfold. The skinfold thickness is measured just posterior to the inferior angle of the scapula, with the calliper positioned perpendicular to the length of the skin fold and the jaws of the calliper applied medial to the fingers, at a point lateral and just inferior to the inferior angle of the scapula.

Supra-iliac skinfold

Where possible, the patient maintained an upright position holding his left arm across his chest while the supra-iliac skin-fold thickness was measured in the diagonal plane 2 cm above the iliac crest in the mid-axillary line. In bed-bound patients, the patient maintained the same position as for the measurement of triceps skinfold. The measurement was made in the diagonal plane 2 cm above the iliac crest in the mid-axillary line.

2.2.6 Circumference measurements

Measurements of body circumferences were made with a plastic insertion tape measure (Lasso, Child Growth Foundation, London, UK). The elasticity and deformation of the measuring tape was determined to be 25N (2.5kg) (see **Appendix 5**). Measurements were made with the tape snug to the skin but not compressing the soft tissues. All circumference measurements were recorded to the nearest 0.1 cm.

Mid-arm circumference

For consistency with the reference data, measurements were made on the right arm in patients aged under sixty-five years (Bishop *et al.* 1981) (see **Figure 2.4**) and on the left arm (Burr & Phillips, 1984) in those aged sixty-five years or more. The circumference was measured at the mid-point of the arm with the arm hanging loosely by the side of the trunk, the palm towards the thigh. To locate the mid-point of the arm, the subjects elbow was flexed to ninety degrees with the lower arm across the body and the palm facing upwards. The mid-point of the back of the upper arm between the tip of

the olecranon and acromial processes was measured and marked with a pen. In patients who were bed-bound, the arm was extended alongside the body, with the palm facing upwards. The arm was then raised slightly off the surface of the bed by placing a pillow under the elbow. The hand was placed through the loop of the tape measure and the measurement recorded.

Arm muscle circumference

Mid-arm muscle circumference was calculated from mid-arm circumference and triceps skinfold thickness according to the formula:

Mid-arm muscle circumference (cm) = mid-arm circumference (cm)
- [π x triceps skinfold thickness (cm)]

This formula assumes that the upper arm is cylindrical and ignores the contribution to arm volume made by the humerus. Nonetheless, the measurement derived from this formula is widely used.

Calf circumference

Calf circumference was measured on the left side of the body in all hospitalised patients (Chumlea *et al.* 1987). It was measured on both sides of the body in the healthy elderly population (see **Chapter 6**). The hospitalised patients lay in the supine position with the left knee and ankle each bent at a ninety degree angle. The calf circumference was measured by slipping the loop of the tape over the left foot and moving it up and down the calf to locate the maximum circumference in a plane perpendicular to the long axis of the calf. The measurement was then recorded to the nearest 0.1 cm. In the healthy elderly (see **Chapter 6**), the diameter of the calf was recorded with subjects standing upright as it was not possible to measure calf circumference in the recumbent position in this group. An undergraduate student project (O'Toole, 1998) observed significant differences in young healthy volunteers (*n* 20) between calf circumference measured in the standing position when compared to measurements made in the sitting, lying, relaxed and held positions. Obviously it would be preferable to have reference

data for calf circumference for a variety of positions and a similar study should be carried out to ascertain if this finding is also pertinent to elderly subjects. However, as these data are currently not available it was not valid to reanalyse the calf circumference data from the first study (see **Chapter 3**) using the data described in **Chapter 6** as all calf measurements in the former study were made in the recumbent position while those made in the latter study were in the standing position.

Arm muscle area

Arm muscle area was derived only in the healthy elderly subjects (see **Chapter 6**). It was calculated according to the formula:

$$\text{Arm muscle area } (mm^2) = (\text{arm muscle circumference})^2 \div 4\pi$$

As with arm muscle circumference, this formula also assumes a circular and concentric model. Corrections for estimated bone areas in each sex are recommended for some purposes (World Health Organisation, 1995).

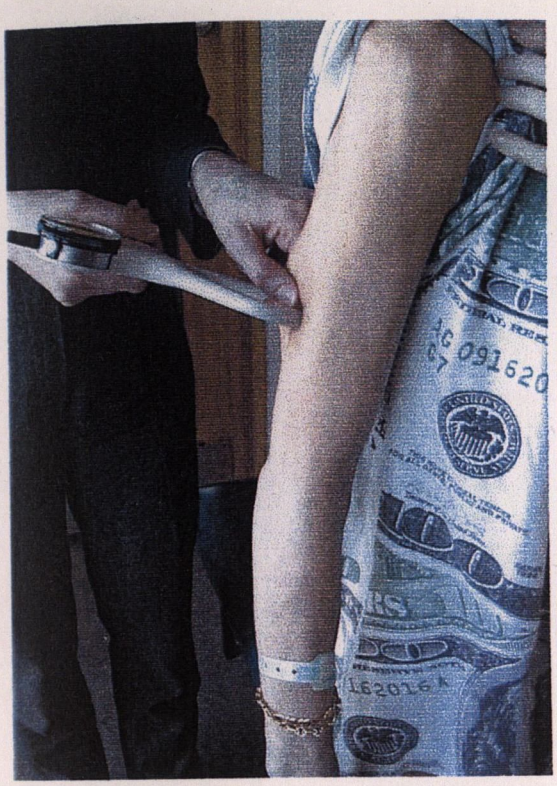


Figure 2.3.
Measurement of triceps skinfold thickness

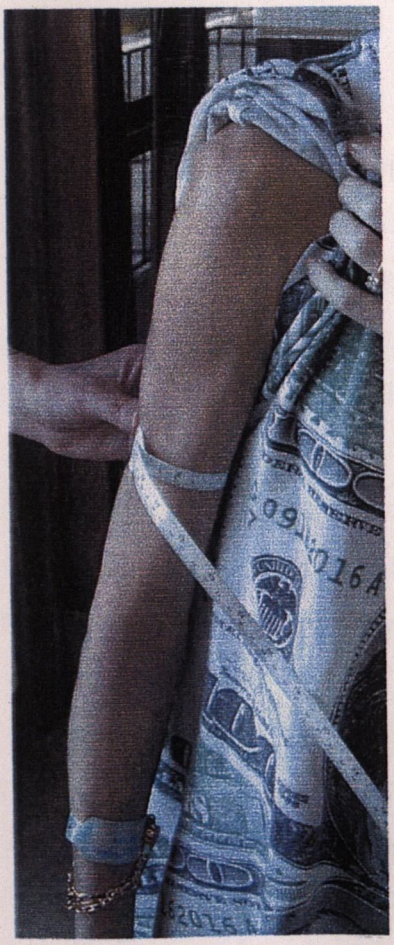


Figure 2.4.
Measurement of mid-arm circumference

2.2.7 Anthropometric reference data

All anthropometric measurements were compared with reference data. The values obtained for patients aged sixteen to sixty-four years were compared with published American reference tables (Bishop *et al.* 1981; Grant *et al.* 1981). The values obtained for those aged sixty-five years or more were compared to Welsh reference data (Burr & Phillips, 1984). In the study on the healthy elderly (see **Chapter 6**), the values obtained for those aged sixty-five to seventy-four years were also compared to the American reference tables (Bishop *et al.* 1981). The hospital survey data in **Chapter 3** were also compared to other published anthropometric reference material for the British (body mass index) (Gregory *et al.* 1990) and Irish (body mass index) (Lee & Cunningham, 1990) populations.

2.3 Functional status

2.3.1 Hand-grip dynamometry

Functional status was measured with a hand-grip dynamometer (TKK 5101, Takai Scientific Instruments Limited, Japan). Grip strength was measured in kilograms to the nearest 100 grams. All subjects were instructed to squeeze the handle as hard as they could upon the examiners signal. The control was reset after each attempt. The highest of three readings made with the non-dominant arm was used in the analyses. Hand dominance was reported by the subject. The measurements recorded were compared to the age and sex specific reference data of Webb *et al.* 1989. Reanalysis of the elderly patient data from the first hospital survey (see **Chapter 7**) used the reference data derived from the healthy elderly Irish population (see **Chapter 6**).

2.3.2 Modified Norton Scale

In the hospital study on surgical oncology patients (see **Chapter 5**), functional status was also measured using a modified Norton scale (Ek & Bjurulf, 1987) (see

Appendix 6). This consists of seven sub-scales; mental condition, activity, mobility, food intake, fluid intake, incontinence and general physical condition, each scored between one and four. The maximum score is twenty-eight, indicating the patient is fully functional. The minimum score is seven, indicating severe impairment. This score has been previously used in a number of studies assessing the clinical outcome of patients receiving nutritional intervention (Unosson *et al.* 1992; Olind Olin *et al.* 1996).

2.3.3 Measurement of fatigue

In the hospital study on surgical oncology patients (see **Chapter 5**), subjective levels of fatigue were also measured using a visual analogue scale (Christensen *et al.* 1982) (see **Appendix 7**). A score of one corresponded to feeling totally fit, while a score of ten implied total fatigue. This score was recently used in a large study assessing the effects of nutritional supplements in post-operative patients who had undergone abdominal surgery (Keele *et al.* 1997).

2.3.4 Quality of life

Quality of life is a broad term and encompasses general physical condition and mental health status as well as psychological adjustment. It is a difficult concept to measure and requires patients' appraisals of their current level of function, that is, their ability to perform routine physical and social functions (Cella & Tulsky, 1990). Studies that incorporate quality of life measures attempt to quantify the presence and severity of disease and show how manifestations of illness and treatment are experienced by the patient. This is useful when comparing those receiving treatment with those not receiving treatment, or when comparing the same patient both before and after treatment (Berzon, 1998). Quality of life was only measured in the hospital study on surgical oncology patients (see **Chapter 5**). It was assessed at each interview using Part 1 of the Nottingham Health Profile quality of life score (Bowling, 1997) (see **Appendix 8**). This score was developed in the UK by Galen Research, Manchester, after interviews with a large number of lay people about the effects of illness on behaviour. It reflects lay rather than professional perceptions of health status. It provides an assessment of perceived health problems in the areas of energy, pain, emotional reactions, sleep, social

isolation and physical mobility. Scores calculated for an individual within each of the above categories vary between 100 (severe impairment of function) and 0 (no impairment of function). The Nottingham Health Profile Part 2 consists of questions directed towards activities of daily living. Patients record yes or no answers to standard questions on whether they have difficulties in the areas of job of work, looking after the home, social life, home life, sex life, interests and hobbies, and holidays. In the UK, the Nottingham Health Profile has been used to evaluate the outcomes of many therapies from the patients perspective, and to assess the perceived health status of patients before and after undergoing specific surgery (e.g. coronary bypass, varicose veins, haemorrhoids, heart transplantation and various orthopaedic conditions) (Bowling, 1997). It has also been used to assess the effects of nutritional intervention in a group of outpatients receiving nutritional support (Jamieson *et al.* 1997). The Nottingham Health Profile was chosen for this study, as a non-disease specific health related quality of life measure was required to assess a study population made up of individuals with very different types of cancers (Fitzpatrick *et al.* 1992; Fletcher *et al.* 1992). This quality of life instrument has also been shown to correlate well with other tests of health status (Hunt *et al.* 1980).

2.4 Blood biochemistry

Blood biochemistry was included only in the surveys of hospitalised patients. No funding for additional biochemical tests was available for these studies. Therefore, only routine blood measurements were used where these were available. All blood samples were analysed according to standard procedures in the Central Pathology Laboratory of St. James's Hospital. Results of blood tests were obtained through the centralised computer system of St. James's Hospital. Serum albumin was measured on a Hitachi 717 or Hitachi 747 machine using the Bromocresol green (BCP) method. Haemoglobin and lymphocytes were measured on a Coulter STKS machine. Haemoglobin is a directly measured variable. Volume, conductivity and light scatter (VCS) technology is used to calculate the differential percentage for lymphocytes. The

absolute number of lymphocytes can then be computed by multiplying the differential percentage for the population of lymphocytes by the white cell count.

2.5 Socio-demographic data

Socio-economic grouping from the 1986 census of Ireland (Central Statistics Office, 1986) was used in this study. Each subject was asked about their employment. The entire population is classified into one of eleven socio-economic groups plus a residual "unknown" group if sufficient details are not available. The occupation assigned to each of the eleven groups are generally similar as regards the level of skill or educational attainment required. The socio-economic group of persons aged fifteen years or over who are at work is determined by their occupation. Unemployed or retired persons are classified by socio-economic group according to their former occupation. Persons engaged in home duties or at school or college, who are members of a family unit are classified to the socio-economic group of the person in the family on whom they are deemed to be dependent.

A summary of the socio-economic groups can be seen in **Table 2.1** (for full details of socio-economic groups see **Appendix 9**):

Table 2.1. Summary of the socio-economic grouping used in this thesis

0	Farmers, Farmers' Relatives and Farm Managers
1	Other Agricultural Occupations and Fishermen
2	Higher Professional
3	Lower Professional
4	Self-Employed (with Employees) and Managers
5	Salaried Employees
6	Intermediate Non-Manual Workers
7	Other Non-Manual Workers
8	Skilled Manual Workers
9	Semi-Skilled Manual Workers
10	Unskilled Manual Workers
11	Unknown

2.6 Referral for dietetic/clinical nutrition intervention

Daily liaison with the dietitians / clinical nutritionists on each of the wards to monitor the patients referred to them was undertaken. The ward nursing staff recorded nutritional supplement usage in the event of non-referral to the dietitian / clinical nutritionist. In the first survey (see **Chapter 3**), referral or non-referral to the dietitian was noted. In the study on surgical oncology patients (see **Chapter 5**), an attempt was made to record the day of referral (i.e. admission day +1 or +2 etc.). This, however, was not always a true reflection of the day of commencement of nutritional intervention. Although the dietitian / clinical nutritionist may have had the patient's details on her books, no nutritional intervention was sometimes instigated until further into the

hospital admission. This occurred for a number of reasons including hospital procedure and the practice of the patient's medical consultant.

2.7 Data handling

All results were entered into a database using the Statistical Package for the Social Sciences for Windows version 6.0.1 (SPSS Inc., Chicago). Details of the statistical methods used are described in each chapter. P values of less than 0.05 were considered to indicate statistical significance. All graphs were plotted using Powerpoint for Windows version 7.0 (Microsoft Corporation, 1995).

The issue of patient confidentiality was dealt with by assigning a code number to each patient in the hospital studies (see **Chapters 3, 4, 5** and **7**). Hospital medical charts were read and the information recorded either on the hospital wards or in the patient medical records room. The collection of anthropometric data on the healthy elderly did not require the names of the participants. Therefore, in this study each participant was assigned a code number.

Copies of the data collection forms for each study can be seen in **Appendix 10**.

Chapter 3

Prevalence of undernutrition on admission to hospital

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3.1 Summary

Protein-energy undernutrition, or the possibility of its development, has been documented to occur frequently in patients on admission to hospital. Deterioration in nutritional status is known to occur in hospital. In a prospective study of 594 sequential hospital admissions, we aimed to assess the prevalence of undernutrition among patients on admission to two acute teaching hospitals in Dublin using the widely accepted anthropometric criteria applied in a large study from Dundee (McWhirter & Pennington, 1994) and to determine changes in nutritional status in hospital. The mean prevalence of undernutrition (11 %) was considerably lower than was reported from Dundee (40 %). Unintentional weight loss before admission and functional impairment on admission occurred to a similar extent in both centres. Weight loss in hospital occurred in the same proportion of patients, but less frequently among those undernourished on admission to hospital, in Dublin compared with Dundee. The patients found to be undernourished on admission in this study had a mortality rate in hospital (6.5 %) over three times that of the adequately nourished group (2 %). The magnitude of the difference in prevalence of undernutrition between the two centres could not be explained by ethnicity, case-mix or age distribution. With the secular increase in body mass index in the population, the thresholds for classifying patients as undernourished or at risk of nutritional deterioration may need to be reviewed. The anthropometric reference data currently routinely used for assessing the nutritional status of patients on admission to hospital in the United Kingdom and Ireland were derived from measurements of healthy Caucasian Americans (Bishop *et al.* 1981; Frisancho, 1981) and from elderly people from South Wales in the United Kingdom (Burr & Phillips, 1984). Contemporary, population-specific anthropometric reference data are not available for either the Irish or Scottish populations to date. For clinical use, recent weight loss and functional status may be more appropriate parameters to use for the evaluation of nutritional status on admission to hospital.

3.2 Introduction

The deleterious effects of impaired nutritional status on clinical outcome (Gallagher-Allred *et al.* 1996; Giner *et al.* 1996; Lumbers *et al.* 1996) and hospital costs (Tucker & Miguel, 1996) are widely acknowledged. If undernutrition is adequately documented on hospital admission and appropriate nutrition therapy is initiated, an improvement in clinical outcome should be expected. Protein-energy undernutrition, or the possibility of its development, has been documented to occur frequently in patients on admission to hospital (Butterworth, 1974; Bistrian *et al.* 1976; Hill *et al.* 1977; McWhirter & Pennington, 1994; Naber *et al.* 1997; Gariballa *et al.* 1998*a*). However, these studies examined specific patient groups and employed a number of definitions of undernutrition. As a result, direct comparison between the published studies and current assessment of the overall prevalence of undernutrition on admission to hospital is difficult.

Many studies assessing the prevalence of undernutrition based their results on formulas which included biochemical measurements (Bistrian *et al.* 1976; Hill *et al.* 1977; Coats *et al.* 1993; Veterans Affairs Total Parenteral Nutrition Co-operative Study Group, 1991; Naber et al.1997), for example, albumin, which may reflect either disease severity or nutritional status. The use of serum proteins may lead to inaccuracy in the estimation of prevalence of undernutrition in sick patients as many patients have reduced levels as a result of their disease, although they would not be classified as undernourished if an alternative method of classification were used. Although many believe that anthropometric criteria can define nutritional status more accurately, the reference data available to define nutritional status does not always reflect the normal distribution of the local healthy population (McWhirter & Pennington, 1994). The lack of such local reference material may make interpretation of the estimates of undernutrition more difficult. The reference data in current use in the UK and Ireland were derived from measurements made in the early 1970s of healthy Caucasian Americans (Bishop *et al.* 1981; Frisancho, 1981) while reference data derived from people in South Wales in the United Kingdom, published in 1984, are frequently used for defining the nutritional status of those aged sixty-five years or more (Burr &

Phillips, 1984). Considerable geographical variation in anthropometric variables has been observed (Bishop *et al.* 1981; Frisancho, 1981; Burr & Phillips, 1984; Delarue *et al.* 1994; Launer & Harris, 1996; Bannerman *et al.* 1997; Rea *et al.* 1997). Whereas for survey purposes, the use of standard data allow the rates of obesity and underweight to be estimated in different areas of the world and for secular changes to be monitored, for clinical purposes, reference to local, healthy population data may be more appropriate. Although the standard cut-off values for categorising underweight are based on physiological and medical correlates, these do not consider recent weight loss. In ill patients recent weight loss is also correlated with undernutrition-related-complications, which are, in turn, linked to poor outcome. Therefore, the criterion of body mass index below 20 kg/m^2, widely used in clinical practice, may not always detect those patients at risk of undernutrition-related-complications, for example, patients of high initial body weights who have lost weight (Stack *et al.* 1996) or different ethnic (Launer & Harris, 1996; Norgan, 1994) or age groups (World Health Organisation, 1995; Zemel *et al.* 1997). With the secular increase in adult body mass index, the cut-off values at which patients are considered to be at nutritional risk may have to be reviewed (*e.g.* a BMI less than 22 kg/m^2 was observed to be a significant predictor of mortality in older Italian people living in the community (Landi *et al.* 1999) while in the USA, the BMI at which the elderly are now considered at nutritional risk is now defined as 24 kg/m^2).

3.3 Aims and Objectives

The aims of this study were, firstly, to measure the prevalence of undernutrition among medical and surgical patients admitted to two teaching hospitals in Dublin, using the same anthropometric criteria as were used in a large study from Dundee (McWhirter & Pennington, 1994) and, secondly, to determine changes in nutritional status during the hospital stay. The results of the survey were intended to provide a background for planning the resources needed for effective nutritional care in the study hospitals.

3.4 Patients and methods

During an 8-month period, including a summer (1996) and a winter (1996/1997) season, data were collected from every 10th and 3rd patient respectively admitted to a larger (812 beds) and a smaller (275 beds) Dublin teaching hospital, both with busy Accident and Emergency units and on active call every second day. The list of patient names was obtained from computerised admission records on a daily basis. All patients were assessed within 48 hours of admission. Acute admissions to the special care units in either hospital were excluded such as Intensive Care, Coronary Care, Burns and Bone Marrow Transplant Units. This was because such patients are generally well nourished on admission to hospital and assessment of their anthropometric status is difficult or impossible. Patients admitted to day wards and children under the age of sixteen years were also omitted. Patients were excluded from the analysis of both admission (*n* 25) and discharge (*n* 16) data if gross fluid retention had been documented or if body mass index was not calculable. In order to use the criteria for undernutrition devised by McWhirter & Pennington, 1994, both body mass index and upper arm anthropometry must be calculated. Of the twenty-five patients omitted from the analysis, potentially six may have been undernourished, as five had a mid-arm muscle circumference or triceps skinfold between the 5th and 15th percentile, and one had a mid-arm muscle circumference or triceps skinfold below the 5th percentile. However, the inclusion of these six patients in the undernourished group would not have altered the overall prevalence of undernutrition in our study. Of 594 patients assessed, 569 were analysed to estimate the prevalence of undernutrition on admission. This represented 7.6 % of total admissions during the recruitment periods in the larger hospital, and 15.3 % in the smaller hospital. Of the 760 patients picked for inclusion, 10 (1.3 %) patients refused, 117 (15.3 %) were discharged before they could be assessed, 29 (3.8 %) could not be assessed within the first 48 hours of their admission, 7 (0.9 %) were picked for a second time and 3 (0.4 %) died before they could be assessed. The distribution between specialities of patients recruited in this study was comparable to that of patients admitted throughout the previous year, suggesting that the sample was representative of the usual admission profile. **Table 3.1** shows the admission details of the patients studied. Follow up data were available on discharge from 218 (71 %)of those staying in

hospital for a minimum of seven days. These patients were not pre-selected. Every attempt was made to reassess as many patients as possible by liaison with medical, nursing, dietetic and secretarial staff. Despite this, 21 % of patients were discharged before a second assessment could be carried out. The remaining 8 % of patients died in hospital and were therefore, not reassessed. The data were analysed from these 202 patients to determine the extent of change in nutritional status during the hospital stay. In the 16 cases omitted from the discharge analysis, body mass index could not be calculated or gross fluid retention was documented.

Written informed consent was obtained before measurements were made, and ethical approval was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals (see **Appendix 2**).

The current nutritional status of the subjects was classified as normal, mildly, moderately or severely undernourished, overweight or obese. Patients were considered to be mildly undernourished if their body mass index was less than 20 kg/m^2 and if their triceps skinfold thickness or mid-arm muscle circumference was below the 15th percentile. A body mass index of less than 18 kg/m^2 and a triceps skinfold thickness or mid-arm muscle circumference below the fifth percentile were evidence of moderate undernutrition, and a body mass index of less than 16 kg/m^2 and a triceps skinfold thickness or mid-arm muscle circumference below the fifth percentile were evidence of severe undernutrition (McWhirter & Pennington, 1994).

Height was measured with a Leicester portable stadiometer (Chasmors Weighing Equipment Ltd, London, UK). If height could not be measured (*n* 95), stature was calculated from knee height using the equations devised by Chumlea (Chumlea *et al.* 1985). Weight was measured with a high specification portable scales (Chasmors Weighing Equipment Ltd, London, UK) which was regularly checked against two others of similar make. No re-calibration of the scales was required during the study period. Patients who could not stand were weighed on a mechanical chair scales (calibrated against the high specification portable scales) or if not possible (*n* 50) weight was calculated using calf circumference, knee height, mid-arm circumference and subscapular skinfold thickness using the equations of Steinbaugh (Steinbaugh *et al.*

1986). Body mass index (weight (kg)/height $(m)^2$) was calculated and was used to grade patients into normal weight, overweight and obese. Mid-arm and calf circumferences were measured with a plastic insertion tape measure, and skinfold measurements were made with Holtain skinfold callipers, according to standard techniques (World Health Organisation, 1995). Mid-arm circumference and triceps skinfold thickness were used to calculate mid-arm muscle circumference (mid-arm muscle circumference (cm) = mid-arm circumference - triceps skinfold thickness x 0.314) (World Health Organisation, 1995). As in the Scottish study (McWhirter & Pennington, 1994), the values obtained for patients aged 16 to 64 years were compared with American published reference tables (Bishop *et al.* 1981) while the values obtained for the elderly population were compared to Welsh reference data (Burr & Phillips, 1984). Our data were also compared to other published anthropometric reference material for the British (body mass index and mid-arm circumference) (Gregory *et al.* 1990) and Irish (body mass index) (Lee & Cunningham, 1990) populations where these exist. Weight loss before admission to hospital was calculated from either recalled weight or from measurements recorded on a previous hospital visit. Functional status was measured with a hand grip dynamometer (Takai Scientific Instruments Ltd., Japan). The highest of three readings made with the non-dominant arm was used.

3.5 Statistical analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences for Windows version 6.0.1 (SPSS Inc.). Chi-squared analysis was used to test for differences between groups and to identify associations between unintentional weight loss before admission and undernutrition on admission. Independent sample *t* tests were used to test for differences in mean body mass index, muscle and fat stores between the Dublin patients and published data from Edinburgh (Bannerman *et al.* 1997) and South Wales (Burr & Phillips, 1984). Spearman's correlation was calculated to test the association between arm and calf muscle circumferences, between triceps and subscapular skinfold measurements and between hand grip strength on admission to hospital and weight loss before admission. P values of less than 0.05 were considered to indicate statistical significance.

Table 3.1. Details of patients admitted to Hospital in Dundee and Dublin.

	Elective procedures		Non-elective procedures		Total	
	Dundee	Dublin (%)	Dundee	Dublin (%)	Dundee	Dublin (%)
General medicine:	47	38 (19)	53	160 (81)	100	198 (100)
Ischaemic heart disease	8	4	21	26	29	30 (15)
Malignant disease	11	18	2	21	13	39 (20)
Neurological disorders	3	3	9	16	12	19 (10)
Inflammatory bowel disease	9	1	4	1	13	2 (1)
Other gastrointestinal disorders	7	2	4	20	11	22 (11)
Diabetes Mellitus	0	2	3	3	3	5 (2)
Vascular disease	5	1	5	23	10	24 (12)
Protein energy malnutrition	1	0	2	1	3	1 (0.5)
Investigation of weight loss	2	1	0	1	2	2 (1)
Renal failure	1	1	3	3	4	4 (2)
Congestive cardiac failure	0	0	0	8	0	8 (4)
Haematological disorders	0	0	0	1	0	1 (0.5)
Fevers of unknown origin	0	0	0	4	0	4 (2)
Drug overdose	0	0	0	4	0	4 (2)
Psychiatric disorders	0	1	0	9	0	10 (5)
Acquired immune deficiency syndrome	0	0	0	5	0	5 (2)
Others	0	4	0	14	0	18 (9)
Respiratory medicine:	38	5 (8)	62	55 (92)	100	60 (100)
Chronic obstructive pulmonary disease	6	0	32	23	38	23 (38)
Asthma	7	0	11	4	18	4 (7)
Malignant disease	12	3	0	7	12	10 (17)
Tuberculosis	3	0	0	0	3	0
Trauma	0	0	3	1	3	1 (2)
Other respiratory disease	10	2	16	20	26	22 (37)
Medicine for the Elderly:	18	10 (38)	82	16 (62)	100	26 (100)
Respite care	18	2	0	0	18	2 (8)
Neurological disorders	0	4	15	4	15	8 (31)
Respiratory symptoms	0	0	14	6	14	6 (23)
Malignant disease	0	2	4	0	4	2 (8)
Gastrointestinal disorders	0	0	5	1	5	1 (4)
Renal disease	0	0	2	0	2	0
Investigation of weight loss	0	0	1	1	1	1 (4)
Ischaemic heart disease	0	0	15	0	15	0
Other acute illness	0	0	26	2	26	2 (8)
Vascular disease	0	2	0	2	0	4 (15)
General surgery:	53	132 (57)	47	100 (43)	100	232 (100)
Major abdominal surgery	14	12	11	17	25	29 (12)
Oesophageal surgery	4	9	2	0	6	9 (4)
Minor surgical procedures	10	59	7	36	17	95 (41)
Other major surgery	16	18	2	15	18	33 (14)
Vascular surgery	8	9	6	8	14	17 (7)
Surgical emphysema	0	0	1	0	1	0
Urological procedures/ surgery/renal colic	0	24	2	14	2	38 (16)
Pancreatic disease	0	1	4	0	4	1 (0.4)
Abdominal pain	1	0	12	4	13	4 (2)
Investigations for gastrointestinal bleeding	0	0	0	6	0	6 (3)
Orthopaedic surgery:	43	6 (11)	57	47 (89)	100	53 (100)
Metastatic bone disease	6	2	0	0	6	2 (4)
Trauma fractures	0	0	47	33	47	33 (62)
Joint replacements	19	0	0	0	19	0
Minor surgical procedures	18	3	10	4	28	7 (13)
Neurological observations	0	0	0	7	0	7 (13)
Investigations joint pain	0	1	0	3	0	4 (8)

Dublin: Values are numbers (percentages)

Dundee: Values equal percentages

3.6 Results

Body mass index

Of the 569 patients analysed on admission, 62 (11 %) were undernourished, a considerably lower proportion than the 40 % reported from Dundee. There was no difference in the prevalence of undernutrition between seasons (summer, *n* 269; winter, *n* 300) ($P = 0.39$), males (*n* 318) and females (*n* 251) ($P = 0.97$), higher (*n* 132) and lower (*n* 437) socio-economic groups ($P = 0.55$) and those aged equal to and above (*n* 218) or below (*n* 351) sixty-five years ($P = 0.53$).

A body mass index of 20 - 24.9 kg/m^2 was recorded in 225 (40 %), of 25 - 29.9 kg/m^2 in 179 (31 %) and 30 kg/m^2 or more in 88 (15 %). A body mass index below 20 kg/m^2 was recorded in seventy-seven (14 %) of patients, 18 - 20 kg/m^2 in forty-nine (9 %), 16 - 18 kg/m^2 in twenty-one (4 %) and below 16 kg/m^2 in seven (1 %). The use of body mass index as the sole determinant of undernutrition (i.e. disregarding triceps skinfold thickness or mid-arm muscle circumference measurements) gave a higher prevalence of undernutrition than when the additional anthropometric measurements were also considered.

Direct comparison by speciality between Dublin and Dundee shows a lower prevalence of undernutrition in each patient group (see **Table 3.2**) and a higher prevalence of overweight and obesity in Dublin ($P < 0.001$) (see **Table 3.3**). In addition, the severity of undernutrition was less in Dublin with more normally nourished ($P < 0.001$) or mildly undernourished ($P < 0.001$). Despite these overall differences, the prevalence of overweight and obesity among respiratory and general surgical patients was similar in both centres.

Mean body mass index in the patient group was similar to that of the healthy subjects measured in the Irish National Nutrition Survey (Lee & Cunningham, 1990). In Dublin patients aged over seventy-five years, females had significantly lower ($P < 0.05$) and males had a trend towards lower ($P = 0.05$) mean body mass index than their

community-based Edinburgh counterparts. Body mass index for both male and female Dublin patients aged 65 years or more was similar to healthy males and females from South Wales (see **Table 3.4**).

Anthropometric measures of body composition

A triceps skinfold thickness below the 5th percentile was found in 20 (3 %) Dublin patients while 83 (15 %) were between the 5th and 15th percentiles. A mid-arm muscle circumference value below the 5th percentile was found in 64 (11 %) Dublin patients with 131 (23 %) between the 5th and 15th percentile. Fewer Dublin than Dundee patients aged 16-64 years had a mid-arm circumference less than 25 cm ($P < 0.001$) (see **Table 3.5**). In all patients aged over 75 years in Dublin, mid-arm muscle circumferences were higher than in healthy people from South Wales ($P < 0.05$), but lower than recently reported from Edinburgh ($P < 0.05$). Triceps skinfold measurements in both male ($P < 0.01$) and female ($P < 0.05$) patients in Dublin were higher than expected from the Welsh data, although they were similar to those found in Edinburgh (see **Table 3.6**).

Calf circumference and subscapular skinfold measurements were recorded in this study as additional measures of body composition. A significant correlation was observed between calf circumference and mid-arm muscle circumference (r 0.59, $P < 0.001$) and between subscapular and triceps skinfold measurements (r 0.6, $P < 0.001$).

Weight loss on admission

Unintentional weight loss of over 10 % in the six months before admission occurred in sixty-four (12 % of the 538 patients for whom data on previous weight was obtained) patients by comparison with 13 % in the Dundee study (McWhirter & Pennington, 1994). A further twenty-nine (5 %) patients had unintentional weight loss of more than 5 % in the month before admission. Of the sixty-two undernourished patients, twenty-one (37 %) lost more than 10 % body weight over the previous six months while a further nine (16 %) lost more than 5 % over the previous month.

Undernutrition on admission was significantly associated with unintentional weight loss over the six months before admission ($P < 0.001$).

Functional status on admission

The grip strength of 523 patients was measured. A similar percentage of patients in both the Dublin and Dundee studies recorded a hand grip strength below 85 % of standard (Webb *et al.* 1989) (69 % versus 67 %). Highly significant negative correlations between hand-grip strength on admission to hospital and weight loss over both the six months (r 0.19, $P < 0.001$) and the one month (r 0.18, $P < 0.001$) before admission were observed. Of 218 patients reassessed before discharge, it was possible to measure hand-grip strength in 191 of these. In the undernourished and high-nutritional-risk groups, a significantly higher proportion of patients who lost weight in hospital lost hand grip strength in comparison to those in the same groups who gained weight ($P < 0.05$).

Table 3.2. Comparison of prevalence of undernutrition at admission between Dublin and Dundee

	Dublin		Dundee		Statistical
	Number undernourished	Number assessed	Number undernourished	Number assessed	significance*
General medicine	25 (13 %)	198	46	100	P < 0.001
General surgery	17 (7 %)	232	27	100	P < 0.001
Respiratory medicine	11 (18 %)	60	45	100	P < 0.01
Medicine for the elderly	4 (15 %)	26	43	100	P < 0.05
Orthopaedic surgery	5 (9 %)	53	39	100	P < 0.001

Values are absolute (percentages).

*Chi-squared analysis.

Table 3.3. *Distribution of nutritional status at time of admission*

Hospital speciality		Undernutrition			Normal weight	Overweight/Obese
		Mild	Moderate	Severe		
General medicine:	Dublin (*n* 198)	17 (9)	7 (4)	1 (0.5)	90 (45)	83 (42)
	Dundee (*n* 100)	11	27	8	30	24
General surgery:	Dublin (*n* 232)	10 (4)	7 (3)	0	96 (41)	119 (51)
	Dundee (*n* 100)	10	16	1	25	48
Respiratory medicine:	Dublin (*n* 60)	8 (13)	0	3 (5)	26 (43)	23 (38)
	Dundee (*n* 100)	13	19	13	17	38
Medicine for the elderly:	Dublin (*n* 26)	4 (15)	0	0	11 (42)	11 (42)
	Dundee (*n* 100)	4	20	19	27	30
Orthopaedic surgery:	Dublin (*n* 53)	4 (7)	0	1 (2)	23 (43)	25 (47)
	Dundee (*n* 100)	28	5	6	30	31

Values are absolute (percentages).

Table 3.4. Body mass index of Dublin patients compared with Irish National Nutrition Survey (1990), Edinburgh (1997) and South Wales data (1984)

Men	Dublin patients			Irish National Nutrition Survey			Edinburgh			South Wales	
Age group	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	*n*
16-18	21.1	1.4	5	21.2	2.5	73					
18-25	23.9	4.2	35	23.1	3.1	51					
25-40	25.5	5.3	68	26.0	3.2	85					
40-60	26.0	4.9	81	27.3	3.1	87					
≥ 60	25.0	4.4	129	25.6	3.8	82					
75-79	24.4	4.6	24				26.4	3.5	31	23.9	188
80-84	23.8	4.9	13				25.9	2.6	18	23.7	87
≥ 85	23.5	4.2	5				24.5	4.1	10	23.1	41
Women											
16-18	22.8	5.5	4	21.7	2.7	110					
18-25	23.8	4.6	18	23.2	3.0	54					
25-40	24.6	4.0	40	24.2	4.7	122					
40-60	26.1	5.7	59	26.6	4.3	111					
≥ 60	24.8	5.5	130	26.4	4.9	84					
75-79	24.1	4.0	32				26.2	4.7	66	26.1	329
80-84	23.8	5.5	20				26.8	4.6	32	25.5	200
≥ 85	22.5	3.5	11				24.9	3.8	30	23.6	88

Table 3.5. *Distribution of mid-arm circumference in people aged 16-64*

Mid-arm circumference (cm)	Men			Women		
	Dublin patients (*n* 214)	Dundee patients (*n* 134)	General British population* (*n* 1191)	Dublin patients (*n* 137)	Dundee patients (*n* 90)	General British population* (*n* 1187)
< 25	20 (9)	29 (22)	36 (3)	26 (19)	28 (31)	167 (14)
25.1 - 27.5	43 (20)	35 (26)	167 (14)	33 (24)	17 (19)	320 (27)
27.6 - 30	46 (21.5)	19 (14)	333 (28)	33 (24)	17 (19)	320 (27)
30.1 - 32.5	59 (28)	27 (20)	369 (31)	19 (14)	8 (9)	202 (17)
> 32.5	46 (21.5)	24 (18)	286 (24)	26 (19)	20 (22)	178 (15)

Values are absolute (percentages).

*Data from Gregory *et al.*(1990).

Table 3.6. Mid-upper arm circumference, triceps skin-fold thickness, and arm muscle circumference for Dublin patients aged 75 years or more compared with those in Edinburgh and South Wales

	75-79 years					80-84 years					≥85 years				
	Dublin patients		Edinburgh		South Wales	Dublin patients		Edinburgh		South Wales	Dublin patients		Edinburgh		South Wales
Men	*n* 27		*n* 31		*n* 119	*n* 16		*n* 18		*n* 56	*n* 6		*n* 10		*n* 31
	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean
MAC (cm)	27.1	3.1	29.7	3.2	24.9	26.8	3.8	29.2	2.4	23.5	28.1	4.2	27.3	3.9	22.1
TSF (mm)	10.4	3.9	11.4	5.9	7.0	9.2	3.3	10.1	3.2	6.6	9.5	3.5	9.5	3.0	6.5
MAMC (cm)	23.8	2.4	26.1	2.7	22.1	23.8	3.1	26.0	2.0	21.5	25.1	3.2	25.4	4.2	20.8
Women	*n* 32		*n* 66		*n* 219	*n* 22		*n* 32		*n* 131	*n* 12		*n* 30		*n* 75
MAC (cm)	28.2	3.6	29.9	4.1	24.9	26.3	4.6	30.1	3.9	23.5	26.2	3.8	27.9	2.9	22.1
TSF (mm)	18.1	6.2	17.1	5.5	14.6	17.0	7.2	17.9	5.3	12.7	15.2	6.9	14.0	3.4	11.5
MAMC (cm)	22.5	2.5	24.5	2.9	20.0	20.5	2.6	24.5	2.7	19.2	21.4	2.1	23.5	2.1	18.2

Changes in nutritional status during hospital stay

Table 3.7 shows details of the weight changes for the 202 patients in whom body mass index could be calculated both on admission and on discharge. The median length of stay for these patients was twelve days. Weight loss occurred in 65 % of overweight and obese (median length of stay eleven days), 66 % of normal weight (median length of stay thirteen days) and 43 % of underweight patients (median length of stay fifteen days). Weight gain occurred in 31 % of overweight and obese, 30 % of normal weight and 43 % of underweight patients. None of the undernourished patients moved into a worse category of the three categories of undernutrition (mild, moderate, severe). Two normal weight (BMI 20 - 24.9 kg/m^2) patients became mildly underweight (BMI < 20 kg/m^2 and mid-arm muscle circumference or triceps skinfold below the 15th percentile), six obese patients (BMI 30 - 39.9 kg/m^2) became overweight (BMI 25 - 29.9 kg/m^2) and seven overweight patients became normal weight. Of the twenty-three undernourished patients (BMI below 20 kg/m^2 and mid-arm muscle circumference or triceps skinfold below the 15th percentile) reassessed on discharge, twelve (52 %) were referred for nutritional support. Six of these patients gained weight while six lost weight from time of admission to discharge.

Table 3.7. Changes in weight during the hospital stay among 202 Dublin patients who were reassessed on discharge

	Patient's status on admission					
	Overweight	Normal	Undernourished			
			Mild	Moderate	Severe	Number referred
	(*n* 91)	(*n* 88)	(*n* 16)	(*n* 5)	(*n* 2)	(*n* 12)
No change	4 (4)	4 (5)	2 (12)	1 (20)	0	0
Weight loss:	59 (65)	58 (66)	7 (44)	2 (40)	1 (50)	6
Weight gain:	28 (31)	26 (29)	7 (44)	2 (40)	1 (50)	6

Values are absolute (percentages).

3.7 Discussion

Using identical criteria to define undernutrition, this study found that 11 % of patients admitted to hospital in Dublin were undernourished by comparison with 40 % in a similar study in Dundee (McWhirter & Pennington, 1994). The reasons for the difference are not clear but a number of possibilities must be considered. Firstly, the case mix of patients may be different. The diagnoses and nature of admissions for both Dublin and Dundee can be seen in **Table 3.1**. While the case mix of two such studies can never be identical, with the exception of the general surgical group where admission for minor surgical procedures was more common in Dublin, and admission for abdominal pain higher in Dundee, the mix within each patient group is similar. While the Dublin study included more surgical patients who were certainly better nourished than their counterparts in Dundee, if only medical patients had been considered, the prevalence of undernutrition among such patients (*n* 284) was only 15 %, significantly lower than the 45 % among medical patients (*n* 100) in Dundee. The Dublin study included sixty patients in respiratory medicine by comparison with 100 in the Dundee study. Prevalence of undernutrition was 18 % in Dublin versus 45 % in Dundee. It is unlikely that if a further forty respiratory patients were assessed, thirty-four would be undernourished. The same principle applies to orthopaedic surgical patients where only 9 % of patients in Dublin versus 39 % in Dundee were undernourished. The differences in case mix are unlikely to account for the discrepancy in results, particularly when the prevalence of undernutrition is compared within diagnostic categories. Indeed, malignant disease occurred more frequently in all diagnostic categories (with the exception of general surgery) in Dublin than in Dundee. Although only twenty-six patients admitted under Medicine for the Elderly were assessed in Dublin, 40 % (*n* 218) of the total patient group were aged sixty-five years or more. There was no difference in the prevalence of undernutrition occurring in either the under sixty-five year old patients or those aged sixty-five years or more in this study ($P = 0.53$), or in the Dundee study (43 % in patients admitted under Medicine for the Elderly versus an overall prevalence of 40 %). The proportion of elective and non-elective patients admitted to each speciality can also be seen in **Table 3.1**. Although it could be postulated that differences between numbers of elective and non-elective admissions could account for

the difference in prevalence of undernutrition, it is unlikely to account for a 29 % disparity between the two studies. Indeed, medical, respiratory, orthopaedic and elderly patients admitted acutely are in general sicker, and therefore one would expect, more undernourished than their counterparts admitted for elective procedures.

Secondly, there is a possibility that Scottish and/or UK patients are different in some way from Irish patients. Undoubtedly, while there is a significantly greater proportion of patients admitted to hospital in Dundee with a BMI below 20 kg/m^2, this has not been observed in other, more recent, studies carried out in Scotland and the UK. The recent Scottish study (Tessier *et al.* 1999) reported that 13 % of 219 patients admitted to hospital in Glasgow were undernourished on admission (defined as a BMI below 18.5 kg/m^2 or 18.5 - 20 kg/m^2 with reported weight loss greater than 3 kg in three months). Two studies from London reported that 16.5 % of 410 general medical, general surgical and orthopaedic patients (Vlaming *et al.* 1998) and 22 % of 192 general medical admissions (Weekes, 1998) had a BMI below 20 kg/m^2 on admission while a study from Manchester (Strain *et al.* 1998) reported that 24 % of 400 medical, surgical and orthopaedic patients who were expected to be in hospital for at least one week (therefore choosing those who were sickest on admission) were undernourished according to the criteria of McWhirter and Pennington (BMI below 20 kg/m^2 and MAMC or TSF below the 15th percentile). It is widely accepted that rates of undernutrition in nursing homes and institutions are broadly comparable to those found in hospital. The recent UK National Diet and Nutrition Survey (Finch *et al.* 1998) reported that 16 % of men and 15 % of women living in institutions were underweight, a figure identical to that found in Dublin among those admitted under Medicine for the Elderly (see **Table 3.2**) and to all elderly patients (*n* 218) admitted in Dublin (16 %). It could be postulated that a unique situation exists in Dundee and that the figure of 40 % undernutrition found there is not representative of rates in other parts of the UK and Ireland. One possible explanation for this could be that the normal anthropometric profile in the Dundee population is different to that found more usually in the UK and Ireland. The recent data from the UK (Finch *et al.* 1998) and from a study carried out subsequent to this one (see **Chapter 6**) shows that for those aged sixty-five years and over, the anthropometric profile for the healthy elderly is identical in both Ireland and the UK. Although not all patients are in this age group, 40 % of the Dublin patients and

55 % of those in Dundee were elderly, and as stated previously, differences in the prevalence of undernutrition between the younger and older age groups were not observed in either study. That the normal anthropometric profile is different in Dundee is supported by the fact that in both studies, a similar percentage of patients reported weight loss of more than 10 % in the six months before admission to hospital (12 % in Dublin versus 13 % in Dundee) and suffered functional impairment as indicated by a hand grip strength less than 85 % of the reference data (Webb *et al.* 1989) (69 % in Dublin versus 67 % in Dundee). If patients in Dundee have to wait longer for hospital admission and are, therefore, presumably sicker on admission it is highly probable that recent weight loss and functional impairment would be observed to a far higher degree there compared with Dublin. The possibility that the population of Dundee has a lower distribution of BMI is supported by another Scottish study. This study from Edinburgh (Bannerman *et al.* 1997), using the same criteria as McWhirter & Pennington (1994), could find no undernutrition among 200 elderly patients ($\geq$ 75 years) registered with two general practices. Given that 43 % of patients admitted under Medicine for the Elderly are undernourished on admission to hospital in Dundee and therefore, must become undernourished while still living at home, it is surprising that none of the 200 elderly people in Edinburgh were found to be undernourished when assessed in their own homes which allowed for the inclusion of those too ill to attend the clinic of the general practitioner.

A number of other studies using anthropometry to determine nutritional depletion have reported prevalence rates between 20 % and 53 %. However, each used different criteria to define undernutrition which makes direct comparisons less meaningful. Bastow *et al.* in 1983, classified elderly female orthopaedic surgical patients in Nottingham according to arm circumference and triceps skinfold thickness with reference to the mean and standard deviation of a group of home and hospital patients in the anthropometric study carried out in Belfast by Vir and Love, 1980. Patients were divided into three groups; well nourished (greater than or equal to the mean or less than one standard deviation below the mean), thin (one to two standard deviations below the mean) and very thin (over two standard deviations below the mean). A recent study has shown that healthy people in Northern Ireland aged over ninety years old (Rea *et al.* 1997) are heavier and have higher fat and muscle stores than

their Welsh counterparts in the early 1980s (Burr & Phillips, 1984), the reference data used in both the Dublin and Dundee studies. We now know that this also applies to 'younger' elderly. The recently published data on free-living elderly from the British Diet and Nutrition Survey (Finch *et al.* 1998) are similar to data on the free-living Irish elderly observed by this author (C. Corish) (see **Chapter 6**), this data being significantly different for all anthropometric variables than the older Welsh data. The use of reference data from a different geographical region may explain the high prevalence of undernutrition (53 %) in the Nottingham study, or it may be that undernutrition is now less common among orthopaedic patients when referenced to older population data. Recent studies carried out in London (Vlaming *et al.* 1998) and Manchester (Strain *et al.* 1998), which included a large number of orthopaedic patients do not support the results of the Nottingham study. Indeed the London study (Vlaming *et al.* 1998) reported a trend towards a higher mean BMI in orthopaedic, compared to general medical and general surgical patients. Another study examining of prevalence of undernutrition on admission to hospital using anthropometry was a Swedish study of elderly patients (Larsson *et al.* 1990) (which included a weight index derived from actual weight/reference weight, triceps skinfold thickness and mid-arm muscle circumference). However, this study used anthropometry as only one of the determinants of undernutrition and reported a prevalence of undernutrition of 28.5 %. To fulfil the criteria for undernutrition, patients had to have three or more subnormal measurements, at least one relating to serum proteins, one to anthropometry and one to anergy. The anthropometric measurements used cut-off values derived from data from the Norwegian population (Symreng, 1983), that is, locally derived reference data which did not include cut-off values for BMI. The same criteria were used in another Swedish study (Cederholm *et al.* 1993) which reported a prevalence of undernutrition of 20 % among general medical patients. Again, anthropometry was only one of the determinants of undernutrition. An American study by Giner *et al.* in 1996, divided patients on admission to an intensive care unit into well-nourished and malnourished groups according to their nutrition status as assessed by serum albumin level and weight/height ratio using life insurance tables published in 1959. An editorial on this paper (Pennington, 1996), states that serum albumin is a negative acute phase protein and the serum concentration is influenced by fluid shifts and that the use of weight-height ratio without other anthropometric data may well include fit lean patients and

exclude obese patients with muscle wasting. It concludes by stating that it is unlikely that such measurements can truly reflect the nutritional status of acutely ill patients admitted to an intensive care unit. Because of the problems with comparisons between studies, one of the objectives of the Dublin study was to use the same anthropometric criteria and reference data as that used in Dundee (McWhirter & Pennington, 1994).

Although the differences in the proportion of patients with a BMI below 20 kg/m^2 in Dublin and Dundee cannot be disputed, one must query the current applicability of such a cut-off for clinical purposes in most centres in the UK and Ireland. Selective catabolic loss of protein due to infection or injury causes extreme illness in overweight patients who lose muscle whilst still retaining substantial amounts of total body and subcutaneous fat (Ferro-Luzzi & James, 1996). Such selective loss of lean tissue was observed in this study. Although only 18 % of patients had a triceps skinfold thickness below the 15th percentile, 34 % had a mid-arm muscle circumference below this value. It is therefore probable that these patients are more undernourished than indicated by the measurement of BMI and fat stores. The prevalence of obesity is increasing in Ireland (Lee & Cunningham, 1990; Kilkenny Health Project, 1992), the United Kingdom (Prentice & Jebb, 1995; Jebb, 1999) and the United States of America (Van Itallie, 1996; Galuska *et al.* 1996; Flegal *et al.* 1998). We know that the mean BMI for the healthy elderly population in both the UK and Ireland is 26.7 kg/m^2 (Finch *et al.* 1998; **Chapter 6**). The shift in the distribution of anthropometric data could lead to significant biases when used for assessing the nutritional status of patients on admission to hospital if the normal healthy local population from which these patients come is getting fatter, and the average and percentile lines for anthropometric measures are changing. Although we know that the pragmatic cut-off values for BMI are based on physiological and medical correlates, weight loss is also associated with undernutrition-related complications, particularly if it occurs with functional impairment, regardless of pre-illness weight (Haydock & Hill, 1986). Furthermore, there is little information in older age groups as to the appropriateness of a cut off value of 20 kg/m^2 to define undernutrition in this age group. With the secular increase in adult body mass index, the cut-off values at which patients are considered to be at nutritional risk may have to be altered and in the elderly in the USA, nutritional risk is now defined as a BMI below 24 kg/m^2 while a BMI less than 22 kg/m^2 was observed to

be a significant predictor of mortality in older Italian people living in the community (Landi *et al.* 1999). Significantly more elderly patients with an average BMI of 20.9 kg/m^2 who were undergoing lung volume reduction surgery required ventilatory support and had significantly longer hospital length of stay than those patients with an average BMI of 26.1 kg/m^2 (Mazolewski *et al.* 1999). A recent Danish review on this topic (Beck & Ovesen, 1998) concluded that in the elderly, a BMI less than 24 kg $/m^2$ or any degree of weight loss should be used to assess nutritional risk in order to allow for the initiation of nutritional support in time to reduce nutrition related complications. The definition of undernutrition in both the Dundee and Dublin studies included triceps skinfold or mid-arm muscle circumference measurements in addition to the BMI cut-off of 20 kg/m^2. These had to fall below the 15th percentile compared to reference data in routine use in the United Kingdom and Ireland (Bishop *et al.* 1981; Burr & Phillips, 1984). The secular changes observed in the anthropometric distribution of the population obviously will change where the 15th percentile lies and define a different proportion of patients as undernourished compared to the use of the older reference data. A population shift in anthropometric variables has also recently been reported in infants in the United Kingdom (Paul *et al.* 1998; Savage *et al.* 1999) who conclude that there is a need for new reference data sets for head circumference and skinfold thickness for infants in the United Kingdom.

Anthropometric screening has been recommended for the detection of undernutrition in hospital and in the community as it is simple, cheap and non-invasive (McWhirter & Pennington, 1994; World Health Organisation, 1995; Edington *et al.* 1996, 1997). It's use however, requires reference data. These data are used both by nutritional epidemiologists, for monitoring secular changes in populations, and for making cross-country comparisons between population, and by clinicians for assessing nutritional status among ill individuals, either in hospital, or at hospital or community clinic visits. The reference data routinely used in the UK and Ireland are over twenty years old and derived from the American population for younger adults and from South Wales for the elderly. We know that these data are significantly different from current anthropometric data on the elderly (Bannerman *et al.* 1997; Finch *et al.* 1998; see **Chapter 6**). The current reference data are therefore useful for monitoring trends in the population but their use as a tool in clinical practice must be questioned.

The effects of disease on nutritional status are experienced universally. A similar proportion of patients with weight loss of more than 10 % in the six months before admission was found in both Dublin and Dundee (12 % versus 13 %). In addition, an equal proportion of patients in both studies suffered functional impairment as indicated by a hand grip strength less than 85 % of standard (Webb *et al.* 1989) (69 % versus 67 %). The similarities in loss of weight and function before admission to hospital suggest that the prevalence of undernutrition should be similar in both areas, although this was found not to be the case. The small number of undernourished individuals in Dublin and the high mortality rate in this group (6.5 % versus 2 % in the adequately nourished group, (P = 0.05)) may suggest that the criteria used identified patients whose underlying disease had progressed to the point where nutritional intervention could no longer be of therapeutic benefit. If we state that there is a genuinely lower level of undernutrition in Dublin, we must then assume that few patients will benefit from nutritional intervention, as in general, studies have demonstrated benefits only in undernourished patients (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991; Bastow *et al.* 1983; Delmi *et al.* 1990; Beattie *et al.* 1998) with no benefits being observed in well-nourished patients (Heslin *et al.* 1997; Watters *et al.* 1997). There are of course some notable exceptions (Beier-Holgerson *et al.* 1996; Keele *et al.* 1997) where well nourished patients have benefited from nutritional intervention. However, we also know that pre-operative weight loss is associated with increased post-operative complications and increased mortality (Studley, 1936; Klidjian *et al.* 1980; Meguid *et al.* 1988; Windsor & Hill, 1988; Reilly *et al.* 1988; Von Meyenfeldt *et al.* 1992) and increased post-operative mortality (Busby *et al.* 1980; Giner *et al.* 1996). These adverse effects can result in longer post-operative convalescence times (Bastow *et al.* 1983; Lumbers *et al.* 1996) and increased duration of hospital stay (Bastow *et al.* 1983; Shaw-Stiffel *et al.* 1993). The average length of hospital stay is doubled in surgical patients who develop complications (McAleese & Odling-Smee, 1994) while more frequent re-admission to hospital has been reported in undernourished elderly patients who continue to lose weight after discharge from hospital (Friedmann *et al.* 1997). It is obviously not necessary and uneconomical for all patients to receive nutritional intervention. It is equally unsatisfactory if patients who would benefit from nutritional intervention do not receive it. It is therefore necessary that outcome data should be considered among those

falling at the lower end of the population distribution curve for a particular population to assess the potential benefits for this group from nutritional intervention.

Weight loss in hospital occurred as frequently in Dublin as in Dundee (63 % versus 64 % of patients lost weight). However, the mean weight loss was less in Dublin than in Dundee (4 % versus 6 %). Weight loss also occurred less frequently in the undernourished group in Dublin (43 % versus 75 %) ($P < 0.05$). Referral for nutritional intervention occurred in 20 % of patients in Dublin including 40 % of the undernourished patients. In Dundee, only 18 % of the undernourished group were referred. The higher referral rate in Dublin may either reflect better nutritional practice in Dublin, or the fact that that in response to earlier studies such as that of McWhirter & Pennington there is generally a greater awareness with more referrals as a consequence. It is difficult to draw conclusions without historical data on referral rates in Dublin.

The Dundee study results give the impression of an alarmingly high prevalence of undernutrition on admission to hospital. There are now results of similar surveys from several locations in the United Kingdom (Vlaming *et al.* 1998; Strain *et al.* 1998; Weekes, 1998; Tessier *et al.* 1999) which are much closer to the Dublin figures than to the Dundee findings. To use the widely-cited Dundee findings as representative of the UK as a whole may create a view that the problem of undernutrition is of a magnitude almost impossible to deal with under current financial and staffing constraints.

Anthropometry provides a simple method of assessing nutritional status for this purpose but, in order to assess patients in the clinical setting, knowledge of the normal anthropometric status of the local healthy population may be necessary. Although, we can certainly say that fewer patients in Dublin than in Dundee are undernourished using the current reference data and threshold levels, the changing anthropometric profile of the normal population in both the UK and Ireland means that this may not tell the full story. A review of the anthropometric criteria to assess nutritional status on admission to hospital is, therefore, mandatory. We need to have agreement on the most appropriate anthropometric thresholds to decide which patients in the clinical setting are at risk. Other variables (e.g. weight loss, loss of lean tissue and/or functional impairment) should also be fully evaluated and recommendations made as to how they

should be incorporated into the definition of undernutrition. Complacency on the basis of these results from Dublin could result in many patients not receiving nutritional intervention who could benefit from it.

3.8 Conclusions

Nutritional status on admission to hospital is thought to be an important factor in determining clinical outcome. It has been argued that nutrition screening on admission to hospital is worthwhile to identify those who would benefit most from nutrition intervention (Lennard-Jones, 1992; Reilly *et al.* 1995). Anthropometry provides a simple method of assessing nutritional status for this purpose. However, in comparative studies where large differences exist in the apparent prevalence of undernutrition, we need to consider the possibility that reference data may not be appropriate for clinical purposes as well as the possibility that actual differences in nutritional status exist. In order to assess patients in the clinical setting, knowledge of the normal anthropometric status of the local healthy population should be available. In the current climate of evidence based medicine, the changing anthropometric profile of the normal population means that a review of the anthropometric criteria to assess nutritional status is now mandatory and that weight loss with functional impairment should be investigated as a more precise indicator of the need for nutritional intervention.

3.9 Addendum

Following the submission of this thesis, a further study from Dundee was published (Beattie *et al.* 2000). This study examined the use of oral nutritional supplements post-operatively in malnourished surgical patients. Entry to the study was determined by the presence of malnutrition defined by anthropometric criteria on admission or on the resumption of the oral diet by the eighth post-operative day, and /or a weight loss of 5 % or more from admission until oral intake was resumed by the eighth post-operative day. In this study, 2486 patients were admitted to the wards in which the studies were undertaken, of which 450 were screened with 111 meeting the criteria for entry. In the discussion the authors state "The study population represents approximately 24 % of patients who were screened. Thus 9 % of the total population screened were entered on the basis of admission anthropometric criteria, a value lower than a previous study undertaken in this hospital examining the incidence of malnutrition (McWhirter & Pennington, 1994)".

It thus appears that for some reason, not explored in their current paper (Beattie *et al.* 2000), using the anthropometric criteria used in their previous study (McWhirter & Pennington, 1994) which we also used, the Dundee research group are observing similar figures for malnutrition in their surgical patients (9 %) as observed currently in Dublin (7 %). However, whether this also applies to the other patients groups in Dundee cannot be deduced from this paper.

Beattie AH, Prach AT, Baxter JP & Pennington CR (2000) A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. *Gut* **46,** 813-818.

Chapter 4

Assessment of nutritional risk on admission to hospital

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4.1 Summary

The study of McWhirter & Pennington (1994) reported that 40 % of patients were undernourished. McWhirter & Pennington defined undernutrition as a body mass index below 20 kg/m^2 and a mid-arm circumference or triceps skinfold thickness below the 15th percentile. Although this definition now is increasingly being criticised, at the time this study was undertaken, it was the most widely accepted definition of undernutrition among clinical nutrition specialists. In addition, nutrition screening on admission to hospital was being widely advocated with increasing numbers of nutrition risk screening tools being recommended. The nutrition risk index (Veterans Affairs Total Parenteral Nutrition Cooperative Study group, 1991) and the nutrition risk score (Reilly *et al.* 1995) are two of the more commonly used nutrition screening tools. In a prospective study of 594 sequential medical and surgical patients to two acute teaching hospitals in Dublin, we aimed to assess the number of patients at nutritional risk using each of these screening tools, the reliability of the two screening tools to screen for undernutrition as defined by McWhirter & Pennington (1994). We also planned to evaluate a number of factors which could possibly improve the performance of a nutrition screening tool. Using the McWhirter & Pennington definition of undernutrition, forty-nine patients who underwent both screening processes were classified as undernourished. The nutrition risk index failed to recognise 16 (33 %) of these forty-nine patients; the nutrition risk score missed 9 (18 %). The incorporation of mid-arm circumference into the nutrition risk score significantly improved the detection of undernutrition (defined as described above) while the addition of mental status and age over sixty-five years did not. Classification of patients' nutrition risk was significantly different depending on the screening tool used. Although it is recognised that a 'gold standard' to assess nutritional status is not available, the definition used by McWhirter & Pennington (1994) has been widely accepted. Both of the popular nutrition screening tools evaluated in this study failed to recognise all cases of undernutrition as defined by this method. As expected, prevalence of nutritional risk was considerably higher than the level of undernutrition recorded but classification of the degree of nutritional risk varied depending on the screening tool used. The addition of another objective parameter (mid-arm circumference) improved the reliability of the

nutrition risk score. This measurement is easily done and further work on its use as part of a nutritional screening tool should be evaluated.

4.2 Introduction

The prevalence of undernutrition on admission to hospital varies between studies (McWhirter & Pennington, 1994; Naber *et al.* 1997; Strain *et al.* 1998; Vlaming *et al.* 1998; Weekes, 1998; Tessier *et al.* 1999; **Chapter 3**). This occurs even when the same criteria are used for its diagnosis (McWhirter & Pennington, 1994; Strain *et al.* 1998; Vlaming *et al.* 1998; Weekes, 1998; Tessier *et al.* 1999; **Chapter 3**). Most studies also document deteriorating nutritional status during the hospital stay (Coats *et al.* 1993; McWhirter & Pennington, 1994; Incalzi *et al.* 1996; Garriballa *et al.* 1998*a*; **Chapter 3**) which is not recognised by medical and nursing staff (McWhirter & Pennington, 1994, Lennard Jones *et al.* 1995; Reilly *et al.* 1995). Poor clinical outcome (Gallagher-Allred *et al.* 1996; Green, 1999), reduced functional status (Windsor & Hill, 1988; Congleton, 1999; Green, 1999), a deterioration in quality of life (Larrson *et al.* 1994; Jamieson *et al.* 1997) and increased hospital costs (Tucker & Miguel, 1996) have all been associated with undernutrition.

Nutrition screening is defined as the process of identifying characteristics known to be associated with nutrition problems. Its purpose is to identify individuals who are nutritionally at risk for malnutrition or who are malnourished (Dougherty *et al.* 1995). A risk factor is a major identifiable biological or environmental circumstance or event that, if left unchecked, might directly cause an individual to become malnourished (Davies & Knutson, 1991). Adults considered to be nutritionally at risk include those with, involuntary loss or gain of more than 10 % usual body weight within 6 months or more than 5 % in 1 month, weight of 20 % over or under ideal weight, chronic disease or increased metabolic requirements. Patients requiring alterations to diet or artificial nutrition support as a result of recent surgery, illness or trauma are also considered to be nutritionally at risk, as are patients with an inadequate dietary intake due to inability to ingest or absorb food adequately (American Society for Parenteral and Enteral Nutrition, 1995). In the elderly in particular, weight loss of more than 5 % over the last 1-6

months is considered to increase their nutritional risk (Beck & Ovesen, 1998). The progression from being nutritionally at risk to becoming undernourished and the clinical consequences of this are difficult to define. Despite this, it is believed that the identification of patients who are nutritionally at risk is worthwhile and routine nutritional screening has been recommended by both the King's Fund report (Lennard-Jones, 1992) and the British Association for Parenteral and Enteral Nutrition in the United Kingdom (Sizer *et al.* 1996), and by the American Society for Parenteral and Enteral Nutrition in the United States of America (1995). The introduction of nutritional screening has, however, been hindered by the lack of a simple, valid nutritional assessment tool which can detect patients who are undernourished or at risk of nutritional depletion (Reilly, 1996). The issue as to who can most effectively provide nutritional screening has also delayed its implementation. Dietitians have skills in nutritional assessment but cannot see every hospital admission. All patients are admitted by a nurse and a junior hospital doctor but they are rarely trained in the techniques necessary for routine nutritional screening (Lennard-Jones *et al.* 1995). General practitioners assess and refer patients to hospital but operate within tight time constraints and have little nutrition training (Jackson, 1996).

The nutrition risk index (NRI) formula (see **Table 1.2.3**) was devised by the Veterans Affairs Parenteral Nutrition Cooperative Study Group (1991) for use in their clinical trial evaluating the efficacy of peri-operative total parenteral nutrition in malnourished patients undergoing major abdominal or thoracic surgery. The nutrition risk index relies on serum albumin concentration and percentage usual weight and has been used to define nutritional risk in a number of recent studies where the effects of undernutrition (Reynolds *et al.* 1996) or nutritional intervention were investigated (Heslin *et al.* 1997; Keele *et al.* 1997). Nutrition risk is classified as mild (NRI score 97.5 - 100), moderate (NRI score 83.5 to < 97.5) or severe (NRI < 83.5).

The nutrition risk score (see **Table 1.2.4**) was developed in 1992 by the Department of Nutrition and Dietetics in Birmingham Heartlands Hospital to assess patients' risk on admission for nutritional deterioration in hospital (Reilly *et al.* 1995). Incorporated into the nutrition risk score are the variables weight loss (amount and duration over the previous three months), BMI (kg/m^2), food intake (appetite and ability

to eat and retain food) and stress factors (effect of medical condition on nutritional requirements). The NRS does not include the variables of age and mental status and the only objective measurement is BMI. The score is intended to be completed within 24 h of admission, and repeated weekly during a hospital stay if the patient's condition has changed. Patients are categorised as at low, moderate or high risk for the development of undernutrition. Guidance for appropriate action is provided as a poster on each ward (Reilly, 1996) with nursing staff encouraged to provide nutritional supplements and monitor weight for patients at moderate nutritional risk. Patients deemed to be at high nutritional risk are highlighted for dietetic referral to enable more detailed nutritional assessment and for the provision of appropriate nutritional support. In a validation study (Reilly *et al.* 1995), the nutrition risk score correlated well (P <0.001) with a sixteen-item nutrition risk index designed to assess nutritional risk among community-dwelling elderly Americans (Wolinsky *et al.* 1990) and with the dietitian's clinical impression of the degree of risk of undernutrition (P <0.001). Reproducible scores were produced between dietitians (P <0.001) and between dietitians and nursing staff (P <0.001). The nutrition risk score has been adopted as a national standard in the UK (Sizer *et al.* 1996), despite some criticisms that the age and mental status of the patient are not considered, and a number of screening tools based on the NRS have been developed for specific patient groups. It has also received some criticism for not considering a greater number of objective factors.

The modifications made to the nutrition risk score for this study included determining the percentage of unintentional weight lost over both the six months and one month before admission to hospital. The original NRS (see **Table 1.2.4**) looked at amount and duration of weight loss over the previous three months. In addition, mid-arm circumference, mental status and age over sixty-five years were added to the original NRS to determine the degree to which these variables affect the classification of nutritional risk (see **Table 4.1**). Both screening tools were compared to determine accuracy of detection of undernutrition as defined by McWhirter & Pennington in those aged over or under sixty-five years. Associations were defined between the symptoms affecting nutritional status which are included in nutrition screening tools and the presence of undernutrition as defined by McWhirter & Pennington on admission to hospital.

Table 4.1. The modified Nutrition Risk Score, adapted from the original Nutrition Risk Score devised by the Nutrition and Dietetic Department, Birmingham Heartlands Hospital

Hospital : _____	**Height :** _____ **cm**
Hospital No : _____	**Weight :** _____ **kg**
Name : _____	**Ward :** _____

Please circle relevant score. Only select one score from each section. Select the highest score that applies.

	SCORE
1. BODY MASS INDEX	
20 or more	0
18 or 19	1
15 - 17	2
Less than 15	3
2. WEIGHT LOSS (UNINTENTIONAL).	
Calculate from present and previous weights	
No weight loss	0
> 1% weight loss in past month / > 2.5% weight loss in past 6months	1
> 2.5% weight loss in past month / > 5% weight loss in past 6months	2
> 5% weight loss in past month. / > 10% weight loss in past 6months	3
3. APPETITE IN 3 MONTHS PRIOR TO ADMISSION	
Good appetite, manages most of 3 meals / day (or equivalent)	0
Reduced appetite, poor intake, leaves > half of meals	2
Appetite nil or virtually nil, unable to eat, NBM (for > 4 meals)	3
4. ABILITY TO EAT / RETAIN FOOD	
No difficulties eating, able to eat independently No diarrhoea or vomiting	0
Problems handling food, e.g. needs special cutlery Vomiting / frequent regurgitation / mild diarrhoea Difficulty swallowing, requires modified consistency Problems with dentures affecting food intake Problems with chewing affecting food intake Moderate vomiting and / or diarrhoea Needs help with feeding	1 2
Unable to take food orally Unable to swallow (complete dysphagia) Severe vomiting and / or diarrhoea Malabsorption	3

5. STRESS FACTOR

No stress factor (includes admission for investigations only)		0
Mild	Minor surgery / minor infection	1
Moderate	Chronic disease. Major surgery. Infections. Fractures. Pressure sores / ulcers. CVA. Inflammatory bowel disease. Other gastrointestinal disease.	2
Severe	Multiple injuries. Multiple fractures / burns. Multiple deep pressure sores / ulcers. Severe sepsis. Carcinoma / malignant disease.	3

6. PSYCHOLOGICAL STATE

Fully orientated in time, person, place	0
Orientated by 2	1
Orientated by 1	2
Orientated by 0	3

7. AGE

Over 65 years add 2 to score	2

8. MID-ARM CIRCUMFERENCE*

> 25th percentile	0
> 10th percentile	1
> 5th percentile	2
< 5th percentile	3

TOTAL SCORE : ☐

*Percentile tables used:
Bishop *et al.* 1981 (for those aged 16 - 65 years)
Burr & Phillips, 1984 (for those aged over 65 years)

4.3 Aims and objectives

This study aimed to compare the efficacy of two nutrition screening tools, the nutrition risk index and the modified form (see **Table 4.1**) of the nutrition risk score in detecting undernourished patients on admission to hospital. Undernutrition was defined using the method of the widely cited study from Dundee (McWhirter & Pennington, 1994; see **Chapter 3**). A validation study on this method as the 'gold standard' of nutritional assessment was beyond the remit of this study.

4.4 Patients and methods

The methods of data collection from patients admitted to two Dublin teaching hospitals have been described previously (see **Chapter 3**). Patients with documented fluid retention on admission or where body mass index was not calculable were excluded from the analysis of nutritional status (*n* 25). Nutrition risk index could be calculated only in those cases where serum albumin was known and where percentage weight loss from normal could be obtained (*n* 359). Nutrition risk score was calculated for all patients (*n* 594) but if weight loss before admission was unknown (*n* 47), a score of zero was given in that section. This meant that these forty-seven patients may have been given a lower risk score than if their previous weight was available.

Ethical approval was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals. Written informed consent was obtained either from the patient or a relative before patients were assessed (see **Appendix 2**).

4.5 Statistical analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences for Windows (SPSS Inc. Chicago). Chi-squared analysis or Fisher's Exact Test

were used to test for differences between groups and to identify associations between the symptoms affecting weight loss and undernutrition as defined by McWhirter & Pennington on admission. Independent sample *t* tests were used to test for differences in mean length of hospital stay and loss of muscle function between groups. P values of less than 0.05 were considered to indicate statistical significance.

4.6 Results

Nutritional risk on admission

Of 594 patients seen, 569 were suitable for classification of nutritional status according to the criteria of McWhirter & Pennington (1994). Of these, 62 (11 %) were undernourished (see **Chapter 3**) using the defining criteria (McWhirter and Pennington, 1994), forty-nine of whom underwent both nutrition screening processes. Nutrition risk score was defined for all 594 patients, nutrition risk index was calculated in 359. Nutrition risk score was in the high risk category for 129 (22 %) cases while 96 (16 %) required monitoring of nutritional status. Both nutrition risk score and nutrition risk index were available for 359 (63 %) cases. Significant differences ($P < 0.001$) were found in the classification of both mild/moderate nutrition risk and high nutrition risk using the two screening tools (see **Table 4.2**). In the forty-nine undernourished patients, these differences were also significant ($P < 0.001$) (see **Table 4.3**). A number of undernourished patients were misclassified as well nourished; 9 (18 %) by the nutrition risk score and 16 (33 %) by the nutrition risk index method. Normal serum albumin levels were found in 71 % of the undernourished patients. The degree of misclassification of cases by nutrition risk index was similar in both surgical (six of thirteen) and medical (eight of twenty-one) cases.

The addition of extra variables such as mental status or age over 65 years into the nutrition risk score only increased the detection of undernutrition, among the forty-nine undernourished patients, by one patient. Use of mid-arm circumference, significantly reduced the degree of misclassification ($P < 0.05$), highlighting a need for nutritional monitoring in eight of the nine patients incorrectly classified as normally

nourished, while correctly reclassifying a further six patients to be at high nutritional risk.

When the undernourished patients were divided into those aged under 65 years and those aged 65 years or more, both the NRI and NRS screening tools correctly detected those who were undernourished in over 80 % of the undernourished (as defined by McWhirter & Pennington (1994)) older group (see **Table 4.4**). The nutrition risk index could only identify 55 % of undernourished patients aged under 65 years, significantly different than its performance with the older patients (P <0.05). For the younger patients, the trend was for more accurate detection of undernutrition (defined by McWhirter & Pennington) using the nutrition risk score (P = 0.07).

Prevalence of symptoms affecting nutritional status

The prevalence and duration of symptoms affecting nutritional status can be seen in **Table 4.5**. A reduction in appetite or poor dietary intake was reported by 198 (33 %) patients on admission to hospital, with 38 (6 %) reporting that their appetite was virtually absent. Reduced ability to eat or retain food was reported by 134 (23 %) patients on admission, with 13 (2 %) being unable to take food orally or having severe vomiting or diarrhoea. The pattern of weight change and referral rates for nutritional intervention in patients having symptoms affecting nutritional status during the hospital stay can be seen in **Table 4.6.**

Loss of weight and muscle function in hospital

Weight loss was the predominant nutritional change during the hospital stay in all groups of patients, regardless of nutritional risk on admission (see **Table 4.7**). In any repeat measure it would be expected that on average 50 % of patients to have gained and 50 % to have lost (albeit a very small amount) of weight. However, a significantly higher proportion (two-thirds) of patients lost weight. Those at highest risk on admission had the greatest loss of weight, in spite of a higher referral rate for nutritional intervention in this group. This observation is in keeping with the findings of our previous study where the severely undernourished patients lost most weight (see

Chapter 3). Anthropometric measurements were analysed in the patients who lost weight in hospital (see **Table 4.8**). Between one-third and a half of patients classified as well nourished or at low to moderate nutritional risk on admission lost sufficient mid-arm muscle circumference to re-categorise them to a lower percentile. Between 28 % and 36 % of these patients lost sufficient triceps skinfold thickness to re-categorise them. Reductions in calf circumference followed the same pattern. **Table 4.9** shows that in the undernourished and high risk groups, a significantly higher number of patients who lost weight lost muscle function as measured by hand-grip dynamometry in comparison to those in the same groups who gained weight ($P < 0.05$).

Associations between symptoms and nutritional status

Appetite and the ability to eat were compared between the well and undernourished groups. On admission, reduced appetite was significantly more likely in the undernourished group ($P < 0.001$) who were also significantly more likely to have reduced ability to eat or to retain food ($P < 0.05$).

Table 4.2. Differences in classification of nutrition risk using the nutrition risk index and nutrition risk score (*n* 359)

		Nutrition risk score		
		Low Risk	Mild / Moderate Risk	High Risk
Nutrition risk index	Low Risk	148 (41)	29 (8)	28 (8)
	Mild / Moderate Risk	46 (13)	27 (8)	64 (18)
	High Risk	0	6 (2)	11 (3)

Values are absolute (percentages).

Table 4.3. Classification of undernourished patients by nutrition risk index or by nutrition risk score (*n* 49)

		Nutrition risk score		
		Low Risk	Mild / Moderate Risk	High Risk
Nutrition risk index	Low Risk	8 (16)	2 (4)	6 (12)
	Mild / Moderate Risk	1 (2)	4 (8)	19 (39)
	High Risk	0	1 (2)	8 (16)

Values are absolute (percentages).

Table 4.4. Identification of undernutrition in patients aged over or under 65 years using the Nutrition Risk Index and the Nutrition Risk Score

	Nutrition risk index	*n*	Nutrition risk score	*n*
Patients aged less than 65 years	17 (55)	31	32 (78)	41
Patients aged 65 years or more	16 (89)	18	17 (81)	21

Values are absolute (percentages).

Table 4.5. Prevalence and duration of symptoms which can affect nutritional status

	Time period							
	> six months		< six months		< one month		< one week	
	Under nourished	Well nourished	Under nourished	Well nourished	Under nourished	Well nourished	Under nourished	Well nourished
Category 1	17 (27)	51 (10)	5 (8)	37 (7)	4 (7)	29 (6)	1 (2)	16 (3)
Category 2	0	1 (0.2)	1 (2)	1 (0.2)	6 (10)	11 (2)	3 (5)	15 (3)
Category 3	4 (7)	24 (5)	1 (2)	7 (1)	2 (3)	9 (2)	1 (2)	9 (2)
Category 4	1 (2)	11 (2)	3 (5)	8 (2)	4 (7)	14 (3)	2 (3)	21 (4)
Category 5	1 (2)	1 (1)	0	0	1 (2)	1 (0.2)	1 (2)	8 (2)

Values are absolute (percentages)

Category 1: Reduced appetite, poor intake, leaves more than half of meals.
Category 2: Appetite nil or virtually nil, unable to eat, nil by mouth for more than 4 meals.
Category 3: Problems handling food, vomiting, frequent regurgitation, mild diarrhoea.
Category 4: Difficulty swallowing, requires modified consistency, problems with dentures or chewing affecting food intake, moderate vomiting and/or diarrhoea, needs help with feeding.
Category 5: Unable to take food orally, unable to swallow, severe vomiting and/or diarrhoea, malabsorption.

Table 4.6. Pattern of weight change and referral for nutritional support during the hospital stay in patients with symptoms on admission which can affect nutritional status

Symptoms affecting nutritional status	Patients with weight loss in hospital		Patients who gained weight in hospital	
	Total	Referred	Total	Referred
Good appetite, manages most of 3 meals/day or equivalent	78 (61)	21 (27)	30 (47)	3 (10)
Reduced appetite, poor intake, leaves more than half of meals	38 (30)	15 (40)	27 (42)	6 (22)
Appetite nil or virtually nil, unable to eat, nil by mouth for more than 4 meals	11 (9)	5 (46)	7 (11)	4 (57)
No difficulties eating, able to eat independently, no diarrhoea or vomiting	94 (74)	24 (26)	47 (73)	6 (13)
Problems handling food, vomiting, frequent regurgitation, mild diarrhoea	12 (9)	4 (33)	12 (19)	4 (33)
Difficulty swallowing, requires modified consistency, problems with dentures or chewing affecting food intake, moderate vomiting and/or diarrhoea, needs help with feeding	16 (13)	10 (63)	3 (5)	2 (67)
Unable to take food orally, unable to swallow, severe vomiting and/or diarrhoea, malabsorption	5 (4)	3 (60)	2 (3)	1 (50)

Values are absolute (percentages).

Table 4.7. Changes in weight during hospital stay in patients reassessed on discharge

	Well nourished		Mild / moderate nutritional risk		High nutritional risk	
	NRI	NRS	NRI	NRS	NRI	NRS
	n 88	*n* 119	*n* 67	*n* 37	*n* 9	*n* 62
Weight loss:	56 (64)	70 (59)	39 (58)	25 (68)	5 (56)	32 (52)
Mean weight loss (%)	4.3 (SD 4.6)	3.3 (SD 3.2)	3.7 (SD 2.8)	3.6 (SD 2.8)	5.1 (SD 3.1)	5.8 (SD 4.9)
Referred for nutritional intervention	18 (32)	15 (21)	11 (28)	9 (36)	5 (100)	17 (53)
Weight gain:	23 (26)	33 (28)	23 (34)	10 (27)	4 (44)	22 (35)
Mean weight gain (%)	2.6 (SD 2.0)	2.6 (SD 3.0)	3.2 (SD 4.2)	4.2 (SD 4.3)	3.4 (SD 2.8)	4.2 (SD 5.5)
Referred for nutritional intervention	2 (9)	2 (6)	6 (26)	2 (20)	2 (50)	9 (39)

Values are absolute (percentages).
NRI, nutrition risk index; NRS, nutrition risk score.

Table 4.8. *Loss of muscle and fat in different risk category patients who lost weight in hospital*

	Under nourished	Well nourished	High risk		Mild / moderate risk		Low risk	
			NRS	NRI	NRS	NRI	NRS	NRI
	n 8	*n* 117	*n* 31	*n* 5	*n* 25	*n* 39	*n* 69	*n* 55
Reduced MAMC (%)	25	33	22	40	28	31	40	50
Reduced TSF (%)	0	28	28	40	28	33	27	36
Mean reduction in calf circumference (mm)	2.2 (SD 12.0)	5.4 (SD 18.4)	4.7 (SD 17.0)	+4.3 (SD 8.0)	7.2 (SD 12.4)	5.5 (SD 16.1)	7.0 (SD 19.0)	8.8 (SD 21.2)

NRS, nutrition risk score; NRI, nutrition risk index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

Table 4.9. *Loss of muscle function as measured by hand-grip dynamometry in patients who lost or gained weight in hospital*

	Undernourished patients	Normally nourished patients	NRS High risk	NRI High risk	NRS Mild/moderate risk	NRI Mild/moderate risk	NRS Low risk	NRI Low risk
% patients with weight loss	67	50	56	50	35	54	54	49
Mean loss of function (%)	11.5 (SD 9.8)	9.7 (SD 7.4)	8.8 (SD 6.6)	3 (SD 0)	6.9 (SD 6.9)	9.6 (SD 7.1)	10.9 (SD 7.9)	10.4 (SD 7.8)
	n 6	*n* 96	*n* 23	*n* 4	*n* 20	*n* 33	*n* 59	*n* 65
% patients with weight gain	20	58	39	25	60	57	56	51
Mean loss of function (%)	7 (SD 5.7)	8 (SD 7.7)	9.4 (SD 7.2)	6	6.8 (SD 10.0)	8.2 (SD 7.6)	7.7 (SD 7.0)	7.8 (SD 7.8)
	n 10	*n* 50	*n* 18	*n* 4	*n* 10	*n* 21	*n* 32	*n* 35

NRS, nutrition risk score; NRI, nutrition risk index.

4.7 Discussion

The King's Fund Centre Report (1992), highlighted the lack of national standards for nutritional support in the United Kingdom and called for such standards to be established (Lennard-Jones, 1992). Guidelines were developed subsequently by the British Association for Parenteral and Enteral Nutrition (Sizer *et al.* 1996) recommending the routine nutritional assessment of patients on admission, and at regular intervals in hospital, in order to identify undernourished patients or those at risk of becoming undernourished. As full nutritional assessment of all patients admitted to hospital by a dietitian is not practical, a number of nutritional screening tools for use by nursing staff have been developed (Elmore *et al.* 1994; Reilly *et al.* 1995; Kovacevich *et al.* 1997). Although the routine use of nutrition screening protocols is recommended because their use raises awareness amongst medical and nursing staff of the importance of nutrition in total patient management, it is recognised that many protocols have not been properly validated (Sizer *et al.* 1996). In this study, the reliability of two widely used nutritional screening tools, the nutrition risk index and the nutrition risk score was assessed by determining their ability to detect undernutrition (as defined in a widely cited study (McWhirter & Pennington, 1994)).

Although a precise definition of undernutrition has yet to be agreed, one would expect that a nutrition screening tool should identify those patients fulfilling the accepted criteria of a body mass index less than 20 kg/m^2 and triceps skinfold thickness or mid-arm muscle circumference below the 15th percentile (McWhirter & Pennington, 1994). Both screening tools wrongly classified a considerable proportion of the undernourished patients. The nutrition risk index was originally devised for screening the nutritional status of surgical patients but in this study, was found to be equally unreliable in surgical and medical cases. As a nutrition screening tool, the nutrition risk index is open to criticism for including serum albumin in its formula and nowadays, it would be expected that nobody would seriously consider including serum albumin as a marker of nutritional status. It is therefore inevitable that NRI measures something other than nutritional status. However, in recent clinical papers (Reynolds *et al.* 1996; Heslin *et al.* 1997; Keele *et al.* 1997), NRI continues to be used as a marker of

nutritional risk. Protein energy malnutrition causes a decrease in the rate of synthesis of albumin but this has little impact on plasma concentrations. The metabolic response to stress is usually more important in the development of low serum albumin concentrations (Klein, 1990; Doweiko & Nompleggi, 1991; Vanek, 1998)

The nutrition risk score includes BMI and a number of reasonable indicators of weight loss and food intake. It is therefore highly likely that it would agree better with the index of McWhirter & Pennington than the NRI. However, although the nutrition risk score was devised for use with all hospital patients, it too failed to detect all undernourished (using the McWhirter & Pennington (1994) definition) patients. The NRS, although validated against the Wolinsky index (Wolinsky *et al.* 1990), has been criticised for containing mainly subjective data and for the omission of age over 65 years and psychological status, commonly believed to be risk factors for the development of undernutrition (White *et al.* 1991; Allison, 1995; Fenton *et al.* 1995; Gariballa & Sinclair, 1998; Morley, 1998; Yeh & Schuster, 1999). However, in our study, the addition of mental status and age to the score did not improve detection of undernutrition as defined by McWhirter & Pennington (1994). The addition of an extra objective parameter, mid-arm circumference, significantly increased detection of undernutrition as defined above($P < 0.05$). Measurement of mid-arm circumference is simple and reproducible (i.e. there is both low intra-observer and inter-observer error (Ulijaszek & Kerr, 1999) and further research should evaluate its role when added to nutrition screening instruments.

Our previous study showed weight loss of more than 10 % in the six months before admission strongly predicted undernutrition on admission to hospital (see **Chapter 3**). We can now also show that both reported reduction in appetite and inability to eat also accurately predict undernutrition as defined by McWhirter & Pennington (1994). If percentage weight loss and questions relating to appetite and ability to eat are included in routine nutrition screening, detection of undernutrition as defined in this manner should improve. However, it is also important to remember that the majority of patients do not complain of reduced appetite or inability to eat on admission to hospital although up to 50 % suffer reductions in lean body mass in hospital which are likely to impede recovery.

Nutrition screening should be able to detect patients at highest risk as these are the most difficult to rehabilitate nutritionally. We have shown (see **Chapter 3**) that those patients classified as undernourished as defined by McWhirter & Pennington (1994) stay in hospital significantly longer (sixteen versus ten days in the adequately nourished group, $P < 0.01$) and show a trend towards a higher mortality rate (6.5 % versus 2 % in the adequately nourished group, $P = 0.05$). These patients require intensive nutritional support from the onset of their illness if nutritional deterioration is to be minimised. However, a recent review on the topic of nutritional screening (Arrowsmith, 1999) which critically evaluated six nutrition screening tools concluded that few have undergone replication studies to test their validity and reliability. None have been tested for sensitivity or specificity. Perhaps, most importantly, none of the nutrition screening tools have demonstrated a beneficial effect on clinical outcome. The author of this review recommended that each of the nutrition screening tools should be refined and re-tested before becoming part of nursing practice. She also recommended that clinical judgement should remain a key element in nutrition screening until these screening tools are fully validated. It is therefore imperative that further research into the effectiveness of different nutrition screening tools at detecting patients at risk of nutritional deterioration is carried out and that the clinical benefits of early detection are investigated.

4.8 Conclusions

At present it is unlikely that there is a nutrition screening tool available which can detect all cases of undernutrition. The large number of patients who lose weight, lean body mass and muscle function in hospital, and the fact that those at highest risk lose most, means that the use of nutrition screening tools should continue to be promoted. It is worthwhile remembering that a policy designed to identify undernutrition at its early stage and to treat it by simple means may prevent some patients losing weight to the point where more expensive forms of artificial nutrition become necessary (Allison, 1995). In our study, undernutrition was more reliably identified by the nutrition risk score than by the nutrition risk index. The addition of mid-arm circumference to the variables used improved the performance of the nutrition risk score. It has been recommended recently (McClave *et al.* 1999) that the concept of risk for nutritional nutrition deterioration should replace the term "protein calorie malnutrition". However, in general, the clinical nutrition literature only supports nutritional intervention in malnourished patients. If nutritional screening is to be considered essential in patient management, so that those at risk of nutritional deterioration also receive intervention, simple methods to measure the changes in clinical outcome, functional status and quality of life of those patients who receive nutritional intervention as a result of using these procedures must be developed and evaluated.

Chapter 5

Nutritional status of Irish surgical oncology patients

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5.1 Summary

Weight loss and undernutrition are frequently observed in patients with cancer. It is known that undernourished patients are at higher risk for developing post-operative complications than those who are well nourished. Nutritional, functional and quality of life variables were recorded in a prospective, observational study of fifty-nine surgical oncology patients in a single hospital over a period of ten months. Assessments were made during the hospital stay (pre-operatively and post-operatively) and at six and twelve weeks post-discharge when possible.

Nutrition risk index (NRI; Veterans Affairs Total Parenteral Nutrition Study Group, 1991) was calculated (where possible) to identify patients requiring nutritional support. Thirty-three (63 %) of fifty-two patients were found to be at nutritional risk and seven (13%) were severely malnourished. Body mass index (BMI) estimates identified only three (6 %) of these using the standard threshold value of < 20 kg/m^2.

Involuntary weight loss in the six months before admission to hospital occurred in forty-three of the fifty-seven patients for whom pre-admission body weight was known, with twenty-one (37 %) losing more than 10 % of body weight. In those patients who lost weight, the mean weight loss was 11.2 %. Patients with a BMI < 20 kg/m^2 on admission had a mean weight loss of 13.4 %.

Variables found to have no effect on survival included gender, age $\geq$ sixty-five years and weight loss of > 5 % over the month before admission. Weight loss > 10 % in the six months before admission significantly decreased post-operative survival (P = 0.024). The development of major post-operative complications was the factor most likely to predict mortality in this patient group. Lower percentage body fat on admission to hospital and severity of the surgical operation were best able to predict the development of major post-operative complications. Patients who were below 65 % mean body fat for age and sex were twice as likely to develop a major complication and almost four times as likely to develop a major infectious complication as those patients with percentage body fat above this level. Prolonged hospital stay was predicted by the

development of major infectious complications, higher alcohol intake at the time of admission and the severity of the surgical operation.

Reduced appetite on admission to hospital was reported by twenty-one (36 %) patients, with eleven (19 %) reporting that their appetite was virtually non-existent. Vomiting and / or diarrhoea was reported by fifteen (25 %) patients, difficulties in swallowing requiring food consistency modification by eleven (19 %) while three (5 %) were unable to take food orally. Problems with appetite and swallowing remained throughout the study period, despite curative resection.

The majority of patients (76 %) lost weight in hospital. Mean weight loss was 4.3 (SD 3.3)kg, representing an average of 5.6 % of their admission weight. Two patients with a normal BMI on admission lost sufficient weight in hospital to fall to a BMI < 20 kg/m^2. Of six patients who had two pre-operative assessments, four lost weight (mean 1.9 (SD 2.0)kg, an average of 2.2 % body weight before surgery). Following discharge, twenty-six (70 %) patients lost weight within three months (mean 3.8 (SD 2.7)kg, an average of 5.9 % of their discharge weight). Three patients with a normal BMI on discharge lost enough weight to reach a BMI < 20 kg/m^2 subsequently.

Forty-four (75 %) patients were referred for nutritional support and / or advice during the study period, while two additional patients received nutritional supplements from the nursing staff. Referral occurred if there was an obvious inability to eat or when clinical complications occurred. A history of weight loss >10 % did not automatically result in early referral on admission (only in sixteen cases of twenty-one eligible). Neither the use of BMI (< 20 kg/m^2) nor NRI ($\leq$100) identified all patients in this study who required nutritional intervention. There are a number of other widely used screening tools which are made up of both subjective and objective elements (e.g. the mini-nutritional assessment, the nutrition risk score and subjective global assessment). These were not evaluated in our study but may possibly perform better in the surgical oncology patient group as it is apparent from our study that details of weight loss and subjective elements such as appetite and ability to eat are important indicators of the need for nutrition support in this group. It is probable therefore that only a screening tool which contains a number of subjective, in addition to objective variables, will

detect surgical oncology patients who are at nutritional risk. Indeed, a specific screening tool for oncology patients containing a number of pertinent subjective and objective elements may need to be designed and evaluated.

5.2 Introduction

Weight loss and undernutrition are frequently observed in patients with cancer (Bellantone *et al.* 1990; Daly *et al.* 1992; Daly *et al.* 1995; Hunter, 1996; Mercadente, 1996; de Blaauw *et al.* 1997*a,b*; Hammerlid *et al.* 1998; Sikora *et al.* 1998). Cancer cachexia and its accompanying metabolic changes (see **Appendix 11**), nausea and vomiting, decreased energy intake and oncology treatments may contribute to the development of impaired nutritional status both before and after a surgical procedure. Patients who are most at risk of developing surgical complications associated with undernutrition (e.g. increased wound and anastomotic dehiscence) are those who have a weight loss of greater than 10 %, clinical evidence of respiratory and limb muscle weakness and a plasma albumin of less than 30g / l (Heys *et al.* 1996). However, a study by Windsor *et al.* (1988) observed that pre-operative food intake had a greater effect on wound healing in surgical patients than absolute losses of body muscle and fat.

Undernutrition can result in impairment of respiratory, skeletal, cardiac and gut muscle function, and dysfunction of the immune system (see **Chapter 1.1.4**). An association between extended length of stay and malnutrition if nutritional support is withheld has been established in malnourished surgical patients, even in those without peri-operative complications (Shaw-Stiffel *et al.* 1993). A relationship between impaired quality of life and poor nutritional state has been observed in patients undergoing surgery (Larsson *et al.* 1994).

Certain tumour types are more likely to be associated with loss of weight than others, for example, patients with gastric and pancreatic cancers (De Wys *et al.* 1980). However, recent studies which have tried to assess the effects of nutritional intervention in either cancer patients undergoing major abdominal surgery, or in surgical patients where a large proportion of the subjects had cancer, have observed that relatively few

were undernourished (Beier-Holgerson *et al.* 1996; Carr *et al.* 1996; Heslin *et al.* 1997; Keele *et al.* 1997; Watters *et al.* 1997), for reasons that are not clear. It may be that with improved diagnostic and surgical techniques, the majority of patients undergo surgery at an earlier stage in their disease and so have less time to deteriorate nutritionally. This hypothesis has not been fully evaluated however.

While the research is being accumulated to support the use of nutritional interventions for the reduction of morbidity and mortality and for improved quality of life, cancer patients continue to demand consensus-based recommendations from their physicians, most of whom are poorly educated regarding nutritional therapy and also lack the resources to provide it. Dietitians frequently work in isolation trying to nourish cancer patients, assuming that even those who are obese are malnourished (Heber *et al.* 1999).

A complete evaluation of the nutritional status of a patient with cancer should include an assessment of the patient's protein, fat and carbohydrate stores, vitamin and trace element status, history of food intake, weight change and degree of physical activity. Routinely used indices of nutritional status in this group of patients in clinical practice include body mass index, the comparison of actual body weight with 'ideal body weight', percentage weight loss in the previous six months and anthropometric assessment of body composition (Heys *et al.* 1996). Biochemical assessment of plasma proteins, most commonly albumin, is also routinely used to indicate undernutrition, either solely or, as part of a prediction equation (e.g. Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991). However, the use of either plasma albumin alone, or in combination with other factors, to detect undernutrition is flawed. Although protein energy malnutrition causes a decrease in the rate of synthesis of albumin, this has little impact on plasma concentrations (see **Chapter 1.2.4**). However, plasma albumin is useful in predicting those patients who are at risk of post-operative complications (see **Chapter 1.2.5).**

Clinical studies have been carried out to determine the effects of oral, enteral and parenteral nutritional therapy on the post-operative morbidity and mortality of cancer patients (Daly *et al.* 1992; Daly *et al.* 1995; Beier-Holgerson *et al.* 1996; Carr *et al.*

1996; Heslin *et al.* 1997; Keele *et al.* 1997; Watters *et al.* 1997). There seems to be no uniform acceptance that in either malnourished patients, or those at high risk for the development of malnutrition, peri-operative nutrition support corrects nutritional deficits sufficiently to reduce the incidence of post-operative complications to that of well-nourished patients undergoing similar operative procedures without accruing additional risks (Campos & Meguid, 1992). Many of the earlier studies used parenteral nutrition; it was widely presumed that many of the clinical improvements hoped for with the use of nutritional support were not observed because of the risks associated with this route of feeding. It was, therefore, expected that the use of enteral nutrition would result in improvements in surgical oncology patients similar to those observed in burns (Chiarelli *et al.* 1990; McDonald *et al.* 1991; Sologub *et al.* 1992; Clevinger *et al.* 1995) and surgical trauma patients (Moore *et al.* 1989; Moore & Moore, 1991; Moore *et al.* 1992; Kudsk, 1994). Early oral food, enriched by enteral supplementation, used with laparoscopic surgery, epidural analgesia and early mobilisation in elderly high-risk patients undergoing colonic resection for neoplastic disease was reported to reduce hospital stay to two days from a normal stay of 8-10 days (Bardram *et al.* 1995). Early oral feeding after elective colorectal surgery is also reported as safe and tolerated by the majority of patients (Reissman *et al.* 1995). However, the surgical nutrition literature remains conflicting, leading to major differences in clinical practice. Two of the most recent studies examining the effects of enteral nutrition support on the clinical outcome of surgical patients, the majority of whom were undergoing resections for cancer, report no improvements (Heslin *et al.* 1997; Watters *et al.* 1997) while two others report the opposite (Beier-Holgerson *et al.* 1996; Keele *et al.* 1997). A number of studies have examined the effects of nutritional intervention with enteral feeds containing enhanced amounts of specific nutrients. The initial studies demonstrate reductions in post-operative morbidity but have not shown improved mortality (Daly *et al.* 1992; Daly *et al.* 1995; Bower *et al.* 1995; Kenler *et al.* 1996; Heys *et al.* 1997). The results of a recent study (Reynolds *et al.* 1997) confuse the picture further. The perceived clinical advantage of the enteral route was not observed in a study of patients undergoing major upper gastrointestinal surgery for carcinoma. The study failed to demonstrate a clinical or scientific basis to support the hypothesis that enteral feeding reduces endogeneous sepsis and preserves gut barrier function compared with total parenteral nutrition.

5.3 Aims and objectives

The aims of this study were, firstly, to record the nutritional status of patients admitted to a large teaching hospital in Dublin and secondly, to monitor their nutritional and functional status and quality of life in hospital and for twelve weeks after discharge from hospital. The third aim was to assess the impact of nutritional status and current nutritional practice on patient outcome as judged by the effects of pre-operative nutritional status and nutritional intervention on mortality, post-operative complications (infectious and non-infectious), functional status (measured by hand-grip strength, modified Norton score and fatigue score) and quality of life. As with the work described in **Chapter 3**, the results of the survey were intended to provide a background for planning the resources needed for effective nutritional care in this group of patients.

5.4 Patients and methods

During a 20 week period, sixty-nine patients admitted to a Dublin teaching hospital (812 beds) who were believed at time of admission to require resection of carcinoma were enrolled into the study. Two patients did not have a carcinoma, five were inoperable at resection and three did not undergo surgery during the study period. Post-operative data were not collected for these ten patients and they have been omitted from the analysis. The cases included in the study were patients with lung (*n* 16), ovarian (*n* 4), bowel (*n* 12), head and neck (*n* 13), oesophageal (*n* 10), gastric (*n* 2) and pancreatic (*n* 2) cancers. A summary of the numbers enrolled into the study and the timing of assessments can be seen in **Table 5.1**. The full details of which patients were assessed and the timing of their assessments can be seen in **Appendix 12**. The cases in hospital were assessed weekly, from admission until day of operation and weekly, thereafter, until discharge. Assessments were carried out at six (*n* 36) and twelve weeks (*n* 22) post-discharge from hospital when possible. A total of 244 assessments were carried out by the same trained dietitian on the fifty-nine patients who underwent a curative surgical procedure.

The age profile of the patients who underwent resection for different cancers can be seen in **Table 5.2**. The mean age of the patients was sixty-six (SD 11.5) years; 44 % were under sixty-five years, 56 % were sixty-five years or more. The mean age of those who received nutritional intervention in hospital was similar to those who did not [65.3 (SD 12.2) versus 66.5 (SD 11.5) years]. Sixty-three per cent were male, 37 % female (**Table 5.3**). Forty-one per cent were current or recent smokers and 59 % drank alcohol regularly. A summary of patient characteristics on admission can be seen in **Table 5.4**.

Details of the diagnosis and histological observations can be seen in **Table 5.5** while details of the operative procedures carried out can be seen in **Table 5.6**. The Tumour, Node, Metastasis (TNM) staging system was used to classify the stage of the cancer. The TNM system integrates all clinically available information, including that obtained by endoscopy and radiological testing (Allen-Mersh, 1996). Generally, designations of TI to T3 indicate the increasing size of the primary lesion; a designation of T4 indicates the involvement of an adjacent structure. The staging of lymph node involvement is uniform for all sites. Together, the T and N classifications determine the overall clinical stage (I, II, III, IV) for most patients. Patients with distant metastases are classified as having stage IV disease.

The severity of surgical insult was determined by the difference between serum albumin pre-operatively and as measured on the first post-operative day. The decrease in post-operative serum albumin has been shown previously to correlate with the post-operative increase in serum C-reactive protein (CRP) (Reynolds *et al.* 1997). Intra-operative blood loss was also noted (**Table 5.6**).

Written informed consent was obtained before measurements were made, and ethical approval was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals (see **Appendix 2**).

Height was measured on admission with a Leicester portable stadiometer (Chasmors Weighing Equipment Ltd, London, UK). Weight was measured with a high specification portable scales (Chasmors Weighing Equipment Ltd, London, UK). Patients who could not stand post-operatively were weighed on a mechanical chair

scales, calibrated against the portable scales. Body mass index (BMI) (kg / (m) ^{2}) was calculated and was used to grade patients into undernourished, normal weight, overweight and obese. Mid-arm and calf circumferences were measured with a plastic insertion tape measure, and skinfold measurements were made with Holtain skinfold callipers (Crymmych, Wales) according to standard techniques (World Health Organisation, 1995; see **Chapter 2**). Measurements of mid-arm circumference and triceps skinfold thickness were used to calculate mid-arm muscle circumference (mid-arm muscle circumference (cm) = mid-arm circumference - triceps skinfold thickness x 0.314). Where valid anthropometric measurement of skinfold thickness at the four skinfolds sites (triceps, biceps, subscapular and supra-iliac) could be carried out, percentage body fat was calculated using the formula of Durnin & Womersley (1974).

Nutrition Risk Index (NRI) was calculated according to the formula (NRI=1.519 × the serum albumin level (g /l) + 0.417 × (current weight/usual weight) × 100. Nutrition risk is then classified as borderline (NRI score 97.5-100), mild (NRI score 83.5 to < 97.5) or severe (NRI < 83.5) (see **Table 1.2.3**).

Weight loss before admission to hospital was calculated from either recalled weight or from measurements made on a previous hospital visit. Patients were observed eating the main hospital meal and were questioned at each interview about their perceived need to eat.

Functional status and subjective levels of fatigue were measured at each assessment (see **Chapter 2.3**). Functional status was measured with a hand grip dynamometer (Takai Scientific Instruments Ltd., Tokyo, Japan) using the highest of three readings made with the non-dominant arm and compared to standardised grip strengths for age and sex (Webb *et al.* 1989). Functional status was also calculated using the modified Norton scale (Ek & Bjurulf, 1987). This consists of seven sub-scales; mental condition, activity, mobility, food intake, fluid intake, incontinence and general physical condition, each scored between one and four. Subjective levels of fatigue were measured using a visual analogue scale (Christensen *et al.* 1982). A score of one corresponds to feeling fit, while a score of ten equates with total fatigue.

Quality of life was assessed at each interview using Part 1 of the Nottingham Health Profile quality of life score (Bowling, 1997; see **Chapter 2.3**). This score was developed in the UK by Galen Research, Manchester, after interviews with a large number of lay people about the effects of illness on behaviour. It reflects lay rather than professional perceptions of health status. In the UK, the Nottingham Health Profile has been used to evaluate the outcomes of many therapies from the patients perspective, and to assess the perceived health status of patients before and after undergoing specific surgery (e.g. coronary bypass, varicose veins, haemorrhoids, heart transplantation and various orthopaedic conditions) (Bowling, 1997). It has also been used to assess the effects of nutritional intervention in a group of outpatients receiving nutritional support (Jamieson *et al.* 1997).

Patients were monitored for post-operative complications throughout the study period. Monitoring took place by daily observation of the patient, by checking their medical and nursing notes, and by liaison with the attending surgical team and nursing staff. Details of all post-operative complications observed can be seen in **Table 5.7**. For the purposes of analysis, only those complications previously described by Busby *et al.* (1988) were considered (see **Table 5.8**).

5.5 Statistical analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences for Windows version 6.0.1 (SPSS Inc., Chicago). Chi-squared analysis was used to test for differences between groups and to identify associations between unintentional weight loss before admission and undernutrition on admission. Independent sample *t* tests were used to test for differences in mean weight loss in the six months before admission between those who survived and those who died, for differences in length of stay between patients who developed complications and those who had an uncomplicated recovery and for differences between pre-admission weight loss in those referred or not referred for nutritional intervention. Spearman's correlation was calculated to test the association between arm and calf muscle circumferences and between triceps and sub-scapular skinfold measurements. Stepwise logistic regression analysis was used to estimate the predictive value of anthropometric, functional, disease stage and surgical data on the development of post-operative complications and mortality. P values of less than 0.05 were considered to indicate statistical significance.

Table 5.1. Details of number of patients enrolled and number and timing of assessments (*n* 69)

Type of Cancer	Total number of patients	Total number enrolled into study	No cancer present at surgery	Inoperable	Pre-operative assessments	Post-operative hospital assessments	$^{6}/_{52}$ post-discharge assessments	$^{3}/_{12}$ post-discharge assessments	RIP before discharge
Lung	17	16		1	19	17	8	5	3
Ovarian	4	4			4	5	3	2	1
Bowel	14	12	1	1	14	21	9	4	1
Head & Neck	13	13			15	42	7	4	2
Oesophageal	14	10		1	17	25	7	5	3
Gastric	4	2	1	1	3	3	0	0	0
Pancreatic	3	2		1	7	8	2	2	0

$^{6}/_{52}$, 6 weeks; $^{3}/_{12}$, 3 months; RIP, died before being discharged from hospital

Table 5.2. Age profile of patients who underwent resection for cancer (*n* 59)

Type of Cancer	Number of patients	< 65 years (%) *n* 26	≥ 65 years (%) *n* 33
Lung	16	8 (50)	8 (50)
Ovarian	4	3 (75)	1 (25)
Bowel	12	2 (17)	10 (83)
Head & neck	13	7 (54)	6 (46)
Oesophageal	10	6 (60)	4 (40)
Gastric	2	0	2 (100)
Pancreatic	2	0	2 (100)

Mean age 66 years (31-90 years).

Table 5.3. Sex profile of patients who underwent resection for cancer (*n* 59)

Type of Cancer	Number of patients	Males (%) *n* 36	Females (%) *n* 23
Lung	16	8 (50)	8 (50)
Ovarian	4	0	4 (100)
Bowel	12	8 (67)	4 (33)
Head & neck	13	9 (69)	4 (31)
Oesophageal	10	9 (90)	1 (10)
Gastric	2	0	2 (100)
Pancreatic	2	2 (100)	0

Males, 63 %; females, 37 %

Table 5.4. Patient characteristics on admission to hospital (*n* 59)

	Characteristic	Number of patients
Age	Less than 65 years	26 (44 %)
	65 years or more	33 (56 %)
Sex	Male	37 (63 %)
	Female	22 (37 %)
Type of admission	Accident and emergency	3 (5 %)
	Booked	43 (73 %)
	OPD	9 (15 %)
	Transfer from other hospital	4 (7 %)
Source	Home	52 (88 %)
	Other hospital	7 (12 %)
Socio-economic group	Higher	22 (37 %)
	Lower	37 (63 %)
Patient type	Private	25 (42 %)
	Public	34 (58 %)
Number of health problems	Three or less	47 (80 %)
	More than three	12 (20 %)
Number of medications	Three or less	39 (66 %)
	More than three	20 (34 %)
Medical card	Yes	27 (46 %)
	No	32 (54 %)
Unemployed	Yes	1 (2 %)
	No	58 (98 %)
Retired	Yes	37 (63 %)
	No	22 (37 %)
Education	Primary	59 (100 %)
	Secondary	26 (44 %)
	Third level	6 (10 %)
Home circumstances	Living alone	12 (20 %)
	Living with spouse	20 (34 %)
	Living in own home with family	22 (37 %)
	Living in home of relatives	5 (9 %)
Mental status	Oriented in time, person and place	59 (100 %)
Alcohol		35 (59 %)
Number of units/week in consumers (*n* 35)		21.2 (SD 25.3)
Cigarettes		24 (41 %)
Number of cigarettes/day in consumers (*n* 24)		22 (SD 11.7)
Dentures	Yes	46 (78 %)
	No	13 (22 %)
Dentures removed to eat	Yes	4 (7 %)
	No	55 (93 %)
Help with feeding in patients who could eat		None
Pain or discomfort while eating		19 (32 %)
Ability to eat	Full lunch	32 (54 %)
	Less than half lunch	13 (22 %)
	Half - three quarters lunch	3 (5 %)
	Soup and/or dessert	8 (14 %)
	Nothing	3 (5 %)
Perception of hunger on admission	More	5 (8 %)
	Less	24 (41 %)
	Normal	30 (51 %)
Perception of need to eat	More important	31 (53 %)
	Less important	2 (3 %)
	No change	26 (44 %)

Table 5.5. Diagnoses of patients undergoing resection for cancer (*n* 59)

Patient study number.	Type of cancer	Cancer staging (TNM)	Diagnosis
1	Lung	I	Adenocarcinoma left upper lobe of lung, no spread to lymph nodes
2	Ovarian	III	Bilateral ovarian carcinoma stage III, metastases involving large bowel, poorly differentiated malignant tumour, tightly pleomorphic cells with abundant tumour giant cells and strap-like cells, solid sheet and extends to resection surface extensively
3	Lung	III	Moderately well differentiated squamous cell carcinoma left lower lobe, invading pulmonary artery, 1/6 N1 positive, 1/4 upper lymph nodes (N2) positive
4	Bowel	III	Moderately differentiated Duke's C villous adenocarcinoma with moderate dysplasia, 2/4 lymph nodes have metastases
5	Head & neck	III	Fungating, supra-glottic tumour, recurrence, laryngeal surface of epiglottis extending to the epiglottic fold
6	Oesophageal	III	Squamous oesophageal mucosa with fragments of moderately differentiated adenocarcinoma, evidence of ulceration and invasion, no metastases
7	Head & neck	III	Parotid squamous cell carcinoma, metastases to larynx, thyroid and internal jugular vein

8	Lung	III	Poorly differentiated non-small cell carcinoma, lymph nodes enlarged but free of tumour, bronchial mucosa adjacent to tumour shows squamous metaplasia
9	Head & neck	III	Oesophageal adenocarcinoma, laryngeal metastases
10	Head & neck	III	Left piriform fossa squamous cell tumour, laryngeal-oesophageal metastases
11	Oesophageal	I	Adenocarcinoma lower oesophagus
12	Pancreatic	I	Periampullary neoplasm
13	Head & neck	I	Fungating squamous cell carcinoma of tongue, resection margins free of tumour
14	Bowel	III	Duke's C adenocarcinoma of rectum
15	Bowel	II	Squamous, circumferential non-polypoid tumour at 5-15 cm, polypoid tumour with malignant polypoid appearance at 25 cm
16	Oesophageal	III	Thirty-two cm invasive adenocarcinoma situated underneath intact squamous epithelium
17	Head & neck	II	Squamous cell carcinoma left ear, 3/29 intraparotid nodes contain metastases, one shows extra capsular spread
18	Lung	II	Poorly differentiated squamous cell carcinoma of left lower lung, hilar lymphadenopathy
19	Lung	I	Moderately differentiated 3cm adenocarcinoma right lower lung, extending to within 1cm of pleural surface, hilar and sub-carinal nodes benign
20	Head & neck	IV	Widely infiltrating poorly differentiated squamous cell carcinoma, extends to the subcutaneous adipose tissue, excision margin is complete, metastatic neck disease from advanced lip tumour previously resected
21	Head & neck	II	Well differentiated infiltrating squamous cell carcinoma floor of mouth with lymphadenopathy submental

			area
22	Bowel	II	Infiltrating moderately differentiated Duke's B adenocarcinoma full thickness rectosigmoid junction, extends into serosa with perforation-negative margins
23	Bowel	I	Familial adenomatous polyposis, rectal & caecal cancer, no metastases
24	Bowel	I	Tubulovillous adenoma with moderate dysplasia which was completely excised at operation
25	Bowel	II	Duke's B adenocarcinoma of colon, ileal carcinoid tumour, 1.5 cm with 1/16 lymph nodes involved
26	Oesophageal	II	Oesophageal adenocarcinoma involving mediastinal lymph nodes, no evidence of distant metastases, chemo-radiotherapy prior to surgery
27	Oesophageal	III	Adenocarcinoma proximal stomach extending into oesophagus, no metastases, no nodes, liver or lung metastases
28	Bowel	II	Duke's B moderately differentiated adenocarcinoma of colon, T4 N0 M0
29	Lung	I	Moderately differentiated squamous cell carcinoma of left middle zone of lung
30	Lung	IV	Adenocarcinoma right lower lobe, documented bony metastases, numerous skeletal deposits
31	Lung	III	Invasive poorly differentiated squamous cell carcinoma apex left lower lobe with invasion into pleura
32	Head & neck	IV	Squamous cell carcinoma on right side of floor of mouth extending into mandible with involvement of cervical lymph nodes, extensive basal cell carcinoma of nasal tip and columella
33	Bowel	III	Moderately differentiated Duke's C stage T3 NI M0 adenocarcinoma rectum, tumour maximum dimension of 6 cm, invades through muscle wall to perirectal tissue
34	Bowel	I	Adenocarcinoma rectum
35	Head & neck	III	Metastatic papillary thyroid cancer

36	Head & neck	III	Squamous cell carcinoma buccal mucosa
37	Oesophageal	II	Poorly differentiated squamous cell carcinoma, malignant stricture at 28cm, cancer present in nodes from 23-50cm
38	Lung	IV	High grade leiomyosarcoma with vascular invasion and right upper lobe lesion, mass in inferior angle of blade of right scapula
39	Lung	I	Adenocarcinoma left lower lobe of lung
40	Head & neck	III	Right piriform fossa tumour, invasive well differentiated squamous cell carcinoma upper oesophagus, 4cm in length, circumference invading deeply into the muscle coat but not invading the perioesophageal tissue, all margins free of tumour, mild dysplasia at left upper pharyngeal margin, all paratracheal nodes free, both neck dissections free of tumour
41	Ovarian	II	Stage 2B poorly differentiated adenocarcinoma of cervix
43	Lung	I	Moderately differentiated adenocarcinoma in right upper lobe of lung, bronchial resection margins free of tumour
44	Gastric	I	Gastric adenocarcinoma involving body of stomach, no nodal involvement
45	Oesophagus	III	Moderately differentiated invasive squamous cell carcinoma of oesophagus
46	Bowel	I	Adenocarcinoma of lower rectum
48	Oesophagus	IV	Adenocarcinoma oesophagus extending into left part of stomach, nodal involvement, left lung metastases
49	Gastric	I	Well differentiated adenocarcinoma of body of stomach
50	Bowel	IV	Caecal mass with liver metastases and peritoneal nodules
51	Pancreatic	I	Pancreatic cancer, no metastases

52	Lung	I	Poorly differentiated non small cell cancer
53	Lung	I	Moderately differentiated squamous cell carcinoma right lower bronchus
54	Oesophagus	I	Early oesophageal cancer in extensive Barrett's oesophagus, neck end to side oesophageal-colon, colo-rectal and colo-colo anastomoses
56	Lung	I	Adenocarcinoma right upper lobe of lung
57	Head & neck	III	Invasive, moderately differentiated squamous cell carcinoma of post cricoid region (4 cm circumference) invading through the full thickness of the wall to the level of the cricoid cartilage, all margins free of tumour, 2/5 paratracheal nodes contain metastatic tumour, all other nodes negative for tumour, thyroid unremarkable
58	Ovarian	IV	Bilateral serous papillary adenocarcinoma of the ovary, spread to uterus and omentum, stage IV ovarian cancer, tumour 20-30 cm
59	Lung	II	Moderately differentiated squamous cell carcinoma right upper lobe, total adhesion, nodes positive
60	Ovarian	IV	Primary ovarian malignancy with omental-peritoneal metastases
61	Oesophagus	II	Invasive poorly differentiated squamous cell carcinoma
62	Lung	I	Adenocarcinoma right upper lobe of lung

TNM, tumour, node, metastasis.

Table 5.6. Operative procedures carried out on patients admitted for resection of cancer (*n* 59)

Patient study number	Blood loss (l)	Operative procedure
1	0	Left upper lobectomy
2	3	Pelvic clearance, removal of large mesenteric tumour, resection of transverse colon
3	0	Left lower lobectomy, left retro-lateral thoracotomy through 5th intercostal space
4	3	Abdominoperineal resection, sigmoid colostomy formation
5	0	Bilateral selective neck dissection, sub-total thyroidectomy, total laryngectomy
6	1	1 stage palliative oesophago-gastrectomy,splenectomy, lung stuck to diaghragm & chest wall, division of adhesions
7	2	Right radical neck dissection, total laryngectomy, partial thyroidectomy, excision of right internal jugular vein and one nerve
8	0	Right middle and lower lobectomy
9	unknown	Pharyngectomy, laryngectomy, oesophagestomy, bilateral selective neck dissection, stomach pull up, total thyroidectomy, partial parathyroidectomy, feeding jejunostomy insertion
10	0	Bilateral neck dissection, laryngectomy, left partial thyroidectomy, pharyngectomy, tracheostomy, tracheo-oesophageal fistula, insertion of feeding tube

11	1	Oesophagectomy and splenectomy
12	3.25	Radical pancreaticoduodectomy
13	0	Left partial glossectomy and left neck dissection
14	0	Low anterior resection and total mesorectal excision
15	0	Abdominoperineal resection and total mesorectal excision
16	3	2 stage oesophagectomy and splenectomy
17	1	Excision of left ear tumour, left superficial parotidectomy, posteriolateral modified radical neck dissection
18	unknown	Left lower lobectomy with extra pleural dissection due to fibrinous adhesions
19	0	Right lower lobectomy
20	5.5	Bilateral radical neck dissection and flap, tracheostomy formation
21	2.2	Left radical neck dissection, marginal mandiblectomy, partial glossectomy and excision of floor of mouth tumour, pectoralis major flap reconstruction
22	1.5	Anterior resection
23	0	Total proctocolectomy and mesorectal excision, end ileostomy formation in right iliac fossa
24	0	Colectomy and polypectomy
25	0	Left hemicolectomy
26	unknown	3 stage oesophagectomy
27	4	Radical total gastrectomy and oesophagectomy, feeding jejunostomy insertion
28	0	Anterior resection and subtotal hysterectomy
29	0	Left lower lobectomy

30	3	Right lower lobectomy and resection of diaphragm
31	2.5	Left lower lobectomy
32	2.5	Tracheostomy, right modified radical neck dissection, excision of right floor of mouth tumour, right extended hemimandiblectomy, left submental/submandibular neck dissection, reconstruction post right mandibilectomy, left fibular osteo-cut flap
33	0	Anterior resection of rectum, left hemicolectomy
34	1.5	Anterior resection of rectum, coloanal anastomosis, formation of defunctioning loop ileostomy
35	0	Total thyroidectomy, bilateral neck dissection
36	0	Laser excision of buccal cavity tumour, neck dissection and flap
37	0	Oesophagectomy
38	0	Right upper lobectomy
39	0	Left lower lobectomy
40	0.9	Total laryngectomy, pharyngectomy, thyroidectomy, partial oesophagectomy, bilateral neck dissections, jejunal free flap
41	7.4	Total pelvic exenteration, radical cystectomy, rectal resection, reconstruction of vagina, ileal conduit with sigmoid colostomy formation
43	0	Right upper and middle lobectomy
44	0	Subtotal gastrectomy, no nodal dissection, gastrojejunal anastomosis, intercostal nerve block
45	1+1.8	3 stage oesophagectomy with thoracotomy

within 24 hours

47	0	Abdominoperineal excision of rectum with end colostomy formation
48	2.6	2 stage oesophagectomy, splenectomy
49	0	Distal subtotal gastrectomy ($^3/_4$)
50	0	Right hemicolectomy
51	4.8	Whipple's Procedure, regional pancreatectomy, total pancreas, spleen, distal stomach, CBD, duodenum and proximal jejunum
52	0	Left lower lobectomy
53	1.4	Right lower and middle lobectomy
54	2.625	3 stage oesophagectomy and left colon pull-up, insertion of feeding jejunostomy
56	0.8	Right thoracotomy and upper lobectomy
57	2.375	Bilateral selective neck dissection, total laryngectomy, total pharyngectomy, upper oesophagectomy, total thyroidectomy, interposition of jejunal free flap, small bowel rotated on second jejunal mesenteric break; five days post-operatively, division of externalised portion of jejunal flap left neck
58	0	Bilateral salpingo-oophorectomy, omentectomy, total hysterectomy, 2 litres ascites removed
59	3	Right pneumonectomy
60	unknown	Cystectomy
61	1.5	2 stage oesophagectomy
62	unknown	Right upper lobe lobectomy

Table 5.7. Post-operative complications (*n* 59)

Patient study number	Complications
1	Nausea in hospital; constipation +++ after discharge from hospital, investigative colonoscopy resulted in perforated colon
2	Pyrexia, cellulitis at site of intraveneous cannula; nausea, vomiting, weakness, constipation and weight loss after discharge
3	Low grade pyrexia for 24 hours post-operatively, coarse crepitus right base of lung
4	Nausea & vomiting in hospital
5	Wound infection at wound/stoma site, feeds passing through wound, pyrexia, aspiration of feed, respiratory distress, respiratory arrest, death
6	Intrathoracic sepsis with ultimately fatal haemorrhage secondary to erosion into the aorta
7	Nasal regurgitation of food, poor oesophageal motility, low haemoglobin, at 5 weeks post-operatively developed tightening pain at base of neck & head, pain +++, wound breakdown, including shadowing left lower chest X-ray, pyrexia, dysphagia, and nausea
8	Nausea, vomiting and depression
9	Chylothorax, including neck swelling, leakage from tracheostomy, necrotic trachea, bilateral chest infiltates, death
10	Right- sided perioperative cerebro-vascular accident, persistent lower respiratory tract infection, Methicillin-resistant Staphlococcus aureus septicaemia from day 18 post-operatively
11	None

12	Small pancreatic fistula, two weeks post-operatively developed pancreatic necrosis, sepsis, right basal collapse, atrial fibrillation, right bronchopneumonia, polyuric renal failure (CVVHD not required), hyperglycaemia, respiratory failure; re-operation two weeks after 1st operation, pancreatectomy and splenectomy carried out, abdominal distention ++ after 2nd operation, 3rd operation 3 days later, laparotomy, hepatic-jejunostomy, anastomosis of jejunum to common bile duct; 6 weeks later, infection at site of T tube, vomiting due to infection
13	Cerebral irritability, hypochromic, borderline macrocytic anaemia
14	None in hospital; developed anastomotic stricture requiring dilatation after discharge from hospital
15	None
16	Pleural effusions, respiratory distress, Methicillin-resistant Staphlococcus aureus septicaemia, diarrhoea, herpes simplex, H influenza in sputum, right mid-lobe pneumonia, abdominal pain left iliac fossa, exploratory laparotomy, free pus throughout abdominal cavity, multiple loop abscesses, large walled off mesenteric abscess drained, no gastrointestinal leak; left lower lobe consolidation, hyperthyroidism, constipation +++
17	None
18	Overwhelming sepsis, low blood pressure, high cardiac output, renal shutdown, death
19	None
20	Nausea, supraglottic oedema, oral candida, sinus discharge during radiotherapy
21	Pyrexia, chest crepitus, right lower leg erythematous oedematous rash, wound breakdown
22	Iron deficiency anaemia
23	Vomiting post early removal of nasogastric tube which needed to be re-passed
24	Anaesthetic resulted in atrial fibrillation

25	Cellulitis right arm resulted in pyrexia
26	Respiratory distress, sepsis of unknown origin, acute respiratory distress syndrome, left-sided pleural effusion, acute renal failure, unable to tolerate CVVHD, death
27	Pneumothorax, poor urinary output, pyrexia from unknown source (38-38.5^{0}C), nausea
28	None
29	Breathing difficulties, maculopapular, erythematous believed to be related to Penicillin (Tazocin), sepsis, increased white cell count, pyrexia, mouth ulcers, oral candida, death
30	Constipation due to narcotic analgesia, nausea and vomiting, re-admitted with spinal cord compression and flaccid paralysis of legs due to metastases, death
31	Atrial fibrillation
32	Pyrexia, scleroma on neck requiring drainage
33	Pyrexia, septicaemia, Staphlococcus aureus positive, oedema, increased white cell count, decreased platelet count in hospital; developed mild angular stomatitis and narrowing of anastomosis after discharge from hospital
34	Decreased urinary output, right-sided coarse basal crepitus
35	Slight left upper limb weakness, hypocalcaemia, blurred vision, staggering, abnormal sinus rhythm, old infarct, left ventricular thrombus in hospital; chest pain on exertion after discharge from hospital
36	Mouth stiff and dry
37	Chylothoracic leak requiring surgical repair; admitted to Ballinasloe Hospital 10 days post-discharge with deep vein thrombosis
38	None
39	Air leak, shortness of breath, Herpes zoster at thoracotomy site

40 None

41 Nausea, abnormal liver function tests secondary to Fentanyl patches (Durogesic)

43 None

44 Bibasal crepitus but relatively good air entry; after discharge from hospital lost 3.5 kg in the month after discharge together with poor appetite, and a fear of eating certain foods

45 Persistent hypertension, post-operative haemorrhage, complete white-out right lung field, re-exploration for bleeding, right thoracotomy, atrial fibrillation, right pneumothorax, small pleural effusion left lung, re-ventilated, sepsis, left lower lobe pneumonia, diffuse rash thought to be drug-related, Clostridium difficile, multiple abscesses left lower lobe of lung, myocardial infarction due to hypokalaemia, difficulty swallowing own secretions, gross aspiration on oral intake; leaking of feed at drain site, displacement of jejunostomy; after discharge from hospital developed dysphagia requiring dilatation and headaches

47 Bilateral bibasal crepitus, right basal pneumonia, pyrexia, shortness of breath, cough, increased pulse, increased blood pressure, left ventricular failure, acute fluid overload with poor ventricular reserve, cardiac arrest, death

48 Respiratory distress, poor cough, coarse crepitus both bases, inflammation of central line site; central line removed, Clostridium difficile

49 Nausea and vomiting

50 Nausea and low haemoglobin in hospital, wound infection necessitating 2 day delay in post-operative discharge; after discharge from hospital developed decreased appetite, malaise, intermittent right upper quadrant pain

51 Left lower lobe collapse

52 Hyperglycaemia, right middle lobe collapse, small residual pneumothorax at apex of left lung

53 Vasovagal attack secondary to epidural, surgical emphysema, low blood pressure, residual pain, dyspnoea at rest, productive

	cough, consolidation right lower lobe of lung, pneumothorax right upper lung, increased bilateral lung infiltrates
54	Left basal crepitus, persistent bilateral pulmonary infiltrates with ++sputum, persistent chest wall and abdominal pain, gastrointestinal distension, pyrexia; on post-operative day 14, developed lower respiratory tract infection, left basal effusion; left pleural effusion, pitting oedema to knees, bilateral pulmonary infiltrates, pneumonia, small pericardial effusion, depression, collection at left lateral aspect of intrathoracic stomach, regurgitation of fluids and solids; after discharge from hospital was re-admitted with difficulty swallowing
56	Fast atrial fibrillation, low haemoglobin, severe pain, pneumothorax, pyrexia and nausea
57	Hypoalbuminaemia, hypocalcaemia, bilateral pleural effusions, dyspnoea on exertion, peripheral oedema.
58	Pyrexia, respiratory tract infection, muscle strain due to coughing
59	Intra-operative haemorrhage, required 5 unit transfusion, shortness of breath; after discharge from hospital developed depression, poor appetite, bad taste in mouth and constipation
60	Shortness of breath, cardiac arrest, death
61	None in hospital; after discharge was admitted to Naas Hospital with wound infection
62	Unstable blood pressure, respiratory distress, respiratory and cardiac failure, sepsis, pyrexia, death

CVVHD, continuous veno-venous haemodialysis.

Table 5.8. Classification of complications as described by Busby *et al.* (1988)

Major infectious complications	**Major non-infectious complications**
Pneumonia or empyema	Anastomotic leak
Abdominal abscess	Bronchopleurocutaneous fistula
Extra-abdominal abscess	Wound dehiscence
Fasciitis	Decubitus ulcer
Bacteraemia or fungaemia	Chronic respiratory failure ($\geq$ 4 days)
Other septic complications	Gastrointestinal complications (*includes bleeding, obstruction, perforation and ischaemia*)
	Cardiovascular complications (*includes myocardial infarction, cardiogenic shock, cardiac arrest, and stroke*)
	Pulmonary embolus
	Renal failure
Minor infectious complications	**Minor non-infectious complications**
Wound infection	Uncomplicated arrhythmia
Urinary tract infection	Atelectasis
	Transient respiratory failure (*respiratory failure requiring the use of a ventilator for $\leq$ 3 days post-operatively*)

5.6 Results

5.6.1 Pre-operative status

Nutritional status and nutrient intakes

The mean BMI of the fifty-nine patients who underwent a curative resection was 24.7 (SD 3.9) kg/m^2. Twenty-eight patients (47 %) were normally nourished (BMI 20 - 24.9 kg/m^2), mean 22.6 (SD 1.4) kg/m^2, five patients (8 %) were undernourished (BMI < 20 kg/m^2), mean 18.3 (SD 1.1) kg/m^2 and twenty-six patients (44 %) were overweight or obese (BMI $\geq$ 25 kg/m^2), mean 28.3 (SD 2.7) kg/m^2.

Percentage body fat on admission was calculated in forty-seven (80 %) patients on admission to hospital. Mean percentage body fat on admission was lower than the standard reference mean (Durnin & Womersley, 1974) in males in the age categories of 40-49 (21 % versus 25 %) and 50-72 years (21 % versus 28 %) and in females in the category 50-72 years (34 % versus 39 %) (see **Table 5.9**). Mean percentage body fat on admission was above the standard reference mean (Durnin & Womersley, 1974) in eight (13 %) of the total group (4 males, 4 females). Mid-arm muscle circumference below the 5th percentile (Bishop *et al.* 1981 for those aged below sixty-five years; Burr & Phillips, 1984 for those aged sixty-five years or more) was observed in seven (12 %) patients while a calf circumference below the threshold of 31 cm recommended to define undernutrition (Guigoz *et al.* 1994) was recorded in 12 (20 %).

Pre-operative serum albumin was available for fifty-four (92 %) patients. The mean serum albumin was 37.5 (SD 3.9) g/l. Only ten (18 %) patients had a pre-operative serum albumin below 35 g/l (mean 30.7 g/l), the lower end of the normal reference range for St. James's Hospital. There was no difference in serum albumin on admission to hospital between those patients who received adequate nutritional intervention in hospital (serum albumin 37.5 (SD 4.3) g/l), those who received inadequate nutritional intervention (serum albumin 37.3 (SD 3.4) g/l) and those who received no nutritional intervention (serum albumin 37.6 (SD 4.3) g/l).

In fifty-two patients the risk of developing nutrition-related problems in hospital, as measured by nutrition risk index (NRI; Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991), could be calculated. The mean NRI on admission was 95.2 (SD 8.4). Nineteen patients (36 %) were classified by NRI as at no nutritional risk, mean NRI 102.6 (SD 2.4). Thirty-three (63 %) patients were at nutritional risk, nine (17 %) at borderline risk, mean NRI 98.4 (SD 0.6), sixteen (31 %) at mild risk, mean NRI 92.3 (SD 3.2) and seven (13 %) at severe risk, mean NRI 79.5 (SD 2.4). The mean NRI in those referred for nutritional intervention was 94.5 (SD 8.4) versus a mean NRI of 97 (SD 8.1) in those not referred. In those who received inadequate nutritional intervention, the mean NRI on admission was 95.4 (SD 7.1) versus a mean of 94.1 (SD 9.0) in those who received adequate nutritional intervention throughout their hospital stay. These small differences were not significant.

Involuntary weight loss in the six months before admission to hospital occurred in forty-three (75 %) of the fifty-seven patients for whom pre-admission weight was known, with twenty-one (37 %) losing more than 10 % body weight. The mean weight on admission was 68 (SD 14.4) kg. This represented a mean of 91.8 (SD 7.9) % of usual body weight or 8.2 % weight loss from normal weight. In those patients who lost weight, the mean weight loss was 11 % of their usual weight. Patients who had a BMI below 20 kg/m^2 had a mean weight loss of 13 % in the six months before admission. Weight loss in the six months before admission to hospital positively correlated with an increase in all post-operative infectious complications (r 0.32, $P < 0.05$) and mortality (r 0.3, $P < 0.05$). Weight loss of more than 10 % in the six months before admission significantly decreased post-operative survival ($P < 0.05$). A history of weight loss greater than 10 % resulted in referral for nutritional support and / or advice on admission in 76 % of patients. However, the percentage weight loss before admission to hospital was greater ($P < 0.05$) in those referred for nutritional intervention than in those not referred (90.5 (SD 7.5) % versus 95.6 (SD 7.5) % usual body weight) although mean weight (68 (SD 16) kg versus 68.1 (SD 8.1) kg) and BMI (24.6 (SD 4.3) kg/m^2 versus 25.0 (SD 2.5) kg/m^2) were similar.

Involuntary weight loss in the month before admission to hospital occurred in thirty-two (56 %) of the fifty-seven patients for whom weight was known one month

prior to admission, with sixteen (28 %) losing more than 5 % body weight. In those patients who lost weight, the mean weight loss was 6 % of their usual weight. Patients who had a BMI below 20 kg/m^2 had a mean weight loss of 7 % in the month before admission.

Reduced appetite on admission to hospital was reported by twenty-one (36 %) patients, with eleven (19 %) reporting that their appetite was virtually non-existent. Vomiting and / or diarrhoea was reported by fifteen (25 %) patients, difficulties in swallowing requiring food consistency modification by eleven (19 %) while three (5 %) were unable to take food orally. Pain or discomfort on eating was reported by nineteen (32 %) patients. A summary of the diet-related symptoms experienced by patients with different types of cancers and the mean BMI in each cancer type can be seen in **Table 5.10**.

Thirty-two patients (54 %) were able to eat full meals on admission, sixteen (27 %) could only eat a small amount of the main meal, eight (14 %) could only take soup and / or dessert while three (5 %) were unable to take anything orally. Thirty-one (52 %) patients felt that their illness made it more important to eat in hospital, twenty-six (44 %) felt that no change in their eating pattern was required while two (3 %) felt it less important to eat now that they were ill in hospital.

Of the six patients who were in hospital for more than one week before surgery and who had two pre-operative assessments, four lost weight (mean 1.9 (SD 2.0) kg, mean 2.2 % body weight) in the week between admission to hospital and the second pre-operative assessment. **Table 5.11** shows details of the changes in the nutritional variables which occurred in this group in the pre-operative period.

Functional status and fatigue levels

Hand-grip dynamometry below 85 % of standard (Webb *et al.* 1989) was recorded for forty-four (75 %) patients on admission to hospital, mean 73 % standard. Twenty-eight (47 %) patients were fully functional as measured by the Norton Scale (Ek & Bjurulf, 1987). Of a possible score of twenty-eight, thirty-one (53 %) patients had a score between twenty-one and twenty-seven. The mean fatigue score (Christensen *et al.* 1982) on admission was 4.0 (SD 2.8). Sixteen patients (27 %) considered themselves to be totally fit on admission, five (8 %) totally fatigued. Of the remaining patients, just under two-thirds were at the fitter end of the scale while one-third approached the fatigued end. In patients who had two pre-operative assessments, fatigue scores, and Norton scores remained stable regardless of whether the full group (*n* 6) or the sub-group (*n* 4) of patients who lost weight pre-operatively in hospital were considered (see **Table 5.12**). Although hand-grip strength appeared to deteriorate in the group who lost weight, this deterioration was not significant.

Quality of Life Profile

Of a possible range from zero to twenty-seven, quality of life scores ranged from one to eighteen on admission to hospital, with a mean score of six. In patients who had two pre-operative assessments, quality of life scores remained stable (see **Table 5.12**).

Table 5.9. Percentage body fat on admission compared to reference data* (*n* 47)

Sex	Age range (years)	*n*	Mean % body fat	Range	Reference mean*
Males	50 - 72	28	21	8.5 - 33	28
	40 - 49	2	21	20 - 22	25
	30 - 39	1	23		23
Females	50 - 72	13	34	26 - 43	39
	40 - 49	3	35	29 - 42	35

*Durnin & Womersley (1974).

Table 5.10. Diet-related symptoms experienced by patients with different cancers (*n* 59)

Type of cancer	Lung	Head & neck	Bowel	Oeso-phageal	Ovarian	Gastric	Pancreatic
	n 16	*n* 13	*n* 12	*n* 10	*n* 4	*n* 2	*n* 2
Poor appetite	9	6	5	7	2	2	1
Swallowing problems	0	6	0	8	0	0	0
Vomiting / diarrhoea	1	1	10	0	2	0	1
Mean BMI (kg / m^2)	25.2	24.9	25.3	21.6	24.8	27.6	28.4

Table 5.11. Changes in pre-operative nutritional variables in patients who had two pre-operative assessments

Variable	Admission assessment of full group who had two pre-operative assessments *n* 6	Second pre-operative assessment of full group *n* 6	Admission assessment of patients who lost weight pre-operatively *n* 4	Second pre-operative assessment in weight losing patients *n* 4
Weight (kg)	68.7 (20)	67.8 (18)	74 (22)	72.2 (20.4)
Body mass index (kg/m^2)	24.7 (5.3)	24.2 (4.4)	26.1 (4.8)	25.2 (3.6)
% usual body weight	88.9 (7.9)		88.9 (8.8)	
Weight change (kg)	8.3 (5.5)		8.9 (6.4)	1.9 (2.0)
Weight change (%)	11.5 (8.6)	-0.9 (2.5)	12. 4 (8.5)	2.2 (1.8)
Nutrition Risk Index	87.4 (9.1)	87.1 (9.0)	87 (10.7)	86 (10.5)
Mid-arm circumference (mm)	281 (38)	279 (34)	291 (40)	289 (37)
Triceps skinfold (mm)	121 (75)	113 (62)	144 (83)	131 (69)
Mid-arm muscle circumference (mm)	243 (17)	244 (17)	246 (17)	248 (18)
Calf (mm)	357 (42)	359 (41)	367 (41)	368 (38)
Percentage body fat	23.2 (8.3)	22.4 (8.3)	26.1 (8)	25 (8.4)

Values are mean (SD).

Table 5.12. Changes in pre-operative function, fatigue and quality of life in patients who had two pre-operative assessments

Variable	Admission assessment of full group who had two pre-operative assessments *n* 6	Second pre-operative assessment of full group *n* 6	Admission assessment of patients who lost weight pre-operatively *n* 4	Second pre-operative assessment in weight losing patients *n* 4
Male/female	5 : 1	5 : 1	3:1	3:1
Age	62 (13)	62 (13)	62 (16)	62 (16)
Hand-grip (% normal)	74 (12.3)	72.5 (13.4)	72 (15)	67.5 (13.6)
Norton score	26 (1.8)	26.8 (1.6)	25.7 (2.2)	26.5 (1.9)
Fatigue score	5.0 (3.4)	5.2 (3.6)	5.5 (3.9)	5.8 (3.8)
QOL score	4.8 (3.4)	4.8 (2.8)	4.5 (2.4)	5.0 (2.2)

Values are mean (SD).

QOL, quality of life.

5.6.2 Post-operative course in hospital

Nutritional status and nutrient intakes

Of the fifty-nine patients, fifty-two had at least one reassessment before discharge from hospital. Five patients died, and two were discharged, before a second reassessment could be carried out. Of these fifty-two, 76 % lost weight in hospital, mean 4.4 (SD 3.3) kg, representing a mean 5.6 % loss of their weight on admission. Two patients with a normal BMI on admission lost sufficient weight in hospital to reach a BMI below 20 kg/m^2 in hospital. Details of the number of patients losing weight in hospital and the percentage of admission weight lost for each type of cancer can be seen in **Table 5.13**. The small amount of weight lost pre-operatively in hospital did not affect post-operative outcome in terms of mortality, the development of complications or length of stay (see **Table 5.14**).

Initially patients were classified as receiving or not receiving nutritional intervention. Details of the post-operative pattern of nutritional, functional and quality of life variables for the full group (**Tables 5.15a** and **5.15b**) and the two sub-groups can be seen in **Tables 5.16a**, **5.16b**, **5.17a** and **5.17b**. However, when the adequacy of dietary intake in hospital was assessed, patients could be sub-divided into three groups; those in whom dietary intake to meet nutritional requirements was inadequate for less than seven days (*n* 15); those who were fasting or on minimal oral fluids only for at least seven days (*n* 13) and those who received full nutritional intervention during their hospital stay (*n* 31). In the former group, no patient received nutritional intervention and in the latter two groups nutritional intervention or advice was instigated at some point during the hospital stay. Details of the post-operative pattern of anthropometric, and non-anthropometric (age, gender, biochemical, functional and quality of life) variables for these three sub-groups can be seen in **Tables 5.17a, 5.17b, 5.18a, 5.18b, 5.19a** and **5.19b**. The five patients who died before a post-operative assessment was completed received full nutritional intervention. Omitting their admission data did not alter the admission characteristics of the group (*n* 26) who received adequate nutritional intervention (see **Table 5.20**).

The hospital course of the sub-groups at admission, on post-operative day seven and at discharge or death can be seen in **Tables 5.21a, 5.21b, 5.22, 5.23, 5.24, 5.25** and **5.26**. Of the patients receiving adequate nutritional support, nine (26 %) died, of those on inadequate nutritional support two (15 %) died. No patient died in the group which was given no nutritional intervention. Major complications occurred post-operatively in fourteen (45 %), six (46 %) and four (27 %) respectively in the adequately nourished, inadequately nourished and the group not receiving nutritional intervention. If those patients who died from the development of immediate post-operative complications are omitted from the analysis, only nine (35 %) of the adequately nourished group developed major complications and four (15 %) died. **Tables 5.27a, 5.27b** and **5.27c** show that for those patients who had adequate nutritional intervention and who were followed up until three months post-discharge, nutritional status was maintained in contrast to those who had inadequate nutritional intervention. These were probably the sickest sub-groups of patients with a mean length of stay of forty-three and forty-four days respectively in hospital, and of 5.6 and 5 days respectively in the intensive care unit. However, the number of major complications occurring in each group was similar (adequately nourished, four (44 %); inadequately nourished, three (50 %). Furthermore, the maintenance of nutritional status did not result in the maintenance of functional status as measured by hand-grip strength, Norton score, fatigue score or quality of life score although these were maintained in those receiving inadequate nutritional intervention. This is likely to reflect the fact that those patients who are at high risk for the development of early post-operative complications receive the most intensive nutritional intervention early in their hospital stay.

Table 5.13. Nutritional variables in different cancer types (*n* 59)

Type of cancer	Body Mass Index (kg/m^2)	Nutrition Risk Index	Proportion losing weight*	Percentage weight loss in hospital	Post-operative reduction in albumin (g/l)	Intra-operative blood loss (l)
Lung (*n* 16)	25.2 (3.4)	93.3 (9.0)	8 of 11 (73 %)	4.5 (4.7)	9.1 (4.9)	0.8 (1.2)
Ovarian (*n* 4)	24.8 (6.7)	93.4 (10.0)	2 of 3 (67 %)	5.9 (1.9)	13.7 (6.4)	3.5 (3.7)
Bowel (*n* 12)	25.3 (3.5)	96.8 (7.5)	8 of 12 (67 %)	6.8 (1.1)	11.7 (4.1)	0.4 (0.9)
Head & Neck (*n* 13)	24.9 (4.3)	97.2 (9.5)	11 of 12 (92 %)	4.0 (2.1)	13.7 (5.5)	1.2 (1.7)
Oesophageal (*n* 10)	21.6 (2.7)	95.8 (7.7)	6 of 9 (67 %)	7.2 (4.2)	15.5 (5.4)	1.9 (1.3)
Gastric (*n* 2)	27.6 (3.1)	89.3 (*n* 1)	2 of 2 (100 %)	4.9 (1.8)	8.0 (2.8)	0
Pancreatic (*n* 2)	28.4 (2.8)	90.3 (*n* 1)	2 of 2 (100 %)	9.8 (6.4)	18 (*n* 1)	4.0 (1.1)

Values are mean (SD).

*patients who had at least one post-operative assessment.

Table 5.14. Post-operative outcome in patients with two pre-operative assessments

Variable	Full group *n* 6	Weight losers *n* 4
Post-operative LOS (days)	18.2 (8.6)	16 (6.5)
ICU stay (days)	1.4 (1.6)	1.5 (1.9)
HDU stay (days)	1.2 (1.0)	0.7 (1.0)
Major complications (*n*)	0	0
Major infectious complications (*n*)	0	0
Major non-infectious complications (*n*)	0	0
Total infectious complications (*n*)	3	1
Mortality (*n*)	1	1

Values are mean (SD).

LOS, length of stay; ICU, intensive care unit, HDU, high dependency unit.

Table 5.15a. Anthropometric variables in all patients assessed over the course of the study

	Pre-operative		Post-operative										Post-discharge	
			Day	Day	Day	Day	Day	Day	Day	Day	Day	D/C	6	12
	1	2	7	14	21	28	35	42	49	56	63	70	weeks	weeks
	n 59	*n* 6	*n* 48	*n* 32	*n* 17	*n* 5	*n* 4	*n* 3	*n* 3	*n* 3	*n* 3	*n* 2	*n* 36	*n* 22
Weight (kg)	68	67.8	68.5	66.8	67.7	63.0	57.6	70.4	55.5	63.6	64.1	67.0	65.8	63.4	62.9
	(14.4)	(18)	(14.2)	(14.3)	(12.4)	(11.2)	(6.6)	(10.2)	(5.4)	(12)	(13.6)	(19.2)	(12.4)	(11.3)	(11.3)
			n 41	*n* 29	*n* 15	*n* 4							*n* 51		
BMI	24.7	24.2	25.0	24.2	24.6	22.7	20.7	23.4	20.7	21.1	23.4	21.7	24.0	23.1	22.7
(kg / m^2)	(3.9)	(4.4)	(4.0)	(3.7)	(3.8)	(4.7)	(2.6)	(2.7)	(3.2)	(3.6)	(2.3)	(6.1)	(3.3)	(3.3)	(3.3)
			n 41	*n* 29	*n* 15	*n* 4							*n* 51		
MAC (mm)	280	279	280	276	279	245	245	255	240	243	253	252	271	264	267
	(32)	(34)	(31)	(30)	(30)	(37)	(19)	(19)	(28)	(27)	(30)	(45)	(30)	(30)	(33)
			n 45	*n* 30	*n* 16	*n* 4									
TSF (mm)	133	113	128	130	140	91	93	119	92	78	124	79	126	124	126
	(58)	(62)	(56)	(61)	(68)	(51)	(54)	(20)	(61)	(34)	(45)	(57)	(55)	(51)	(48)
			n 45	*n* 30	*n* 16	*n* 4									
MAMC	238	244	240	235	235	216	216	218	211	219	214	227	231	225	227
(mm)	(28)	(17)	(27)	(27)	(19)	(28)	(34)	(18)	(10)	(19)	(30)	(27)	(27)	(23)	(27)
			n 45	*n* 30	*n* 16	*n* 4									

Calf (mm)	340	359	332	326	323	327	296	313	305	319	315	318	324	327	330
	(34)	(41)	(32.5)	(36)	(34)	(25)	(16)	(4)	(15)	(21)	(24)	(30)	(30)	(34)	(35)
	n 57		*n* 44	*n* 29	*n* 16	*n* 4									
Percentage	26.7	22.4	27.6	25.4	26.9	18.3	19.7	24.7	21.3	17.9	24.1	17.2	26	26.3	26.0
body fat	(8.2)	(8.3)	(8.1)	(8.3)	(8.6)	(7.8)	(10.6)	(4)	(11.9)	(6.4)	(6.3)	(8.7)	(8)	(7.2)	(7.1)
	n 58		*n* 41	*n* 28	*n* 16	*n* 4		*n* 2					*n* 49	*n* 35	

Values are mean (SD).

D/C, discharge assessment.

BMI, body mass index; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSF, triceps skinfold.

Table 5.15b. Functional, fatigue and quality of life variables in all patients assessed over the course of the study

	Pre-operative		Post-operative										Post-discharge	
			Day	Day	Day	Day	Day	Day	Day	Day	Day	D/C	6	12
	1	2	7	14	21	28	35	42	49	56	63	70	weeks	weeks
	n 59	*n* 6	*n* 48	*n* 32	*n* 17	*n* 5	*n* 4	*n* 3	*n* 3	*n* 3	*n* 3	*n* 2	*n* 52	*n* 36	*n* 22
Hand-grip	72.7	72.5	67.2	66.5	72.9	65.5	55.0	53.0	38.0	48.0	27.0	52.5	66.3	68.9	68.5
(% standard)	(4.0)	(13.4)	(20.3)	(19.8)	(21.5)	(23.2)	(22.0)	(35.2)	(15.6)	(11.5)	(25.6)	(9.2)	(21.1)	(18.8)	(19.3)
													n 49		
Norton	26.8	26.8	22.4	23.1	23.6	22.8	19.7	21.0	19.3	23.0	22.0	23.0	24.2	25.7	25.9
score	(1.5)	(1.6)	(3.2)	(3.2)	(3.1)	(2.5)	(3.9)	(2.0)	(2.9)	(2.0)	(3.6)	(1.4)	(2.9)	(2.8)	(2.5)
Fatigue	4.0	5.2	7.5	7.3	6.4	6.9	7.7	8.3	9.2	7.8	7.0	7.5	6.6	5.0	5.0
score	(2.8)	(3.6)	(2.4)	(2.3)	(2.3)	(3.2)	(2.1)	(1.8)	(1.4)	(1.9)	(2.6)	(0.7)	(2.6)	(2.3)	(2.8)
QOL score	5.6	4.8	10.0	8.7	6.7	11.2	9.0	13.3	10.0	12.0	6.7	11.0	7.7	5.6	6.6
	(4.0)	(2.8)	(5.5)	(5.6)	(3.8)	(2.4)	(6.2)	(5.5)	(8.7)	(3.6)	(7.0)	(0)	(4.9)	(3.9)	(5.5)

Values are mean (SD).

D/C, discharge assessment.

QOL, quality of life.

Table 5.16a. Anthropometric variables over the course of the study in patients receiving nutritional intervention (*n* 44)

	Pre-operative		Post-operative									Post-discharge	
	1	2	Day .7	Day 14	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56	Day 63	Day 70	6 weeks	12 weeks
	n 44	*n* 5	n 35	*n* 29	*n* 16	*n* 4	*n* 4	*n* 3	*n* 3	*n* 3	*n* 3	*n* 2	*n* 26	*n* 15
Weight	68		68.5	67.2	67.8	63	57.6	70.4	55.5	63.6	64.1	67	61.7	59.4
(kg)	(16)	68.9	(16.6)	(15)	(13)	(11)	(6.6)	(10)	(5.4)	(12)	(13.6)	(19)	(12.2)	(10.6)
		(20)	*n* 28	*n* 26	*n* 14									
BMI (kg/m^2)	24.6	24.0	25.1	24.4	24.8	22.7	20.7	23.4	20.7	21.1	23.4	21.7	22.5	21.6
	(4.3)	(4.9)	(4.5)	(3.8)	(3.8)	(4.7)	(2.6)	(2.7)	(3.2)	(3.6)	(2.3)	(6.1)	(3.4)	(3.1)
			n 28	*n* 26	*n* 14									
TSF	130	106	131	131	142	91	93	119	92	78	124	79	123	123
(mm)	(57)	(67)	(58)	(64)	(69)	(51)	(54)	(20)	(61)	(34)	(45)	(57)	(49)	(54)
			n 32	*n* 27	*n* 15									
MAMC (mm)	238	246	239	235	234	216	216	218	211	219	214	227	221	219
	(30)	(18)	(30)	(27)	(20)	(28)	(34)	(18)	(10)	(19)	(30)	(27)	(23)	(25)
			n 32	*n* 27	*n* 15									
Percentage	26.3	20.5	28.1	25.4	27.3	18.3	19.7	24.7	21.3	17.9	24.1	17.2	25.8	25.4
body fat	(8.4)	(7.6)	(8.5)	(8.5)	(8.7)	(7.8)	(10.6)	(4.0)	(11.9)	(6.4)	(6.3)	(8.7)	(7.2)	(7.8)
	n 43		*n* 28	*n* 25	*n* 15								*n* 25	

Values are mean (SD).

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

Table 5.16b. Functional, fatigue and quality of life variables over the course of the study in patients receiving nutritional intervention (*n* 44)

	Pre-operative		Post-operative									Post-discharge	
	1	2	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56	Day 63	Day 70	6 weeks	12 weeks
	n 44	*n* 5	n 35	*n* 29	*n* 16	*n* 4	*n* 4	*n* 3	*n* 3	*n* 3	*n* 3	*n* 2	*n* 26	*n* 15
Hand grip (% standard)	73.5 (18.4)	77 (8.5)	67.2 (21.5) *n* 32	65.9 (19.2) *n* 26	74.1 (21.7) *n* 14	65.5 (23.2)	55.0 (22)	53 (35.2)	38 (15.6)	48 (11.5)	27 (25.6)	52.5 (9.2)	68.4 (19.5) *n* 25	64.6 (18.1)
Norton score	26.5 (1.6)	26.6 (1.7)	21.3 (3.0)	22.6 (2.9)	23.4 (3.0)	22.8 (2.5)	19.7 (3.9)	21.0 (2.0)	19.3 (2.9)	23.0 (2.0)	22.0 (3.6)	23.0 (1.4)	25.3 (2.4)	25.4 (2.9)
Fatigue score	4.2 (2.9)	4.2 (3.0)	8.0 (2.1)	7.7 (2.0)	6.7 (2.1)	6.9 (3.2)	7.7 (2.1)	8.3 (1.8)	9.2 (1.4)	7.8 (1.9)	7.0 (2.6)	7.5 (0.7)	5.3 (2.4)	4.9 (2.6)
QOL score	5.8 (4.2)	4.4 (2.9)	10.6 (5.9)	9.3 (5.5)	7.1 (3.7)	11.2 (2.4)	9.0 (6.2)	13.3 (5.5)	10.0 (5.5)	12.0 (3.6)	6.7 (7.0)	11.0 (0)	5.8 (4.3)	6.3 (5.8)

Values are mean (SD).

QOL, quality of life.

Table 5.17a. Anthropometric variables over the course of the study in patients receiving no nutritional intervention (*n* 13)

	Pre-operative		Post-operative				Post-discharge	
	1	2	Day 7	Day 14	Day 21	D/C*	6 weeks	12 weeks
	n 15	*n* 1	*n* 13	*n* 3	*n* 1	*n* 13	*n* 10	*n* 7
Weight (kg)	68.1 (8.1)	62.5	68.5 (7.3)	63.4 (5.9)	67.2	68.2 (7.5)	68 (7.3)	70.5 (9.4)
BMI (kg/m^2)	25.0 (2.5)	25	24.8 (2.5)	23.1 (1.3)	21.8	24.7 (2.6)	24.8 (2.5)	25.2 (2.4)
TSF (mm)	142 (63)	149	120 (50) *n* 13	117 (37)	108	121 (48)	127 (58)	131 (34)
MAMC (mm)	238 (25)	233	242 (18)	231 (28)	242	241 (18)	236 (20)	245 (26)
Percentage body fat	27.9 (7.6)	32.0	26.5 (7.5)	25.2 (7.8)	20.5	26.8 (7.5)	27.4 (7.5)	27.1 (5.6)

Values are mean (SD).

*D/C, discharge assessment.

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

Table 5.17b. Functional, fatigue and quality of life variables over the course of the study in patients receiving no nutritional intervention (*n* 13)

	Pre-operative		Post-operative				Post-discharge	
	1	2	Day 7	Day 14	Day 21	D/C*	6 weeks	12 weeks
	n 15	*n* 1	*n* 13	*n* 3	*n* 1	*n* 13	*n* 10	*n* 7
Hand grip (% standard)	70.5 (16.5)	50	67 (17) *n* 12	71.3 (29.5)	56	67.8 (18)	70 (18)	76.9 (20.4)
Fatigue score	3.3 (2.7)	10.0	6.2 (2.5)	3.3 (1.5)	2	5.0 (2.7)	4.4 (2.1)	5.1 (3.3)
Norton score	27.7 (0.7)	28.0	25.3 (1.6)	28 (0)	28	26.2 (1.4)	26.6 (1.4)	26.9 (1.2)
QOL score	5.0 (3.6)	7.0	3.5 (4.4)	3.7 (3.8)	1	7.2 (4.0)	5.7 (2.8)	7.3 (5.3)

Values are mean (SD).

*D/C, discharge assessment.

QOL, quality of life.

Table 5.18a. Anthropometric variables over the course of the study in patients receiving adequate nutritional intervention (*n* 31)

	Pre-operative	Post-operative				Post-discharge	
		Day 7	Day 14	Day 21	D/C or death*	6 weeks	12 weeks
	n 31	*n* 24	*n* 20	*n* 12	*n* 26	*n* 18	*n* 9
Weight (kg)	67 (17)	69.4 (17.8)	66.9 (15.3)	66.4 (14.3)	64.5 (14.5)	60 (12.6)	54.7 (7)
		n 20	*n* 18	*n* 10			
BMI (kg/m^2)	24.4 (4.5)	25.2 (4.7)	24.3 (3.9)	24.9 (4.3)	23.7 (3.7)	22.4 (3.7)	21 (3.2)
		n 20	*n* 18	*n* 10			
MAC (mm)	274 (36)	278 (35)	276 (34)	279 (35)	266 (36)	257 (35)	250 (34)
		n 22	*n* 18	*n* 11			
TSF (mm)	127 (62)	130 (65)	123 (71)	143 (79)	126 (66)	123 (57)	125 (61)
		n 22	*n* 18	*n* 11			
MAMC (mm)	234 (29)	237 (27)	234 (27)	234 (22)	226 (29)	218 (23)	211 (34)
		n 22	*n* 18	*n* 11			
Percentage body fat	26 (9)	26.9 (9)	25.5 (9.4)	26.9 (10.1)	25.4 (9.1)	25.2 (8.4)	25.5 (9.5)
		n 21	*n* 17	*n* 11	*n* 25	*n* 17	

Values are mean (SD).

*includes patients who died; 24 patients discharged, 2 patients died.

D/C, discharge assessment; BMI, body mass index; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSF, triceps skinfold.

Table 5.18b. Functional, fatigue and quality of life variables over the course of the study in patients receiving adequate nutritional intervention (*n* 31)

	Pre-operative	Post-operative				Post-discharge	
		Day 7	Day 14	Day 21	D/C or death*	6 weeks	12 weeks
	n 31	*n* 24	*n* 20	*n* 12	*n* 26	*n* 18	*n* 9
Hand grip (% standard)	72 (17)	69 (19.6) *n* 22	65.5 (21) *n* 17	71.2 (22) *n* 10	64 (26)	65.6 (18) *n* 17	57 (15.6)
Fatigue score	4.6 (2.7)	7.5 (2.4)	7.4 (2.1)	7.0 (2.1)	6.9 (2.6)	6.0 (2.4)	5.8 (2.8)
Norton score	26.4 (1.6)	21.4 (3.2)	22.5 (2.7)	23.2 (3.3)	23.6 (3.1)	25.0 (2.6)	24.8 (3.4)
QOL score	6.5 (4.6)	10.5 (6.3)	10.4 (5.8)	7.4 (3.9)	8.6 (5.6)	6.7 (4.7)	8.4 (6.5)

Values are mean (SD).

*includes patients who died; 24 patients discharged, 2 patients died.

D/C, discharge assessment; QOL, quality of life.

Table 5.19a. Anthropometric variables over the course of the study in patients receiving inadequate nutritional intervention in hospital (*n* 13)

	Pre-operative	Post-operative				Post-discharge	
		Day 7	Day14	Day 21	D/C or death*	6 weeks	12weeks
	n 13	*n* 11	*n* 9	*n* 4	*n* 13	*n* 8	*n* 6
Weight (kg)	70 (15)	66.2 (14) *n* 8	67.9 (15.3) *n* 8	71.2 (9.5)	68.2 (7.5)	65.4 (11)	66.5 (12)
BMI (kg/m^2)	25.2 (4.1)	24.9 (4.3) *n* 8	24.4 (4) *n* 8	24.5 (2.4)	24.0 (3.2) *n* 12	22.9 (2.6)	22.6 (3)
Hand-grip (% standard)	76.8 (22)	63 (26) *n* 10	66.7 (17) *n* 9	81.2 (22) *n* 4	64 (22)	74.4 (22)	76 (16.5)
MAC (mm)	291 (32)	286 (38) *n* 10	278 (28)	278 (16)	273 (27)	264 (24)	268 (35)
TSF (mm)	135 (42)	133 (43) *n* 10	129 (49)	137 (43)	132 (39)	122 (26)	121 (44)
MAMC (mm)	248 (29)	244 (36) *n* 10	237 (30)	235 (16)	231 (28)	226 (23)	230 (27)
Percentage body fat	27.2 (7.1) *n* 12	31.7 (5.3) *n* 7	25.3 (6.7) *n* 8	28.4 (3.9)	26.4 (6.6) *n* 11	27.2 (3.8)	25.4 (5.1)

Values are mean (SD).

*includes patients who died; 11 patients discharged, 2 patients died.

D/C, discharge assessment; BMI, body mass index; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness.

Table 5.19b. Functional, fatigue and quality of life variables over the course of the study in patients receiving inadequate nutritional intervention in hospital (*n* 13)

	Pre-operative	Post-operative				Post-discharge	
		Day 7	Day14	Day 21	D/C or death*	6 weeks	12weeks
	n 13	*n* 11	*n* 9	*n* 4	*n* 13	*n* 8	*n* 6
Hand-grip	76.8 (22)	63 (26)	66.7 (17)	81.2 (22)	64 (22)	74.4 (22)	76 (16.5)
(% standard)		*n* 10	*n* 9	*n* 4			
Fatigue score	3.2 (3.1)	8.9 (0.8)	8.4 (1.5)	5.7 (2.1)	7.5 (1.8)	3.6 (1.7)	3.5 (1.5)
Norton score	26.8 (1.7)	21.1 (2.5)	22.9 (3.5)	23.7 (2.9)	23.2 (2.9)	26.0 (2.1)	26.3 (1.9)
QOL score	4.0 (2.5)	10.8 (5.0)	6.9 (4.3)	6.0 (2.5)	6.6 (4.1)	3.9 (2.4)	3.0 (2.1)

Values are mean (SD).

*includes patients who died; 11 patients discharged, 2 patients died.

D/C, discharge assessment; QOL, quality of life.

Table 5.20. Admission characteristics of all patients on adequate nutritional intervention (*n* 31) and omitting patients who died before a second post-operative assessment could be completed (*n* 26).

	Admission *n* 31	Admission *n* 26
Male: female	20: 11	16: 10
Age	63 (11)	63.6 (11.5)
Weight (kg)	67 (17)	67.5 (18)
BMI (kg/m^2)	24.4 (4.5)	24.7 (4.7)
Percentage UBW	89.6 (8)	90.5 (7.4)
	n 30	*n* 25
Weight change (%)	10.4 (7.8)	9.5 (7.4)
	n 30	*n* 25
Albumin (g/l)	37.5 (4.3)	38 (4.3)
	n 28	*n* 23
NRI	94.1 (9.0)	95.3 (8.7)
	n 28	*n* 22
Hand-grip (% normal)	72 (17)	73 (16.5)
MAC (mm)	274 (36)	277 (38)
TSF (mm)	127 (62)	128 (66)
MAMC (mm)	234 (29)	236 (29)
Percentage body fat	26 (9)	26.5 (9.4)
Fatigue score	4.6 (2.7)	4.3 (2.7)
Norton score	26.4 (1.6)	26.4 (1.7)
QOL score	6.5 (4.6)	6.2 (4.7)
LOS	31 (20.7)	34.4 (20.6)
ICU stay (days)	3.8 (7.2)	3.2 (7.1)
HDU stay (days)	1.6 (1.5)	1.8 (1.6)

Values are mean (SD).

BMI, body mass index; HDU, high dependency unit; ICU, intensive care unit; LOS, length of stay in hospital; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; NRI, Nutrition Risk Index; TSF, triceps skinfold; QOL, quality of life; UBW, usual body weight.

Table 5.21a. Anthropometric variables on admission in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate *n* 31	Inadequate *n* 13	None *n* 15
Weight (kg)	67 (17)	70 (15)	68 (8)
BMI (kg/m^2)	24.4 (4.5)	25.2 (4.1)	25 9 (2.5)
% UBW	89.6 (8) *n* 30	92.7 (7)	95.6 (7.5)
NRI	94.1 (9.0) *n* 28	95.4 (7.1) *n* 12	97 (8.1) *n* 14
TSF (mm)	127 (62)	135 (42)	142 (63)
MAMC (mm)	234 (29)	248 (29)	238 (25)
Percentage body fat	26.0 (9)	27 2 (7) *n* 12	27.9 (7.6)

Values are mean (SD).

BMI, body mass index; MAMC, mid-arm muscle circumference; NRI, nutrition risk index; TSF, triceps skinfold thickness; UBW, usual body weight.

Table 5.21b. Non-anthropometric variables on admission in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate *n* 31	Inadequate *n* 13	None *n* 15
Male: female	20:11	9:4	8:7
Age	63 (11)	70.5 (14)	66.5 (11.5)
Albumin (g/l)	37.5 (4.3) *n* 28	37.3 (3.4) *n* 12	37.6 (4.3) *n* 14
Hand-grip (% normal)	72 (17)	77 (22)	70.5 (16.5)
Fatigue score	4.6 (2.7)	3.2 (3.1)	3.3 (2.7)
Norton score	26.4 (1.6)	26.8 (1.7)	27.7 (0.7)
QOL score	6.5 (4.6)	4.0 (2.5)	5.0 (3.6)

Values are mean (SD).

QOL, quality of life.

Table 5.22. Assessment variables at post-operative day 7 in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate	Inadequate	None
	n 24	*n* 11	*n* 13
Weight (kg)	69.4 (15.3)	66.2 (14.0)	68.5 (7.3)
	n 20	*n* 8	
BMI (kg/m^2)	25.2 (3.9)	24.9 (4.3)	24.8 (2.5)
	n 20	*n* 8	
TSF (mm)	130 (65.0)	133 (43.0)	120 (50.0)
		n 10	
MAMC (mm)	237 (27.0)	244 (36.0)	242 (18.0)
		n 10	
Percentage body fat	26.9 (9.0)	31.7 (5.3)	26.5 (7.5)
Hand-grip (% normal)	69 (19.6)	62.9 (26.0)	67 (17.4)
		n 10	*n* 12
Fatigue score	7.5 (2.4)	8.9 (0.8)	6.2 (2.5)
Norton score	21.4 (3.2)	21.1 (2.5)	25.3 (1.6)
QOL score	10.5 (6.3)	10.8 (5.0)	8.5 (4.4)

Values are mean (SD).

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; QOL, quality of life.

Table 5.23. Assessment variables on discharge or death* in patients on adequate, inadequate or no nutritional intervention

	Nutritional intervention		
	Adequate *n* 26	Inadequate *n* 13	None *n* 13
BMI (kg/m^2)	23.7 (3.7)	24.0 (3.2) *n* 12	24.7 (2.6)
TSF (mm)	126 (66.0)	132 (39.0)	121 (48.0)
MAMC (mm)	226 (29.0)	231 (28.0)	241 (18.0)
Percentage body fat	25.4 (9.1)	26.4 (6.6)	26.8 (7.5)
Hand-grip (% normal)	64.0 (26.0)	64.0 (22.0)	67.8 (18.0)
Fatigue score	6.9 (2.6)	7.5 (1.8)	5.0 (2.7)
Norton score	23.6 (3.1)	23.2 (2.9)	26.2 (1.4)
QOL score	8.6 (5.6)	6.6 (4.1)	7.2 (4.0)

Values are mean (SD).

*Adequate nutritional intervention, 5 patients died before a second assessment could be carried out; of the 26 patients reassessed, 24 were discharged and 2 died. Inadequate nutritional intervention, of the 13 patients reassessed at discharge or death, 11 were discharged and 2 died. No nutritional intervention, all 15 patients were discharged; 2 patients were discharged before a second assessment could be carried out.

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; QOL, quality of life.

Table 5.24. Assessment variables at 6 weeks post-discharge in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate *n* 18	Inadequate *n* 8	None *n* 10
Weight (kg)	60 (12.6)	65.4 (11.0)	68.0 (7.3)
BMI (kg/m^2)	22.4 (3.7)	22.9 (2.6)	24.8 (2.5)
TSF (mm)	123 (57.0)	122 (26.0)	127 (58.0)
MAMC (mm)	218 (23.0)	226 (23.0)	236 (20.5)
Percentage body fat	25.2 (8.4) *n* 17	27.2 (3.8)	27.4 (7.5)
Hand-grip (% normal)	57.0 (15.6)	74.4 (22.0)	70 (18.0)
Fatigue score	6.0 (2.4)	3.6 (1.7)	4.4 (2.1)
Norton score	25.0 (2.6)	26.0 (2.1)	26.6 (1.4)
QOL score	6.7 (4.7)	3.9 (2.4)	5.7 (2.8)

Values are mean (SD).

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; QOL, quality of life.

Table 5.25. Assessment variables at 12 weeks post-discharge in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate	Inadequate	None
	n 9	*n* 6	*n* 7
Weight (kg)	54.7 (7.0)	66.5 (12.0)	70.5 (9.4)
BMI (kg/m^2)	21.0 (3.2)	22.6 (3.0)	25.2 (2.4)
TSF (mm)	125 (61.0)	121 (44.0)	131 (34.0)
MAMC (mm)	211 (34.0)	230 (27.0)	245 (26.0)
Percentage body fat	25.5 (9.5)	25.4 (5.1)	27.1 (5.6)
Hand-grip (% normal)	57 (15.6)	76.0 (16.5)	76.9 (20.4)
Fatigue score	5.8 (2.8)	3.5 (1.5)	5.1 (3.3)
Norton score	24.8 (3.4)	26.3 (1.9)	26.9 (1.2)
QOL score	8.4 (6.5)	3.0 (2.1)	7.3 (5.3)

Values are mean (SD).

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; QOL, quality of life.

Table 5.26. Length of stay in hospital, ICU and HDU in patients on adequate, inadequate and no nutritional intervention

	Nutritional intervention		
	Adequate *n* 31	Inadequate *n* 13	None *n* 15
LOS (days)	31 (20.7)	38 (19)	17.8 (8.4)
ICU (days)	3.8 (7.2)	2.6 (6.4)	0.2 (0.6)
HDU (days)	1.6 (1.5)	1.5 (2.7)	1.7 (1.3)

Values are mean (SD).

LOS, length of stay in hospital; ICU, length of stay in the intensive care unit; HDU, length of stay in the high dependency unit.

Table 5.27a. Anthropometric variables at admission in subgroups assessed at 12 weeks post-discharge who were given adequate (*n* 9) and inadequate (*n* 6) nutritional intervention

	Adequate intervention *n* 9	Inadequate intervention *n* 6
Weight (kg)	55.8 (11.2)	73.3 (14.3)
BMI (kg/m^2)	21.2 (3.2)	24.8 (3.5)
Percentage UBW	87.8 (5.1)	93.4 (7.5)
Weight change (%)	12 (4.9)	6.6 (7.6)
MAC (mm)	254 (29)	293 (30.0)
TSF (mm)	110 (51)	130 (26)
MAMC (mm)	220 (25)	252 (27)
Calf (mm)	316 (32)	353 (27)
Percentage body fat	24.1 (8.9)	26.5 (5.7) *n* 5

Values are mean (SD).

BMI, body mass index; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; UBW, usual body weight.

Table 5.27b. Non-anthropometric variables at admission and details of length of stay in subgroups assessed at 12 weeks post-discharge who were given adequate (*n* 9) and inadequate (*n* 6) nutritional intervention

	Adequate intervention	Inadequate intervention
	n 9	*n* 6
Age	60 (15)	62 (13.6)
Albumin (g/l)	38.7 (4.0)	38.4 (2.7)
	n 8	*n* 5
NRI	95.6 (8.0)	96.8 (5.3)
	n 8	*n* 5
Hand-grip (% normal)	71.3 (17.2)	80.5 (13.5)
Fatigue score	4.1 (3.0)	3.8 (3.5)
Norton score	26.3 (1.0)	26.8 (1.5)
QOL score	6.7 (5.5)	3.2 (1.7)
LOS (days)	42.7 (28.2)	43.8 (23.3)
ICU (days)	5.6 (11.5)	5.0 (9.0)
HDU (days)	2.3 (2.4)	2.5 (3.8)

Values are mean (SD).

HDU, length of stay in high dependency unit; ICU, length of stay in intensive care unit; LOS, length of stay in hospital; QOL, quality of life.

Table 5.27c. Assessment variables in subgroups given adequate (*n* 9) and inadequate (*n* 6) nutritional intervention at 12 weeks post-discharge

	Adequate intervention *n* 9	Inadequate intervention *n* 6
Weight (kg)	54.7 (7.0)	66.5 (12)
BMI (kg/m^2)	21 (3.2)	22.6 (3)
MAC (mm)	250 (34)	268 (35)
TSF (mm)	125 (61)	121 (44)
MAMC (mm)	211 (34)	230 (27)
Calf (mm)	309 (25)	334 (41)
Percentage body fat	25.5 (9.5)	25.4 (5.1)
Hand-grip (% normal)	57 (15.6)	76 (16.5)
Fatigue score	5.8 (2.8)	3.5 (1.5)
Norton score	24.8 (3.4)	26.3 (1.9)
QOL score	8.4 (6.5)	3.0 (2.1)

Values are mean (SD).

BMI, body mass index; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness; QOL, quality of life.

Operative procedures

Details of the types of operative procedures, blood loss during surgery and the drop in serum albumin from the pre-operative level to that measured on the first post-operative day can be seen in **Table 5.6**.

Post-operative complications

Neither age over sixty-five years ($P = 0.32$) (Fishers exact test) nor gender ($P = 0.18$) (Fishers exact test) significantly affected post-operative survival. Five patients died before a second reassessment could be carried out. A further four died before discharge from hospital giving an overall hospital mortality rate of 15 %. Three (27 %) of the patients who died, did so as a result of major infectious complications, while three (27 %) died as a result of major non-infectious complications. One patient died as a result of extensive metastatic lung disease. Four patients died from a combination of major infectious and major non-infectious complications. Twenty-four (41 %) patients developed major complications, eight (33 %) developing major infectious, eight (33 %) developing major non-infectious complications and eight (33 %) developing both major infectious and major non-infectious complications. When both major and minor infectious complications were grouped, twenty-three (39 %) of patients developed an infectious complication. Details of all post-operative complications observed can be seen in **Table 5.7**.

The median length of stay hospital stay was twenty-four days, (mean 29 (SD 19) days), the median post-operative length of stay was sixteen days (mean 22 (SD 17) days). Median length of stay in hospital, post-operative length of stay, intensive care unit and high dependency unit stay for the different types of cancer can be seen in **Table 5.28**. In those who developed a major complication, the median length of stay was thirty-five days, with a median post-operative length of stay of twenty-four days. Both total length of stay in hospital and post-operative length of stay were significantly longer ($P < 0.01$) in patients who developed a major complication by comparison with patients who did not develop any complications (median length of stay, twenty-three days, median post-operative length of stay thirteen days). In those who developed an infectious

complication of any type, median length of stay was thirty-five days and median post-operative length of stay was twenty-four days, again significantly longer ($P < 0.05$) than in those patients without infectious complications.

In the patient group who had two pre-operative assessments, post-operative outcome was similar in the weight losers when compared to the full group. This was to be expected as only a small non-significant deterioration in pre-operative nutritional status and hand-grip strength was observed (see **Tables 5.11** and **5.12**).

Table 5.28. Hospital stay variables in different cancer types (*n* 59)

Type of cancer	LOS (days)	Post-operative LOS (days)	ICU (days)	HDU (days)
Lung (*n* 16)	12.5	9.5	0	2
Ovarian (*n* 4)	15.5	11.5	0	1
Bowel (*n* 12)	25	14	0	0
Head & Neck (*n* 13)	35	26	2	1
Oesophageal (*n* 10)	30.5	22.5	3.5	2.5
Gastric (*n* 2)	27.5	13	0	0.5
Pancreatic (*n* 2)	55.5	47.5	12.5	2

Median values.

LOS, length of stay in hospital; ICU, intensive care unit; HDU, high dependency unit.

5.6.3 Post-discharge status

Nutritional status and nutrient intakes

Following discharge, twenty-one patients were reassessed at six and twelve weeks post-discharge, fifteen at six weeks only, and one at twelve weeks only. Of these, twenty-six (70 %) patients lost weight within three months (mean 3.8 (SD 2.7) kg, mean 5.9 % body weight on discharge from hospital). Three patients with a normal BMI on discharge reached a BMI of less than 20 kg/m^2 subsequently. Mean BMI continued to decrease during the twelve week post-discharge period (see **Table 5.15a**).

Functional status and fatigue levels

Hand-grip dynamometry was measured in thirty-five patients six weeks after discharge from hospital and in twenty-two patients twelve weeks after discharge. A reading below 85 % of standard was recorded in twenty-seven (77 %) patients, mean 61 % (SD 13) standard at six weeks and in eighteen (82 %) patients, mean 61 % (SD 13) standard at twelve weeks. There was a small improvement in mean hand-grip strength from 65 % (SD 23) standard on discharge from hospital (*n* 50) to 69 % (SD 19) at six weeks after discharge. Functional status as measured by the Norton score similarly improved from a mean of 24.2 (SD 2.9) on discharge to 25.7 (SD 2.8) at six weeks post-discharge. No further improvement was seen in either hand-grip strength, mean 68.5 % (SD 19) standard or Norton score, mean 25.9 (SD 2.5) by twelve weeks post-discharge. Neither had returned to their respective pre-operative levels.

Quality of Life Profile

Quality of life scores improved after discharge from hospital and had returned to baseline by six weeks post-discharge. Further improvement in quality of life was not observed (see **Table 5.15b**).

Post-operative complications occurring post-discharge

Two further patients (3 %) died and one was admitted to a regional palliative care unit during the twelve week follow-up period. Two patients were admitted to their local hospitals, one patient developed a deep vein thrombosis and another a wound infection.

5.6.4 Changes over the course of the study

Nutritional status and nutrient intakes for full group

During the study period, weight loss occurred in all patient types (see **Table 5.15a**), the mean weight (and BMI) being 92 % of admission weight (and BMI). The mean values of all anthropometric indices fell over the course of the study, to approximately 95 % of their values on admission to hospital.

Percentage body fat twelve weeks after discharge was calculated in 22 patients. Mean percentage body fat at final assessment was not significantly different than at admission to hospital [26 % (SD 7.1) versus 26.7 % (SD 8.2)]. Mid-arm muscle circumference below the 5th percentile was observed in six (27 %) patients compared with the prevalence of 12 % observed in patients on admission to hospital. A calf circumference below 31 cm was not recorded in any patient at the final assessment.

Of the twenty-two patients reassessed at twelve weeks after discharge, reduced appetite was reported by five (23 %) patients, with four (18 %) reporting that their appetite was virtually non-existent. No patient reported vomiting and / or diarrhoea at the final assessment. Difficulties in swallowing requiring food consistency modification were reported by four (18 %) while two (9 %) were unable to take food orally. Pain or discomfort on eating was reported by four (18 %) patients.

Of the thirty-six patients re-assessed at six weeks after discharge, fifteen (42 %) patients were able to eat full meals at six weeks, thirteen (36 %) could only eat a small

amount of their main meal, one (3 %) could only take soup and / or dessert while three (8 %) were unable to take anything orally. Of the twenty-two re-assessed at twelve weeks after discharge, twelve (54 %) were able to eat full meals, six (27 %) could only eat a small amount of their main meal, one (4 %) could only take soup and / or dessert while three (14 %) were unable to take anything orally. When questioned regarding their own perceived need to eat, twenty-eight (78 %) patients, at the six week assessment, stated that it was more important than normal to eat while nineteen (86 %) stated this at the twelve week assessment. Despite this, eighteen (50 %) patients reported at the six week assessment that their appetite was reduced while ten (45 %) reported this at the twelve week assessment.

Functional status and fatigue levels

Mean hand-grip strength deteriorated over the course of the study. Fatigue and Norton scores recovered during the post discharge period (see **Table 5.15b**).

Quality of Life Profile

Mean quality of life scores deteriorated over the course of the hospital admission but recovered after discharge from hospital (see **Table 5.15b**).

5.6.5 Predictions of patient outcome

The variables affecting post-operative length of hospital stay, complications and mortality were examined in order to determine those which have the greatest effect on each end-point. All objective and subjective nutritional variables, functional and quality of life data were examined as were factors such as cancer stage and surgical insult.

Post-operative length of stay

Significant correlations were found between post-operative length of stay and the drop in serum albumin due to the surgical insult, (r 0.46, $P < 0.01$), the development of major complications (r 0.43, $P < 0.01$), alcohol intake (r 0.4, $P < 0.05$) and the adequacy of dietary intake over the course of the hospital stay (r 0.29, $P < 0.05$). In a multiple regression model, the factors most likely to predict a prolonged post-operative stay in hospital were the development of major infectious complications ($P < 0.001$), a higher alcohol intake at time of admission to hospital ($P < 0.01$) and the surgical insult as measured by the difference between serum albumin pre-operatively and as measured on the first post-operative day ($P < 0.05$).

Post-operative mortality

Significant correlations were found between patient mortality and the development of major complications (r 0.49, $P < 0.01$), the adequacy of dietary intake over the course of the hospital stay (r 0.31, $P < 0.05$) and weight loss occurring over the 6 months before admission (r 0.3, $P < 0.05$). In a multiple regression model, the factors most likely to predict mortality in this patient group were the development of major complications ($P < 0.001$) and a more adequate nutritional intake during hospitalisation ($P < 0.05$).

Post-operative complications

When the factors affecting the development of post-operative complications were examined, there were significant negative correlations between the development of major complications and serum albumin on the first post-operative day (r 0.36, $P < 0.01$), and percentage body fat (r 0.33, $P < 0.05$) and mid-arm circumference (r 0.32, $P < 0.05$) on admission. Using multiple regression analysis, lower percentage body fat on admission to hospital and lower serum albumin on the first post-operative day predicted an increase in major complications. When major complications were subdivided into major infectious complications and major non-infectious complications, lower percentage body fat had the greatest predictive power ($P = 0.01$) for the development of major infectious complications while the surgical insult as measured by the difference between serum albumin pre-operatively and as measured day one post-operatively had greatest predictive power ($P < 0.05$) for the development of major non-infectious complications. When both major and minor infectious complications were grouped, there were significant negative correlations between the development of infectious complications and the nutrition risk index (r 0.38, $P < 0.01$), mid-arm circumference (r 0.37, $P < 0.01$), serum albumin on the first post-operative day (r 0.35, $P < 0.01$), pre-operative albumin (r 0.3, $P < 0.05$), triceps skinfold thickness (r 0.28, $P < 0.05$), percentage body fat (r 0.26, $P < 0.05$) and appetite (r 0.26, $P < 0.05$) and a significant positive correlation with weight loss in the six months before admission (r 0.32, $P < 0.05$). Multiple regression analysis showed that a lower nutrition risk index on admission to hospital significantly predicted the development of infectious complications ($P < 0.01$).

5.6.6 Relative risk of developing post-operative complications

Following the results of the multiple regression analysis examining the factors which could predict the development of complications, the relative risk of developing these complications was determined.

Major complications

The main predictors of developing a major complication post-operatively were lower percentage body fat and lower serum albumin on the first post-operative day. The relative risk of developing major complications at different levels of percentage body fat and albumin on the first post-operative day were calculated. Initially, percentiles were calculated for percentage body fat on admission and for serum albumin on the first post-operative day.

A patient with percentage body fat below the 15th percentile (65 % percent mean body fat for age and sex) was 2.1 times more likely to develop a major complication than if percentage body fat was above 65 % of the mean. If percentage body fat was above the 75th percentile or 93 % of the mean for age and sex, the relative risk of developing a major complication was 2.75 times less likely than if percentage body fat was below 65 % of the mean. The relative risk of developing a major complication did not increase even when percentage body fat was over the 95th percentile or 116 % of the mean for age and sex.

When different levels of serum albumin on the first post-operative day were examined, a patient with a serum albumin below 22 g/l was 1.8 times more likely to develop a major complication than if serum albumin was above 22 g/l. The relative risk of developing a major complication at a serum albumin above 28 g/l on the first post-operative day was 4.7 times less likely than if the serum albumin was below 22 g/l.

When major complications were subdivided, lower percentage body fat was the main predictor for the development of major infectious complications while the surgical insult (defined as the difference between serum albumin pre-operatively and as

measured on the first post-operative day) was the main predictor for the development of major non-infectious complications. If percentage body fat was below 65 % of the age and sex specific standard, it was 3.75 times more likely that a patient would develop a major infectious complication than if the percentage body fat was above 93 % of the standard. For major non-infectious complications, the relative risk of developing a complication was 4.7 times higher with a post-operative drop in serum albumin of more than 16 g/l compared with a post-operative drop less than 8 g/l.

Total infectious complications

A lower nutrition risk index on admission to hospital was the main predictor for the development of all infectious complications. A patient at high nutritional risk (NRI below 83.5) was 2.85 times more likely to develop an infectious complication than a patient who was not at nutritional risk (NRI > 100). Patients who were at mild to moderate risk (NRI $\geq$ 83.5 -97.5) were 1.9 times more likely to develop an infectious complication than a patient who was not at nutritional risk.

5.7 Discussion

One of the reasons this study was undertaken was to determine if the significantly lower level of undernutrition observed in our first study (see **Chapter 3**) by comparison with the frequently-cited study from Dundee (McWhirter & Pennington, 1994) would also be observed in a study of a group of patients known to be among the most nutritionally vulnerable of all patients admitted to hospital, namely, those requiring major resection of cancer. Although the Dundee study had reported a prevalence of undernutrition of 27 % among surgical patients, the authors had not specified the proportion in this group undergoing major resection for carcinoma. In our first study (see **Chapter 3**), the expectation was that the proportion of patients likely to be undernourished in Dublin would be similar to that reported from Dundee. Because of the unexpectedly low prevalence of undernutrition observed in our first study and a low prevalence of undernutrition reported in recent studies examining the effects of nutrition intervention on patients admitted for surgical procedures (Beier-Holgerson *et al.* 1996; Carr *et al.* 1996; Keele *et al.* 1997; Watters *et al.* 1997; Heslin *et al.* 1997), many of whom required resection of a major carcinoma, we were unsure what prevalence of undernutrition could be expected among cancer resection patients in our hospital.

In fact, body mass index estimates identified only five (8 %) patients to be undernourished using the standard threshold value of a body mass index below 20 kg/m^2, in keeping with the results of our first study (see **Chapter 3**). Using the nutrition risk index to identify those who were at risk of developing nutrition-related complications, thirty-three (63 %) were defined as at nutritional risk, seven (13 %) of whom were identified to be at severe risk. This was higher than that observed within the sub-group of general surgical patients (*n* 125) in **Chapter 3** where 42.5 % were defined to be at nutritional risk using the nutrition risk index, 2.5 % being at severe risk. The discrepancy between the proportion of patients identified using body mass index and nutrition risk index thresholds suggests that use of a body mass index threshold of 20 kg/m^2 is probably not appropriate as a criterion to classify patients who require nutritional support. In the Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, (1991), it was those patients defined to be at severe nutritional risk using

the nutrition risk index who benefited in terms of clinical outcome from the provision of total parenteral nutrition. This was the case even when the intraveneous nutrition used was neither the best route for the provision of nutrition support, nor of the correct nutrient composition for the needs of many of the patients. In our study of surgical oncology patients, 75 % of the patients had lost weight before admission to hospital, with 21 (37 %) having lost more than 10 % of body weight in the six months before admission. There is no doubt that all surgical oncology patients with a body mass index below 20 kg/m^2 should be referred for nutritional intervention, as the mean weight loss before admission in this group was higher than in those with a BMI above 20 kg/m^2 (13 % versus 11 % weight loss in the six months before hospital admission). If we accept that weight loss of more than 10 % in the six months before admission to hospital has indications for clinical outcome, many more patients than those with a body mass index below 20 kg/m^2 should be referred for nutritional intervention. In common with the surgical nutrition literature, where associations have been reported between pre-operative weight loss and increased post-operative mortality (Busby *et al.* 1980; Giner *et al.* 1996), we also found that those with weight loss of more than 10 % in the six months before admission had significantly decreased post-operative survival ($P = 0.024$). However, when we included all possible variables in a multiple regression analysis, pre-operative weight loss alone could not predict an increase in post-operative complications. It was only when combined with low serum albumin, as in the nutrition risk index, those with a lower score were at greater risk of developing an infectious complication. In turn, patients most likely to have a prolonged hospital stay were those who developed a major infectious complication. This observation is supported by the results of the analysis of the sub-group of surgical patients (n 125) in the first study, where, although post-operative complications were not recorded, a lower nutrition risk index on admission correlated with longer hospital stay ($P < 0.01$). In these surgical oncology patients, lower percentage body fat on admission most accurately predicted both the development of major complications ($P < 0.05$) and major infectious complications ($P = 0.01$). The development of a major complication was the most accurate predictor of death ($P < 0.001$). This observation is in keeping with frequent observations in the surgical literature that pre-operative weight loss (Studley, 1936; Klidjian *et al.* 1980; Meguid *et al.* 1988; Windsor & Hill, 1988; Reilly *et al.* 1988; Von Meyenfeldt *et al.* 1992) and impaired nutritional status (Bastow *et al.* 1983; Shaw-

Stiffel *et al.* 1993) result in increased duration of hospital stay and longer post-operative convalescence times (Bastow *et al.* 1983; Lumbers *et al.* 1996). In a retrospective study of over 5000 surgical patients, the average length of hospital stay was doubled in surgical patients who developed complications (McAleese & Odling-Smee, 1994). The observations regarding the effects of nutritional status on clinical outcome in surgical oncology patients supports the findings in our first study (see **Chapter 3**), where a mixed group of undernourished patients had significantly longer mean lengths of stay in hospital ($P < 0.01$), a trend towards higher mortality ($P = 0.05$) and a trend towards reduced ability to return home ($P = 0.06$).

In this group of surgical oncology patients, a number of variables were found to have no effect on survival or the development of complications. These included gender, older age (equal to or more than sixty-five years) and weight loss of more than 5 % in the month before admission to hospital. This latter observation is in contrast to that found in the analysis of the sub-group of general surgical patients (n 221) in our first study (see **Chapter 3**) in whom we observed that weight loss of more than 5 % in the month before admission correlated with increased length of stay in hospital ($P < 0.01$) and reduced ability to return directly home on discharge ($P < 0.05$).

Only a small number of patients had two pre-operative assessments in hospital. In those patients who lost weight, the small amount of weight lost appeared to be fat rather than lean tissue. No effect of this weight loss was observed in terms of post-operative outcome. It is possible, however, that if patients remain in hospital for a longer pre-operative period, they may also lose lean tissue which may, in turn, affect post-operative outcome.

Difficulties eating and retaining food occurred frequently, and in this patient group a careful history including details of weight, appetite and ability to eat remain an important indicator of the need for nutrition support regardless of body mass index. This observation in surgical oncology patients is supported by observations from the surgical sub-group our first study (see **Chapter 3**). In these general surgical patients correlations between reduced appetite and inability to return home ($P < 0.01$), and between reduced ability to eat and increased length of stay ($P < 0.05$) were found.

Although one aspect of the study of surgical oncology patients was to examine the effects of current nutritional management and make recommendations for improving the service, significant differences between those who benefited from nutrition intervention were not observed. All the high risk patients received nutritional intervention. However, weight loss, loss of function as measured by hand-grip strength and complication rates remained high. This study was an observational, not an intervention study, in a hospital with a comparatively large and active department of clinical nutrition. Although small improvements in practice should always be strived for, no patient who required nutritional support did without it for a prolonged period. When the groups were sub-divided into those with adequate and inadequate nutritional support, those with adequate nutritional support, probably the sickest patients, did manage to maintain their nutritional status over the three month post-discharge period in contrast to those who had inadequate nutritional intervention. There was no difference, however, between the groups in terms of clinical outcomes in hospital or in the twelve week post-discharge follow-up period. It may be necessary, therefore, to determine clinical outcomes over the longer term in these patients. It has been recommended recently (Allison, 1996) that outcome measures should include measures of functional status and quality of life. We were unable, in our small observational study to show improvements in these variables as a result of nutritional intervention. Although one small study reported improved quality of life in malnourished outpatients who gained weight (Jamieson *et al.* 1997) and a larger study reported reduction in fatigue scores (Keele *et al.* 1997), it remains to be seen if these improvements will be observed in larger, controlled, randomised trials in other groups of hospital patients.

The majority of patients lost a clinically significant amount of weight in hospital with, or without, nutritional intervention. This was associated with a decline in physical function as measured by hand-grip strength, Norton and fatigue scores. It was not possible from the data collected in our study to conclude that the provision of nutritional support could prevent the deterioration in physical function nor could we determine if differences in quality of life would be observed if nutritional support was not provided over the longer term to those given it. It is increasingly being recognised that post-operative quality of life should be considered in the patient undergoing resection for cancer, recognising that the majority of patients will ultimately die from their disease.

In our study, quality of life scores returned to baseline by six weeks post-discharge, unlike the measurements of functional status which remained depressed, even at twelve weeks after discharge from hospital. It could be postulated that the provision of nutritional support can help in the restoration of mental well-being although physical status remains impaired.

Weight continued to fall in the majority of patients in the period after discharge, with three patients reaching a body mass index below 20 kg/m^2. It is probable that the weight loss is predominantly lean tissue. Mean percentage body fat at final assessment was not significantly greater than at initial assessment on admission to hospital (26 % versus 26.7 %) and, while only 12 % of patients had a mid-arm muscle circumference below the 5th percentile on admission to hospital, 27 % were below the 5th percentile by the final assessment. It may be that the deterioration in both weight (and probably of lean body mass) and functional status are linked, whereas quality of life is determined strongly by environmental factors. Being at home in familiar surroundings may result in improved quality of life when compared to being in hospital although objective measurements such as nutritional and functional status continue to deteriorate.

Difficulties eating and retaining food continued to occur frequently even after a curative surgical procedure, with only 50 % of patients being able to eat full meals three months after discharge from hospital. This was in spite of the patients' perceived requirement to increase their nutritional intake (78 % at six weeks and 86 % at 12 weeks post-discharge believed that it was more important than normal for them to eat). Although difficulties eating and retaining food affected the patients' physical well-being in terms of weight and physical function, these difficulties did not appear to affect their psychological status in terms of quality of life. It would however, require a controlled trial with nutritional intervention being given to one of two groups of surgical oncology patients in the post-discharge phase of treatment. In a mixed group such as this, it would be difficult to obtain ethical approval for such a study. The recent study mentioned earlier (Jamieson *et al.* 1997), using the same quality of life score that we used in this study, reported improved quality of life in undernourished patients attending a nutrition support clinic who gained weight. Those attending the same clinic who were not underweight and maintained weight only, did not show this improvement. A study

similar to that of Keele *et al.* (1997), in which fatigue scores in post-operative patients given nutritional supplements were observed to improve, could perhaps also show improved quality of life if this happens as a result of the provision of nutritional intervention.

Finally, the ethical issue of which very ill patients should be offered nutritional support must be addressed. There is increasing realisation that malnutrition is a complication of many illnesses, patients with cancer being among those at greatest risk. There is an ethical duty to recognise and treat malnutrition (Lennard-Jones, 1998) and in the cases enrolled into this study, no ethical question arose regarding the instigation of artificial feeding while the patient remained in hospital. Although not every patient received nutritional intervention, all patients enrolled into our study underwent what was believed at the time of surgery to be a curative procedure and were provided post-operatively either with normal diet or with artificial nutrition support within a time frame which would be generally medically acceptable. Although debate continues as to the benefits of both pre-operative nutritional intervention and early post-operative feeding, the nutrition literature remains unclear and neither treatment has gained widespread acceptance. Unfortunately, the mortality rate for patients undergoing a resection for these large carcinoma remains high and pre-operative selection of patients expected to have a good outcome remains difficult. In our study, we could not attribute the high mortality rate to lack of nutritional intervention. However, higher mortality could be linked to the development of complications which in turn were associated with worse nutritional status on admission to hospital. It could therefore be argued that all patients undergoing a curative resection should be nutritionally assessed, if possible before admission to hospital in order to optimise pre-operative nutritional status. There is certainly need for further research to establish why not all surgical oncology patients are referred for nutritional assessment. One easily rectifiable reason is, perhaps, poor referral protocols and it seems justifiable to establish these given the effect of poor nutritional status on clinical outcome. An alternative possibility, that medical and nursing staff do not believe that nutritional assessment will provide benefit for the patients could be rectified by greater emphasis on in-service training for nursing and medical staff regarding the indications for nutritional intervention. Even in a hospital such as St. James's, with a well-utilised and respected clinical nutrition service, we

observed several patients with clinically significant pre-admission weight loss who were not referred for nutritional intervention, several patients where earlier nutrition intervention could have been of benefit, and several where enteral instead of parenteral nutrition could more safely and inexpensively have been used. Early nutritional assessment at the time of initial medical or surgical assessment, or perhaps at the patient's own general practitioner's surgery, with the goal of preventing weight loss and further deterioration in nutrition status could prove to be a valuable contribution to a reduction in major, in particular infectious complications. If nutrition counselling is successful and nutritional status can be maintained, mortality rates could be reduced and clinical outcome improved. There is little information on the effects of such early pre-operative nutritional counselling on clinical outcome. Such a study could provide valuable evidence upon which nutrition protocols could be established.

With the current conflict in the surgical nutrition literature, it is more difficult to argue that all patients should have *early* post-operative nutritional intervention. However, where early support is provided there is adequate evidence that enteral feeding should be used in preference to parenteral.

A number of patients, particularly those with head and neck cancers, remained on enteral feeding after discharge from hospital. Several of these developed early metastases within the time frame of the study. Artificial feeding via percutaneous endoscopic gastrostomy remained an integral part of their terminal care. Although the results of a home programme of enteral tube feeding or parenteral nutrition in Italy among carefully selected cancer patients with grossly inadequate food intake, evidence of weight loss, and a life expectancy of more than six weeks did not show clear overall benefit (Pironi *et al.* 1997), nutritional support may benefit individual patients. It is certainly difficult to withdraw artificial nutrition support in a patient established on feeds, who, although they may be at the end stage of a terminal disease, remains able to enjoy some aspects of their life. Again, there is need for more studies looking at the benefits or lack of benefit in providing nutritional support after discharge to those patients with a terminal diagnosis.

5.8 Conclusions

The majority of surgical oncology patients admitted for resection are at nutritional risk with a number of nutritional variables being predictive of post-operative complications. However, only a small proportion are undernourished as defined by a BMI below 20 kg/m^2, although 37 % have lost more than 10 % of their normal body weight in the six months before admission to hospital. Although this degree of weight loss is known to affect clinical outcome, it did not result in automatic referral for nutritional intervention on admission (only in sixteen of twenty-one eligible patients). However, higher rates of referral by comparison with the literature (McWhirter & Pennington, 1994; Bruun *et al.* 1999) were observed with 31 (52.5 %) of patients receiving adequate nutritional intervention and an additional 13 (22 %) receiving some nutritional intervention during the hospital stay. As this was purely an observational study, it is difficult to determine whether earlier referral may have improved clinical outcome for some patients. Further randomised studies are required to determine the effects of nutritional intervention on clinical outcome on this and other groups of hospital inpatients. There is certainly some room for improvement in nutrition management as the majority of patients continued to lose both body weight and lean body mass to a significant extent in hospital and after discharge and to have continued functional deterioration. With our present state of knowledge, it is uncertain whether nutritional treatment alone will prevent this deterioration in physical state. Repletion of nutrients probably has to be accompanied by modification of the altered metabolic pathways that occur in patients with cancer (de Blaauw *et al.* 1997*a*). The future challenge may be to manipulate these pathways by pharmacological intervention and combine this with the specific nutritional therapy needed to redirect nutrients to the right organ at the right time (de Blaauw *et al.* 1997*b*). Although difficult to carry out in surgical patients as ill as those enrolled into our study, the effects of exercise and aerobic training on nutritional recovery and functional capacity should also be investigated, as short term aerobic training has been reported to have positive effects on these variables in elderly malnourished subjects (Bermon *et al.* 1997). Finally, further studies are required to determine the effects of nutritional assessment and intervention during the various stages of a patient's illness.

Chapter 6

Anthropometric survey of healthy elderly people in Dublin

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6.1 Summary

Anthropometric indices of fat and muscle are advocated as measures of nutritional status. However, the use of anthropometry in elderly populations is limited to relatively few studies so that comparative data are scarce. The usefulness of anthropometric indices as an accurate indicator of nutritional status in the clinical setting is dependent on the availability of current age and sex related data. It has therefore been suggested that local anthropometric data should be collected in healthy older age groups (World Health Organisation, 1995).

In a cross-sectional study of healthy Irish born people (*n* 874) recruited through activity groups for the active retired only 3 % had a BMI below 20 kg/m^2. One-third of people had a BMI between 20 - 25 kg/m^2 and approximately two-thirds (68.5 % of males and 61 % of females) were classified as overweight or obese. Almost one-fifth of the total group had a BMI over 30 kg/m^2 (17 % of men and 20 % of women). While almost three-quarters of elderly Irish men reported engaging in active leisure at least four times per week, only just over half of elderly Irish women did so, with 13 % reporting that they never took part in any active leisure activity. Similarly, fewer females than males reported high levels of physical activity, with only 13 % of females versus 24 % of males reporting high levels.

Height, weight, BMI and muscle reserves were observed to decrease with increasing age. The reduction in muscle size was associated with lower hand-grip strength. Fat reserves were observed to decline with age only in females. The Irish data recorded in this study resemble contemporary data from the UK and Edinburgh but are significantly different from the Welsh reference data currently being used for comparative purposes in clinical practice.

6.2 Introduction

Anthropometry in the elderly

Anthropometry is the single most universally applicable, inexpensive, and non-invasive method to assess the size, proportions, and composition of the human body (World Health Organisation, 1995). It has been widely and successfully applied to the assessment of health and nutritional risk, especially in children. However, it is only recently that there has been an attempt to provide guidance on the appropriate uses and interpretation of anthropometry in different population groups (World Health Organisation, 1995). In elderly people, physiological changes occur due to the ageing process. This means that the usual anthropometric assessment variables used in younger patients may not always be appropriate when assessing the nutritional status of the elderly (e.g. the re-distribution of body fat with age may make skinfold thickness measurements less valid in the elderly compared to younger persons (Taren & Schler, 1990)). Despite this, recent studies suggest that simple anthropometric measurements can be used to assess the nutritional status of elderly patients both in hospital and in the community (McWhirter & Pennington, 1994; Edington *et al.* 1996, 1997). To date, in the UK and Ireland, defining nutritional status has been generally based on comparison with reference data from either South Wales (65 years or over) (Burr & Phillips, 1984) or from the National Health and Nutrition Examination Survey (NHANES I) in the United States of America (for elderly aged 65 to 74 years) (Bishop *et al.* 1981; Grant *et al.* 1981).

The reference data compiled by Burr & Phillips (1984) includes body mass index, mid-arm circumference, arm-muscle circumference, arm muscle area and triceps skinfold thickness. The reference data based on NHANES I provides data for triceps skinfold thickness and mid-upper arm muscle circumference (Bishop *et al.* 1981) and for subscapular measurements (Grant *et al.* 1981).

A number of other authors have attempted to produce reference data for normal anthropometric nutritional indices in the elderly. However, the reference data produced

are not commonly used in Ireland. Data from both NHANES I and NHANES II were used to provide reference data for weight, triceps skinfold thickness, subscapular skinfold thickness and bone-free upper arm muscle area for Americans with small, medium and large frame sizes. Frame size was determined by elbow breadth (Frisancho, 1984). However, these data only apply to males from sixty-two to seventy-four years and to females from fifty-eight to seventy years and are therefore of limited use when assessing the nutritional status of those aged over seventy years. Normal values for upper arm anthropometry (triceps skinfold thickness, mid-upper arm circumference, mid-upper arm muscle circumference and mid-upper arm muscle area) for 746 white, non-institutionalised, ambulatory elderly Cinncinati Americans aged sixty to eighty-nine years have been compiled (Falciglia *et al.* 1988). Anthropometric indices of weight/stature^2 and mid-arm muscle area for 269 recumbent elderly white Americans (Chumlea *et al.* 1986) have also been developed. Estimation of body composition (body density, lean body weight and percentage body fat) in elderly Canadian white men (fifty-six to seventy years) from anthropometric measurements of height, weight, skinfold thicknesses (chest, mid-axillary, subscapula, supra-iliac, abdominal and thigh), body girths (neck, abdomen, hip, calf, forearm and thigh) and body diameters (knee, chest, biliac and bitrochanteric) has been reported (Latin *et al.* 1987). These measurements have been formatted into multiple regression equations used to predict body composition. Although these equations may be useful for detailed research on the body composition of elderly men, the number of measurements required limit their use in routine clinical practice. In the UK, anthropometric indices (triceps skinfold thickness, mid-arm circumference and arm muscle circumference) for 114 normal elderly individuals were compiled (McEvoy & James, 1982). More recently, normal values for weight, skeletal size and body mass index for 890 elderly aged sixty-five years and over have been reported (Lehmann *et al.* 1991). These values have been used for comparison with the hospitalised elderly in Ireland (Charles, 1998). Reference data from Northern Ireland (weight, height, body mass index and triceps skinfold thickness) for two hundred community dwelling elderly aged over ninety years have also recently been published (Rea *et al.* 1997).

The anthropometric reference data currently in routine use in Ireland were derived from measurements made in the early 1970s (Bishop *et al.* 1981; Burr &

Phillips, 1984). These measurements were taken over twenty-five years ago and are probably no longer appropriate to define the current nutritional status of the Irish population. The prevalence of obesity is known to be increasing worldwide in every age group (Prentice & Jebb, 1995; Jebb, 1999; Van Itallie, 1996; Galuska *et al.* 1996; Flegal *et al.* 1998). The paper of Rea *et al.* (1997), reported that the values for body mass index obtained were somewhat higher than those obtained by Burr & Phillips in 1984 for a comparable group of over eighty-five year old elderly individuals. This further supports the hypothesis that body composition has changed over the past twenty years and that the Welsh reference data used may not be appropriate to define current nutritional status. Unfortunately, as yet, there is no universally accepted 'gold standard' measurements for the elderly population. This may well be impossible, because population reference norms may differ between countries, both for young and elderly populations and make accurate comparisons impossible (World Health Organisation, 1995; Launer & Harris, 1996). If nutritional status is to be accurately defined using anthropometry, reference data for normal anthropometric values that are age, sex and population specific, must be developed.

The results of our initial study (see **Chapter 3**) which examined the prevalence of undernutrition among patients of all age groups on admission to hospital suggested that there were major body compositional differences between the current Irish population, the population of Dundee, and the American and Welsh reference data used. Our survey used the same anthropometric criteria to define undernutrition as was used in the large Scottish study (Mc Whirter & Pennington, 1994), carried out in Dundee. Using the same criteria, a second study (see **Chapter 5**) examining the nutritional status of Irish patients undergoing resection for major carcinoma (a group well-known to be at high nutritional risk for undernutrition) supported the hypothesis. The anthropometric criteria used could not identify undernutrition in these patients. Analysis of the elderly sub-group in the initial survey (*n* 218), provided further support for the hypothesis that the anthropometric criteria of McWhirter & Pennington with reference to the data of Burr & Phillips could not identify undernutrition in Irish patients.

As it was not possible for one researcher in the context of the current research project to establish reference data for all age groups in the Irish population, it was

decided greatest use would be made of anthropometric reference data for the elderly. This sub-group of the population is most likely to require monitoring of nutritional status, both in hospital and in the community.

In establishing these reference data, the recommendations made by the World Health Organisation (WHO) (1995) regarding the validity of anthropometric data sets in the elderly for use as references were followed. The WHO Expert Committee specified that data should be presented at the maximum by ten-year age groups and by sex; that means, standard deviations, and percentiles should be available for each anthropometric variable and age group and that data for people aged over eighty years should be included. Data from people in their sixties should not be extrapolated to those in their eighties. Moreover, the population sample should be free from major disabilities and living in a healthy environment, although it would be likely to contain some unhealthy individuals, since most elderly people probably have one or more disease conditions. It is recognised that the definition of health used to select the sample has a major influence on the reference data. The high prevalence of disease in the elderly means that very few are completely free of disease. There may also be significant cohort effects; the elderly of today grew up under quite different conditions from those who will be elderly in twenty or forty years time.

Demographic trends in the elderly

According to the higher of two official projections, between 1991 and 2011 the number of people aged over sixty-five years may increase by slightly over 20 % (Organisation for Economic Co-operation and Development, 1999). This would raise the proportion of old people in the population to 13.6 % in 2011 from 11.4 % in 1991. The lower projection would put the proportion at 12.5 % of the total population by the same time. Life expectancy, at birth, in Ireland was 72.7 years for men and 78.2 years for women in 1993, an increase of eleven years for women and nine years for men since 1950. By age sixty-five, average life expectancy is the lowest in the European Union (EU), due mainly to the high prevalence of cardiovascular disease and cancer which each account for approximately one-quarter of all deaths, with incidence rates being substantially above the EU average (Cardiovascular Health Strategy Group, 1999;

British Heart Foundation, 2000). The health disadvantage is, therefore, very much concentrated on the elderly.

Analysis of data on hospital admissions to St. James's and the Meath hospitals showed that 35 - 40 % of current admissions to hospital are aged sixty-five years or more (Hospital In-patient Enquiry, 1995). It is likely, that, as the proportion of elderly in the population increases, the proportion of the hospital population aged over sixty-five years will also increase, although the negative impact on health needs arising from ageing may be offset to a certain extent by the improved average health status of elderly people.

National organisations of older people in Ireland

Over 15,000 people retire in Ireland each year (Age & Opportunity, 1998). Only 3 % attend a retirement preparation course. Retirement presents people with up to 2,000 extra hours a year. As people live longer and retire earlier, life after work is becoming as long as life in work. Many studies (Khaw, 1997) report that continuing mental and physical activity is related to continuing good health. In Ireland, over 90 % of older people live in their own homes and most wish to remain there. However, many join active retirement groups for the stimulation and companionship they provide. The following groups were contacted to establish access to their members (see **Appendix 13**). No group allowed direct access to their members.

Age Action Ireland Limited

This organisation aims to improve the quality of life of older people, especially those who are most vulnerable and frail. The organisation acts as a network of service providers and produces a monthly news bulletin including a calendar of events.

Age and Opportunity

This is a national agency set up to change attitudes to older people. it continually monitors the media and attempts to check negative representations of older people and ageing. It maintains a specialist library collection on the topic of changing attitudes. Age and Opportunity works closely with the media and provides a photographic resource which represents older people in a non-stereotypical way. Projects currently underway in Age and Opportunity include 'Go For Life' (sport), Bealtaine (arts), the 'Older Women's Network' and the 'European Challenging Attitudes Network'.

Bowling League Of Ireland

The Bowling League of Ireland was instituted in 1927. It aims to promote, foster and regulate the game of Bowls in the Republic of Ireland in affiliation with the Irish Bowling Association.

Both the Irish Bowling Association and the Bowling League of Ireland organise indoor and outdoor Bowls. The Bowling League of Ireland runs a Veterans League confined to members over sixty years old on April 1st of the particular year.

Irish Bowling Association

The Irish Bowling Association was instituted in 1904. It aims to promote, foster and regulate the game of Bowls in Ireland.

Federation of Active Retirement Associations (FARA)

There are more than one hundred active retirement associations in Ireland offering companionship and activities to members. These include language teaching, arts, crafts, physical exercise classes and sports, such as, indoor and outdoor bowls, table tennis and golf. There are approximately 10,000 members in FARA and they also produce a monthly news bulletin.

Irish Association of Older People

This association provides information, promotes and encourages activities which improve the lives of older people.

Irish Senior Citizens National Parliament

This was established in 1995 to represent the interests of older people to the Government.

League of Health of Ireland

The Women's League of Health and Beauty was established by an Irish woman, Mrs. Bagot Stack, in 1930 in Great Britain. In 1934, it was brought to Ireland by Kathleen O'Rourke. The League of Health in Ireland is affiliated to the parent organisation in Great Britain and has thousands of members throughout the United Kingdom, Canada, New Zealand, South Africa, Zimbabwe, Pakistan, Holland and Ireland. It aims to teach simple exercises to music and works in close co-operation with the medical and paramedical professions. An extension of the League in Ireland is EXTEND. This offers a specially adapted system of recreational movement to music to help retired men and women and less able people of any age towards a healthier, happier, more fulfilled life by reducing stiffness, sluggishness, isolation and loneliness. Most EXTEND teachers are paramedicals, nurses or physical educationalists and also teach in hospitals, homes and day centres for the elderly. Much of the money received from holding classes is donated to charity, with over £37,000 being donated in recent years.

National Council on Ageing and Older People

This is a statutory organisation which advises the Minister for Health and Children on all aspects of the welfare of older people, either on its own initiative or at the request of the Minister. It produces research documents and fact sheets on ageing and older people in Ireland.

National Federation of Pensioner's Associations

This is an umbrella group for pensioner associations throughout Ireland which aims to protect and promote the interests of pensioners and retired persons in regard to social welfare, taxation, health and superannuation.

Retired Workers Committee (Irish Congress of Trade Unions)

This is a representative group for over eighty Retired Workers Committees of unions affiliated to the Irish Congress of Trade Unions (see **Appendix 14**).

Older Women's Network (OWN)

This is a European network which promotes the sharing of skills and knowledge of older women across Europe. It aims to challenge negative stereotypes of age, gender, race, disability and sexuality and to promote the rights of older women. The Irish Network also tackles policy issues relating to pensions, housing, health and continuing education.

Probus

This is an organisation for retired business and professional people. It is under the umbrella of the Rotary Club of Ireland and has more than fifty-nine groups, both in the Republic and in Northern Ireland.

6.3 Aims and Objectives

The aims and objectives of this study were to characterise the current nutritional status of healthy elderly Irish people and to use this information to provide reference data on healthy Irish elderly people. This data could then be used to evaluate the nutritional status of elderly Irish people and would allow for more accurate interpretation of the nutritional status of the sick elderly whether they are in hospital, institutionalised or attending their general practitioner. The data would also allow for comparisons with data from other countries.

6.4 Subjects and methods

Patient Selection

This survey was carried out in the greater Dublin area. Anthropometric measurements and hand grip strengths of 874 healthy Irish adults, aged sixty-five years or more, were recorded in this cross-sectional study. All subjects (598 women and 276 men) were recruited through activity groups for the active retired. Subjects were recruited between June 1998 and February 1999. The individual groups were contacted by their parent organisations who provided the local organiser with contact details of the research dietitian. A visit to the group was then set up, often in combination with a short talk on 'Healthy Eating for the Older Person'. All individuals present on the day aged sixty-five years and over who reported themselves as healthy were asked by the group organiser to participate in the survey. All who volunteered were measured by the research dietitian. By including only subjects who were community-living, mentally competent and apparently healthy, it was hoped to provide reference values from a group who were nutritionally 'elite' and as free from illness as possible. **Table 6.1** shows the number and percentage of subjects from each recruitment group. Although we cannot definitively state that the anthropometric characteristics of this group of elderly people are representative of Ireland as a whole, no significant differences were observed between our data and that recently reported for the free-living elderly by the

National Diet and Nutrition Survey in the UK (Finch *et al.* 1998) (see **Table 6.2**). The UK survey was carried out on a nationally representative sample of people aged sixty-five years and over. This would encourage us to think that our data is valid for national use. The proportion of participants aged over sixty-five years who *reported* themselves as overweight or obese is substantially lower in the National Health and Lifestyles Survey (SLAN) at 45 % (Rossnagel *et al.* 2000). This, however, may be due to subjects reporting lower weight and or greater height or a combination of both these factors. Ten per cent of the SLAN survey participants were invited to attend a clinical examination where height and weight were measured. The results of the clinical examination are not yet available but it will be interesting to observe whether the proportion of elderly who are overweight or obese based on BMI calculated from measured heights and weights is different to that based on reported heights and weights.

At one event, the Senior Games Festival, three extra research dietitians were trained by the author (C. Corish) and helped with height, weight, circumference and hand-grip measurements, and completion of subjects' details. All measurements were carried out according to the same protocol. However, as greater discrepancy can occur with the measurement of skinfold thickness (World Health Organisation, 1995), all skinfold thickness measurements were carried out by the author (C. Corish).

Ethical approval was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals (see **Appendix 2**).

Inclusion criteria

All subjects who were actively involved in an active retirement group were included. Only subjects who volunteered for the survey were included. All participants reported themselves to be healthy. However, no independent verification of their health status was attempted.

Exclusion criteria

Subjects who had an amputated limb were excluded. Subjects who reported arthritis of the hand were excluded from the hand grip measurements. Subjects who had protruding varicose veins or who needed to wear support stockings were excluded from the calf measurements. No attempt was made to exclude subjects taking medications, smokers or those with specific medical conditions (e.g. diabetes mellitus) who reported themselves as healthy.

A total of 874 subjects (276 men and 598 women) had height measured. One woman was not weighed. Body mass index was calculated for all those with height and weight measurements (*n* 873). Mid-arm circumference and triceps skinfold thickness was measured in all subjects and mid-arm muscle circumference and arm muscle area calculated. Right calf circumference was measured in 860 subjects (274 men and 586 women) while left calf circumference was measured in 859 subjects (272 men and 587 women). Hand-grip dynamometry was recorded in 856 subjects (273 men and 583 women).

Study Design

This study was a cross-sectional study designed to provide reference data on a group of healthy elderly Irish people. This reference data could then be used to evaluate the nutritional status of sub-groups within the elderly Irish population (e.g. hospitalised elderly, elderly patients in institutions and elderly patients attending their general practitioner).

Each participant was seen on one occasion only. Anthropometric and functional measurements were made. Age and sex were noted. All subjects were questioned regarding previous occupation, level of physical activity and amount of time spent in active leisure per week.

Table 6.1. Number of subjects from each recruitment group (*n* 874).

Recruitment group	Location	Number recruited (*n* 874)	% total (*n*)
Active Retirement Association			44 (*n* 387)
	AALSA	13	
	Blackrock	20	
	Bonneybrook	15	
	Donnaghmede	13	
	Donneycarney	26	
	Foxrock	15	
	Glasnevin	17	
	Guinness	23	
	Inchicore	9	
	Kilbarrack	28	
	Killester	30	
	Killiney	38	
	Kilmacud	14	
	Kimmage Manor	16	
	Malahide	25	
	Mount Argus	19	
	Rathgar	20	
	Ringsend	19	
	Summerhill	27	
Probus			8 (*n* 68)
	Blackrock	16	
	Greystones	17	
	Malahide	16	
	Rathgar (Viking)	19	
Senior Citizens			
	Glasnevin	14	4 (*n* 34)
	Mount Argus	14	
	Macushla	6	
Bowls			
	Blackrock	22	10 (*n* 88)
	Greenhills	10	
	Guinness	11	
	Greystones	5	
	IERNE	21	
	Skerries	11	
	St. Brendan's	8	
League of Health			8 (*n* 68)
	Greystones	13	
	Monkstown	16	
	Mount Merrion	16	
	Taney	23	
Holy Ghost Fathers			3 (*n* 24)
	Blackrock	6	
	Kimmage Manor	18	
Miscellaneous			
	Dun Laoighaire EHB class	10	24 (*n* 207)
	Sandymount swimming pool	16	
	Santry Senior Games	179	
	Relatives	2	

EHB, Eastern health Board

Table 6.2. Current Irish and UK* anthropometric data for persons aged sixty-five years or more

	Males		Females	
Anthropometric variable	Irish (*n* 276)	UK (*n* 539)	Irish (*n* 598)	UK (*n* 513)
Height (m)	1.70	1.70	1.56	1.56
Weight (kg)	77.7	76.5	65.1	64.9
Body mass index (kg / m2)	26.8	26.5	26.7	26.8
Mid-arm circumference (cm)	29.5	30.4	29.2	29.7

Values are means.
*Finch *et al.* 1998, free-living group.

Anthropometric Measurements

The anthropometric measurements included weight, height, mid-arm circumference, triceps skinfold thickness. Body mass index (weight (kg)/(height $(m)^2$) was calculated and was used to grade patients into normal weight, overweight and obese. A body mass index below 18.5 kg/m^2 indicated undernutrition, a BMI of 18.5 - 25.9 kg/m^2 normal weight, a BMI of 25 - 29.9 kg/m^2 overweight, a BMI of 30 kg/m^2 or more obesity and a BMI of 40 kg/m^2 or more morbid obesity. All anthropometric measurements were carried out according to standard techniques (World Health Organisation, 1995) as described in **Chapter 2.**

The values obtained were compared with American published reference tables (Bishop *et al.* 1981) for those aged sixty-five to seventy-four years and to Welsh reference data for those age sixty-five years and over (Burr & Phillips, 1984).

Functional measurements

Functional status was measured with a hand grip dynamometer (Takai Scientific Instruments Ltd., Japan). The highest of three readings made with the non-dominant arm was used.

Physical exercise

All participants were questioned regarding physical activity. Up to three different responses were allowed per person. Individuals were classified as being low, moderate or highly active. Low activity was defined as spending most of the day sitting, watching television, writing, reading, knitting or computer work. Medium activity was defined as spending most of the day walking, washing the car, housework and gardening. High activity was defined as spending most of the day engaged in playing sports, cycling, swimming, keep fit and walking the dog.

All participants were also questioned regarding the number of times spent in active leisure of at least twenty minutes per week. Active leisure was defined as

mowing the lawn, cleaning windows, brisk walking, jogging, cycling, swimming, dancing and playing sports. Up to five different responses were allowed per person. The responses classified people as taking active leisure four or more time weekly, two to three times weekly, once weekly, less than once weekly and never.

Socio-economic status

The socio-economic status of each participant was based on their former occupation if they were male or an unmarried female. If the female had worked outside the home during her life she was questioned as to the occupation of her husband. Socio-economic status was based on the occupation of the head of the household. Women who had never worked outside the home were classified according to the socio-economic group of their husband. Details of the method of socio-economic classification are given in **Chapter 2** and **Appendix 9.**

A copy of the data collection form can be seen in **Appendix 10**.

6.5 Statistical analysis

All recorded measurements were entered into the Statistical Package for the Social Sciences for Windows version 6.0.1 (SPSS for Windows) (SPSS Inc., Chicago) and statistical analysis was carried out using this package. Analysis of variance was used to test for the proportion of overweight or obesity in each age and sex group. An independent sample *t* test was used to test for differences between the oldest and the youngest age groups. Independent sample *t* tests were used to test for differences in mean body mass index, muscle and fat stores between the Dublin patients and published data from Edinburgh (Bannerman *et al.* 1997) and South Wales (Burr & Phillips, 1984). Spearman's correlation was calculated to test the association between arm and calf muscle circumferences and between triceps and subscapular skinfold measurements. P values of less than 0.05 were considered to indicate statistical significance.

6.6 Results

Patient details

A total of 874 healthy Irish elderly were recruited into the study, 598 females and 276 males. The age range of the participants was 65 to 92 years, mean age 72.5 (SD 5.4) years. The numbers and proportion of the total for each age and gender group are given in **Table 6.3**. Although many subjects had a history of some ailment, all reported themselves as being of good health at the time of participation in the study.

Socio-economic status

The socio-economic status of survey participants and of the elderly Irish population from the 1996 census (Central Statistics Office, 1996) is summarised in **Table 6.4**. Unfortunately, it was not possible for the purposes of this study to obtain detailed information on the socio-economic status of the elderly living in Dublin or to obtain a breakdown of the national data by gender. This data should be sought in the future as it is unlikely that data on the Irish population reflects that of the Dublin population. We know from the 1996 National Census of Ireland (Central Statistics Office, 1997) that people aged sixty-five years and over account for 11 % of the total population of the State. However, there are more older people in the rural areas than in urban locations. The 65+ age group account for 10 % of the urban population (defined as all towns of 1500 and over) but 13 % of the rural population (the remainder). It is likely that the socio-economic breakdown is quite different in urban and rural areas. From the 1996 census we also know that the towns of Malahide and Greystones occupied the two top positions in each of the socio-economic groups, employers and managers and higher professionals(Central Statistics Office, 1999). In our survey, almost 9 % of participants were from these two towns. However, overall the data would appear to be nationally representative as when sub-divided into higher and lower socio-economic groups, 41 % percent of our survey participants were from the higher, and 59 % from the lower socio-economic groups. The corresponding national figures from the 1996 census are 37.2 % from the higher and 62.8 % from the lower socio-economic

groups. However, the proportion recruited from the higher socio-economic groups was higher, and that from the lower socio-economic groups lower, than the proportions in the elderly group admitted to hospital (*n* 218) in the first survey (see **Chapter 3**) (24 % higher socio-economic groups, 76 % lower socio-economic groups).

Physical activity

The levels of physical activity claimed by all respondents can be seen in **Table 6.5**. A total of 88 % of both sexes claimed to have a moderate to high level of physical activity.

Active leisure

The numbers and proportion of both sexes engaged in active leisure of at least twenty minutes duration can also be seen in **Table 6.5**. Of elderly males, 73 %, and of elderly females, 54 %, reported spending at least twenty minutes engaged in active leisure activities four or more times weekly.

Anthropometric measurements

With the exception of triceps skinfold measurements in males, the distributions of the anthropometric indices followed the Normal (Gaussian) distribution. After logarithmic transformation, the distribution of triceps skinfold measurements in males also followed the Normal distribution. The mean values with standard deviations and the percentile values for all anthropometric variables are shown in **Tables 6.6** to **6.14**.

Table 6.15 shows the mean height and weight for each age and sex group. The mean BMI in males was 26.8 kg/m^2 and in females 26.7 kg/m^2. Using the classification of normal body mass index as 18.5 - 24.9 kg/m^2, no males and only five (0.8 %) females could be considered undernourished. Only 31.5 % of males and 38 % of females had a normal BMI, although 68.5 % of males and 61 % of females were either overweight or obese. **Figures 6.1** and **6.2** show the percentage distribution of BMI in males and in females aged sixty-five years and over. **Figures 6.3** to **6.14** show the percentage

distribution of BMI for each age and sex group. The number of overweight or obese subjects was high at all ages; the proportion overweight or obese did not significantly differ between the age categories, although a trend (P = 0.08) towards a smaller proportion of overweight and obese in the oldest compared to the youngest age group was observed. BMI declined significantly with increasing age in both men ($P < 0.05$) and women ($P < 0.001$). This could not be attributed to a decrease in height without a reduction in weight as both decreased significantly ($P < 0.01$) with increasing age.

Higher BMI was associated with reported lower levels of physical activity (r = 0.14, $P < 0.01$), fewer occasions of active leisure (r = 0.19, $P < 0.01$) and lower socio-economic group (r = 0.10, $P < 0.05$). Although fat and muscle reserves appeared to decline with increasing age, the reduction in fat mass (calculated from triceps skinfold thickness) was significant only in females ($P < 0.01$). Mid-arm muscle circumference and calf circumferences (left and right) declined significantly ($P < 0.01$) with increasing age in both sexes. In all subjects, weight correlated with height (r = 0.56; $P < 0.01$).

Functional measurements

The mean hand grip strength was 30.4 kg in males and 17.3 kg in females. Reduction in muscle size was accompanied by a significant (r = 0.58, $P < 0.01$) reduction in hand-grip strength. The mean values with standard deviations and the percentile values for hand-grip strength are shown in **Table 6.16**. The lower limits of grip strength, 85 % of the standard value for age and sex are shown in **Table 6.17**. The standard is taken as the median value as recommended by Cole, 1993. The mean values for hand-grip dynamometry were significantly lower ($P < 0.01$) in the Irish group when compared with the UK data (males, 30.4 kg versus 34.8 kg; females, 17.3 kg versus 20.0 kg).

Table 6.3. Number and proportion of subjects recruited in each age and gender group

	Males	Females
	n 276 (%)	*n* 598 (%)
65 - 69 years	96 (35)	195 (33)
70 - 74 years	85 (31)	215 (36)
75 - 79 years	51 (18)	120 (20)
80 + years	44 (16)	68 (11)

Table 6.4. Socio-economic status of survey participants and of those aged 65 years and over in the Irish population (Central Statistics Office, 1996)

Socio-economic	Irish population *n* 413,882		Survey population *n* 874	
group*	*n*	(%)	*n*	(%)
0	72,407	17.4	36	4.1
1	13,058	3.2	10	1.1
2	12,790	3.1	94	10.8
3	23,187	5.6	62	7.1
4	30,431	7.4	36	4.1
5	15,140	3.7	59	6.8
6 and 7**	44,240	10.6	120	32.8
8	37,773	9.1	158	18.1
9	26,313	6.4	52	5.9
10	34,995	8.5	12	1.4
11†	103,548	25	0	0

* see **Appendix 9.**

**the method of classification from the 1986 census was used to categorise subjects in the surveys carried out for this thesis; this method was refined for the 1996 National Census of Ireland so that groups 6 and 7 in the 1986 census (i.e. 6: intermediate non-manual workers and, 7: other non-manual workers, are now categorised together as non-manual workers).

†No subject fell into this category i.e. gainfully employed but occupation not stated.

Table 6.5. Levels of physical activity and active leisure in the Irish elderly

		Males (*n* 276)	Females (*n* 598)	Total (*n* 874)
Physical activity	Low	12	12	12
	Medium	64	75	69.5
	High	24	13	18.5
Active leisure (*20 minutes weekly*)	4 or more times	72.5	54	63
	2 - 3 times	19	24	21.5
	once	1	8	4.5
	less than once	0.5	1	0.7
	never	7	13	10

Values are percentages of *n*

Table 6.6. Percentiles for weight for adults aged 65 years and over (kg)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	79.3 (11.3)	58.8	67.0	68.3	70.9	80.0	85.8	91.5	97.0
70-74	85	78.1 (11.4)	58.6	61.1	66.8	70.3	77.0	86.6	92.8	99.1
75-79	51	78.6 (11.3)	58.1	66.8	67.8	71.1	77.8	86.0	94.4	98.8
80-84	38	72.6 (10.8)	55.8	57.6	62.6	65.3	71.6	79.9	85.8	88.5
80+	44	72.6 (11.2)	55.9	57.6	60.7	65.2	71.6	80.3	86.4	92.6
85+	6	72.5 (14.7)	57.3	57.3	57.3	57.9	72	84.5		
Women										
65-69	195	67.6 (10.5)	51.7	55.5	57.4	59.2	66.7	74.5	81.3	85.1
70-74	214	64.8 (10.7)	48.3	52.0	54.1	57.3	64.0	71.3	79.4	84.0
75-79	120	64.6 (10.9)	47.5	51.3	53.1	56.4	64.2	71.7	79.1	86.5
80-84	57	60.2 (9.8)	44.1	46.8	50.2	53.7	58.7	65.9	73.6	80.7
80+	68	59.8 (9.7)	44.1	46.9	50.4	53.3	59.4	65.7	72.3	79.8
85+	11	57.9 (9.0)	38.0	40.5	47.8	51.6	59.4	61.8	71.0	

Table 6.7. Percentiles for height for adults aged 65 years and over (cm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	171 (6.8)	159	162	164	166	172	176	180	183
70-74	85	170 (5.8)	160	163	164	165	170	175	179	180
75-79	51	170 (6.8)	160	162	164	166	170	174	181	183
80-84	38	167 (7.0)	154	159	161	164	167	171	175	180
80+	44	168 (6.7)	155	160	163	164	167	171	175	178
85+	6	169 (4.3)	163	163	163	165	168	172		
Women										
65-69	195	157 (5.9)	147	149	150	153	157	161	165	166
70-74	215	157 (5.3)	149	150	151	153	156	161	165	166
75-79	120	155 (6.1)	146	147	149	151	155	160	164	165
80-84	57	153 (5.2)	144	148	149	150	153	156	162	163
80+	68	153 (5.7)	144	147	149	150	153	156	162	164
85+	11	153 (8.1)	138	139	143	150	151	158	165	

Table 6.8. Percentiles for body mass index for adults aged 65 years and over (kg / m^2)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	27.0 (3.5)	21.4	22.6	23.4	24.8	26.6	29.0	30.5	33.1
70-74	85	26.9 (3.6)	21.5	22.3	23.1	23.9	26.7	29.7	31.4	32.9
75-79	51	27.1 (3.4)	21.2	22.4	23.6	24.7	27.1	29.0	32.4	33.7
80-84	38	25.9 (3.2)	21.0	21.9	22.1	23.5	25.7	27.7	30.8	32.2
80+	44	25.8 (3.3)	21.0	21.5	22.0	23.3	25.7	27.8	30.7	32.1
85+	6	25.3 (3.9)	21.0	21.0	21.1	21.4	25.3	28.7		
Women										
65-69	195	27.6 (4.4)	21.3	22.7	23.6	24.6	26.6	30.4	33.2	36.1
70-74	214	26.3 (4.2)	20.0	21.3	22.0	23.1	26.2	28.8	31.8	34.0
75-79	120	26.8 (4.3)	21.0	21.7	22.3	23.6	26.4	29.3	32.6	34.6
80-84	57	25.6 (4.2)	18.9	21.0	22.0	22.8	25.4	27.6	31.4	34.7
80+	68	25.5 (4.3)	18.2	20.1	22.0	22.7	25.4	27.7	31.1	33.8
85+	11	25.0 (4.9)	15.2	15.8	17.8	22.0	26.1	28.3	31.1	

Table 6.9. Percentiles for mid-arm circumference for adults aged 65 years and over (mm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	300 (23.5)	258	271	279	284	301	315	328	343
70-74	85	298 (28.2)	249	264	268	280	296	313	338	352
75-79	51	295 (22.0)	246	262	276	284	292	310	321	330
80-84	38	279 (22.8)	240	246	257	262	280	296	312	321
80+	44	278 (23.7)	236	241	254	260	280	297	309	319
85+	6	270 (30.3)	234	234	234	239	273	300		
Women										
65-69	195	302 (32.9)	249	260	268	280	298	322	344	356
70-74	215	291 (34.0)	243	247	255	267	286	314	335	352
75-79	120	290 (34.0)	243	250	256	270	288	306	330	351
80-84	57	275 (32.5)	215	226	235	254	279	295	316	327
80+	68	274 (34.0)	211	224	233	256	280	296	316	325
85+	11	269 (42.4)	181	186	199	257	281	296	317	

Table 6.10. Percentiles for mid-arm muscle circumference for adults aged 65 years and over (mm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	264 (19.7)	231	240	244	251	265	276	287	298
70-74	85	259 (20.0)	222	234	242	245	257	272	285	296
75-79	51	258 (17.0)	224	229	240	248	259	271	280	284
80-84	38	247 (19.1)	210	220	224	231	250	260	270	283
80+	44	245 (20.5)	209	218	220	231	249	260	270	280
85+	6	234 (27.0)	198	198	199	212	232	260		
Women										
65-69	195	230 (22.9)	195	204	207	213	228	244	258	269
70-74	215	226 (23.2)	195	199	201	208	223	240	260	267
75-79	120	230 (22.3)	195	204	208	214	227	241	261	269
80-84	57	217 (22.6)	180	183	189	199	218	234	248	258
80+	68	216 (23.8)	179	182	187	197	219	233	248	259
85+	11	215 (30.5)	151	158	176	188	222	229	257	

Table 6.11. Percentiles for arm muscle area for adults aged 65 years and over (mm^2)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	5590 (834)	4235	4587	4758	5022	5594	6082	6566	7056
70-74	85	5375 (836)	3924	4950	4651	4782	5268	5903	6487	6955
75-79	51	5327 (692)	4003	4183	4586	4893	5359	5862	6272	6417
80-84	38	4880 (749)	3511	3837	4003	4266	4988	5397	5818	6388
80+	44	4817 (792)	3482	3774	3836	4259	4956	5377	5796	6244
85+	6	4419 (1012)	3129	3129	3159	3579	4309	5420		
Women										
65-69	195	4249 (848)	3018	3307	3418	3631	4160	4750	5320	5752
70-74	215	4119 (857)	3031	3148	3234	3447	3974	4596	5382	5688
75-79	120	4246 (842)	3030	3300	3453	3634	4102	4621	5433	5776
80-84	57	3779 (781)	2591	2672	2833	3147	3798	4345	4904	5281
80+	68	3773 (812)	2564	2636	2788	3095	3817	4318	4885	5328
85+	11	3739 (999)	1827	1989	2476	2818	3923	4166	5275	

Table 6.12. Percentiles for triceps skinfold thickness for adults aged 65 years and over (mm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	11.4 (3.1)	6.7	8.0	8.7	9.4	11.0	13.1	15.7	16.9
70-74	85	12.3 (4.4)	6.0	7.6	8.2	9.0	12.0	14.5	18.1	20.4
75-79	51	11.8 (4.4)	5.7	7.1	7.4	8.5	11.2	13.9	17.1	20.4
80-84	38	10.2 (3.0)	5.4	6.2	6.9	8.2	10.2	11.9	16.1	16.7
80+	44	10.4 (3.1)	5.5	5.9	6.9	8.2	10.3	12.1	16.3	16.7
85+	6	5.6 (4.0)	5.6	5.6	5.8	8.7	11.3	14.4		
Women										
65-69	195	22.9 (6.4)	13.7	14.7	16.7	18.5	22.5	27.0	30.7	33.1
70-74	215	20.6 (6.0)	12.1	13.4	14.3	16.0	19.8	24.7	28.8	30.8
75-79	120	19.2 (5.9)	10.5	12.2	13.2	15.4	18.3	22.3	28.0	31.4
80-84	57	18.5 (5.7)	9.4	10.9	12.9	14.7	18.2	21.7	26.0	32.0
80+	68	18.3 (5.7)	9.3	10.4	12.7	14.6	18.5	21.6	25.1	30.3
85+	11	17.3 (5.6)	7.0	7.5	8.9	12.7	18.8	21.7	24.4	

Table 6.13. Percentiles for left calf circumference for adults aged 65 years and over (mm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	367 (25.2)	320	332	343	349	368	382	402	409
70-74	82	363 (25.4)	324	333	337	344	360	381	395	414
75-79	50	362 (29.3)	315	325	330	341	359	382	399	415
80-84	38	349 (28.6)	299	307	322	332	352	365	385	412
80+	44	349 (30.6)	300	308	320	331	350	370	394	412
85+	6	350 (44.5)	308	308	308	311	335	402		
Women										
65-69	191	355 (29.0)	314	323	327	337	352	371	394	408
70-74	211	348 (30.1)	302	311	316	326	347	367	392	401
75-79	118	348 (29.8)	306	315	319	325	346	369	382	400
80-84	56	339 (25.4)	296	304	313	317	341	356	370	382
80+	67	337 (27.7)	287	301	312	319	340	356	374	380
85+	11	330 (37.8)	258	261	271	321	328	361	377	

Table 6.14. Percentiles for right calf circumference for adults aged 65 years and over (mm)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	95	370 (26.3)	324	336	340	352	373	385	404	412
70-74	84	367 (28.0)	325	332	339	346	363	385	407	418
75-79	51	365 (26.5)	321	333	334	342	361	386	404	409
80-84	38	351 (28.6)	296	312	321	334	352	374	384	411
80+	44	351 (31.0)	300	312	320	331	351	375	395	413
85+	6	352 (47.2)	311	311	311	318	328	408		
Women										
65-69	192	354 (30.7)	310	320	324	334	352	373	392	405
70-74	211	348 (30.5)	304	311	316	326	347	365	388	405
75-79	117	347 (30.4)	304	311	317	325	346	365	388	402
80-84	55	338 (25.4)	296	305	310	322	337	355	374	388
80+	66	336 (26.9)	288	302	309	322	337	355	374	385
85+	11	330 (34.6)	256	263	282	321	337	348	377	

Table 6.15. Mean height and weight for adults aged 65 years and over

	Age (years)											
	65-69		70-74		75-79		80-84		80+		85+	
	M	F	M	F	M	F	M	F	M	F	M	F
	(*n* 96)	(*n* 195)	(*n* 85)	(*n* 214)	(*n* 51)	(*n* 120)	(*n* 38)	(*n* 57)	(*n* 44)	(*n* 68)	(*n* 6)	(*n* 11)
Mean height (cm)	171	157	170	157	170	155	167	153	168	153	169	153
Mean weight (kg)	79.3	67.6	78.1	64.8	78.6	64.6	72.6	60.2	72.6	59.8	72.5	57.9

M, male; F, female

Table 6.16. Percentiles for hand-grip dynamometry for adults aged 65 years and over (kg)

Age group (years)	*n*	Mean (SD)	Percentiles							
			5th	10th	15th	25th	50th	75th	90th	95th
Men										
65-69	96	33.4 (6.1)	23.4	25.1	26.9	29.0	34.0	38.1	41.1	42.3
70-74	84	29.9 (6.1)	20.4	21.8	23.2	25.6	30.1	33.4	38.6	39.3
75-79	49	29.7 (6.7)	20.1	22.2	22.9	25.2	28.5	35.1	40.1	41.3
80-84	38	26.0 (7.1)	12.4	14.5	19.1	22.7	25.1	30.8	35.7	41.1
80+	44	25.5 (7.2)	11.8	14.3	19.0	20.8	25.1	29.9	35.3	40.0
85+	6	22.0 (6.9)	11.1	11.1	11.6	17.9	20.9	29.4		
Women										
65-69	191	19.0 (3.9)	11.9	13.7	15.3	16.2	18.9	21.9	24.0	25.6
70-74	211	17.6 (4.3)	10.1	11.9	13.3	15.0	17.4	20.5	23.5	25.1
75-79	116	16.3 (3.7)	10.3	11.8	12.5	13.9	16.1	18.8	20.9	23.6
80-84	55	13.5 (3.6)	7.7	8.4	9.7	10.8	13.5	16.2	18.7	19.5
80+	65	13.4 (3.6)	7.7	8.2	8.5	10.8	13.5	16.1	18.3	19.4
85+	10	12.9 (3.5)	7.9	7.9	8.0	8.2	14.1	15.4	16.9	

Table 6.17. Lower limits of hand-grip strength (85 % of Irish reference data)

Lower limits of hand-grip strength*		
Age (years)	Female hand-grip strength (kg)	Male grip strength (kg)
65-69	16.1	28.9
70-74	14.8	25.6
75-79	13.6	24.2
80-84	11.5	21.3
80+	11.5	21.3
85+	12.0	17.7

*85 % age-sex Irish reference data

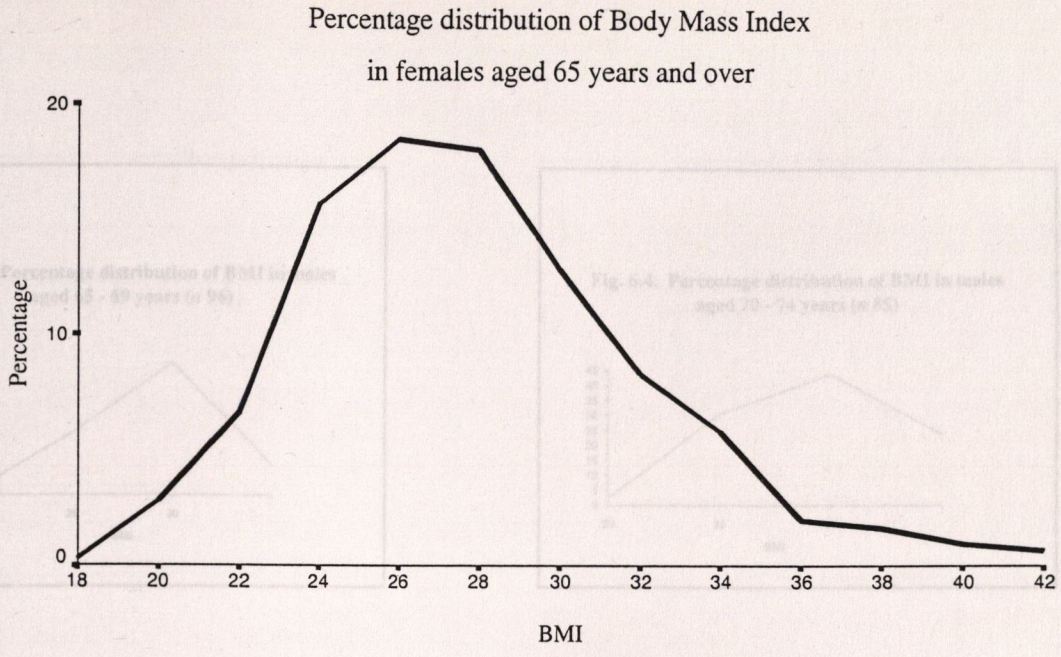


Fig. 6.1. Percentage distribution of Body Mass Index in females aged 65 years and over

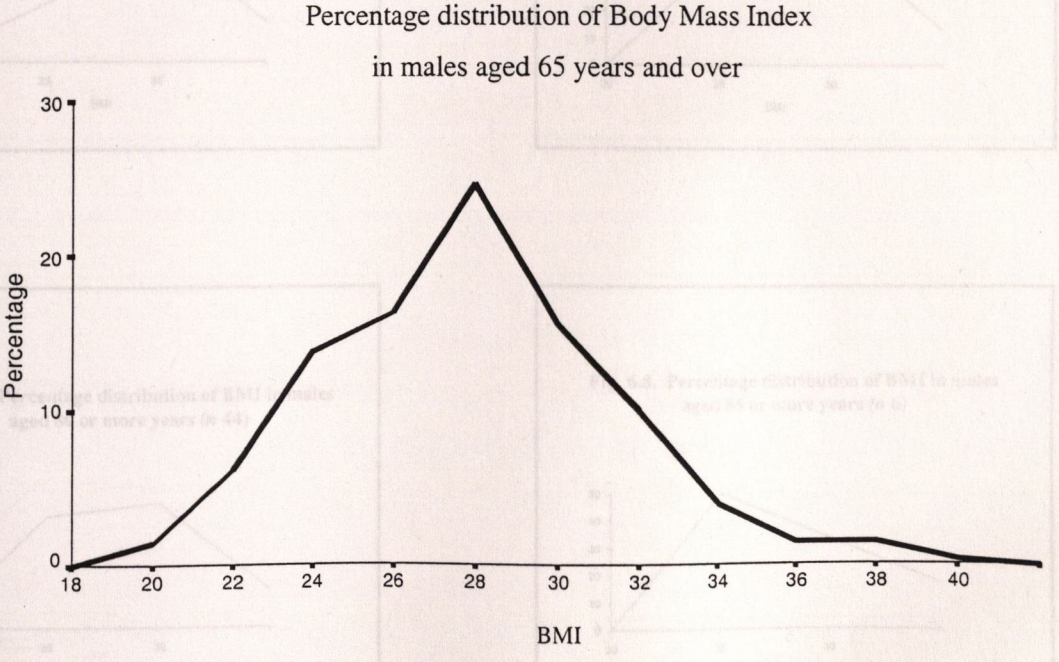


Fig. 6.2. Percentage distribution of Body Mass Index in males aged 65 years and over

Fig. 6.3. Percentage distribution of BMI in males aged 65 - 69 years (*n* 96)

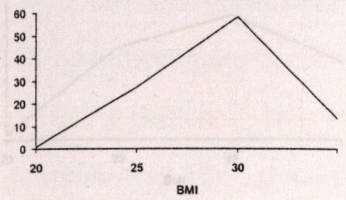


Fig. 6.4. Percentage distribution of BMI in males aged 70 - 74 years (*n* 85)

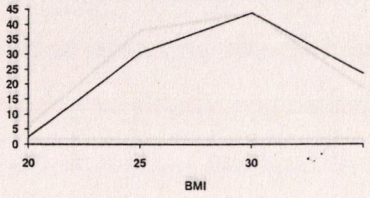


Fig.6.5. Percentage distribution of BMI in males aged 75 - 79 years (*n* 51)

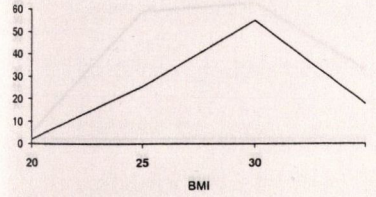


Fig. 6.6. Percentage distribution of BMI in males aged 80 - 84 years (*n* 38)

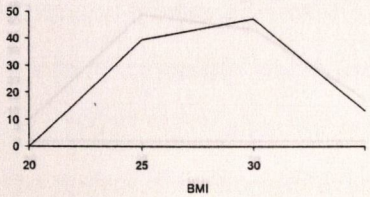


Fig. 6.7. Percentage distribution of BMI in males aged 80 or more years (*n* 44)

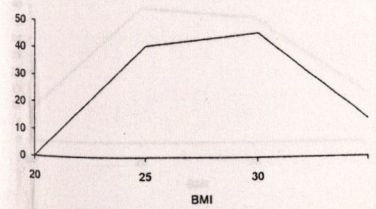


Fig. 6.8. Percentage distribution of BMI in males aged 85 or more years (*n* 6)

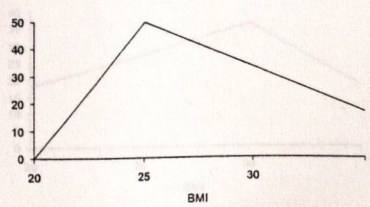


Fig. 6.9. Percentage distribution of BMI in females aged 65 - 69 years (*n* 195)

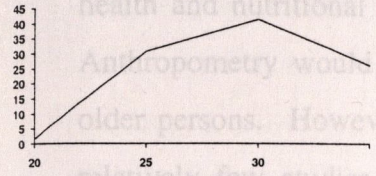


Fig. 6.10. Percentage distribution of BMI in females aged 70 - 74 years (*n* 214)

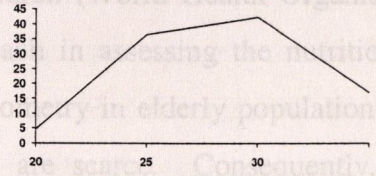


Fig. 6.11. Percentage distribution of BMI in females aged 75 - 79 years (*n* 120)

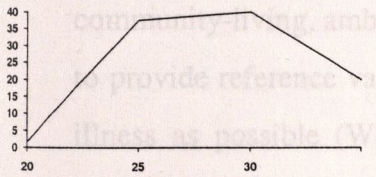


Fig. 6.12. Percentage distribution of BMI in females aged 80 - 84 years (*n* 57)

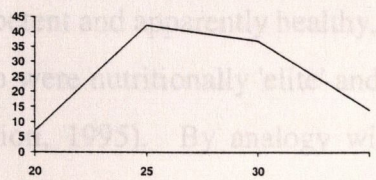


Fig 6.13. Percentage distribution of BMI in females aged 80 or more years (*n* 68)

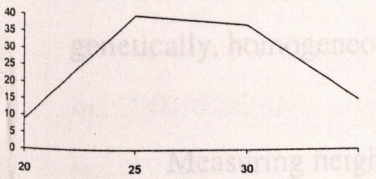
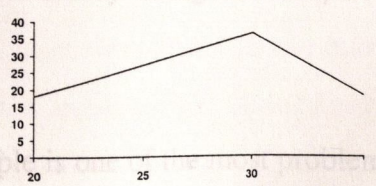


Fig. 6.14. Percentage distribution of BMI in females aged 85 or more years (*n* 11)



6.7 Discussion

Anthropometric indices of weight, height, BMI, skinfold thickness and muscle circumferences are simple, easily obtainable and inexpensive measures of assessing nutritional status. They have been widely and successfully applied to the assessment of health and nutritional risk, especially in children (World Health Organisation, 1995). Anthropometry would seem the ideal approach in assessing the nutritional status of older persons. However, the use of anthropometry in elderly population is limited to relatively few studies, so comparative data are scarce. Consequently, it has been suggested that local anthropometric data should be collected in older age groups so that longitudinal data may evolve (World Health Organisation, 1995). Based on this recommendation, this study has reported percentiles for weight, height, BMI, triceps skinfold thickness, mid-arm circumference, mid-arm muscle circumference, arm muscle area, right and left calf circumference and hand-grip strength for a cross-sectional group of Irish elderly aged sixty-five or more years. By including only subjects who were community-living, ambulatory, mentally competent and apparently healthy, it was hoped to provide reference values from a group who were nutritionally 'elite' and as free from illness as possible (World Health Organisation, 1995). By analogy with studies of nutrition in children in developing countries, the appropriate 'normal' standard is not a cross-section of the population of children found in a an area of deprivation but a well nourished group with no known disease or nutritional deficiency (McEvoy & James, 1982).

The validity of the data was maximised by using the same trained research dietitian and instruments for data collection and by using an adequate number of genetically, homogeneous subjects.

Measuring height reliably in older people is one of the most problematic areas of anthropometry. In old age there is a decline in sitting and standing height due to vertebral compression, change in height and shape of the vertebral discs, loss of muscle tone and postural changes (World Health Organisation, 1995). These are more marked in women who have an average maximum lifetime loss of 4.9 cm, while the average

maximum loss in men is 2.9 cm (Taren & Schler, 1990). In this study, however, the reduction in median height between the younger (65 - 69 years) and older (80 + years) was 5 cm in males and 4 cm in females. As an alternative to measured height, reported height in the elderly is thought to reflect height at a younger age and has been shown to result in overestimation by an average of 4.85 % in the 49 % of elderly inpatients who claim to know their height (Haboubi *et al.* 1990). If reported height is used to calculate BMI, this loss of height may invalidate the BMI result. Methods to estimate height in patients unable to stand, including knee height and arm span measurements, have been developed. However, their validity for use with different population groups of elderly remains uncertain. Standing height is still the most widely collected and quoted statistic for height measurement in the elderly (Van Staveran *et al.* 1995; World Health Organisation, 1995; Rea *et al.* 1997; Finch *et al.* 1998) and was used and measured by standard methods in this study (see **Chapter 2**). Adult height is highly variable because of genetic and socio-economic influences but at all ages, elderly males are taller than their female counterparts (Rea *et al.* 1997; Finch *et al.* 1998). The mean height recorded in this survey was identical to that of free-living participants in the British National Diet and Nutrition Survey of people aged sixty-five years and over (Finch *et al.* 1998) (170.0 cm in both Irish and British males; 156.0 cm in both Irish and British females). These data were also comparable to that obtained in the Health Survey for England, 1995 (170.0 cm and 156.7 cm for males and females, respectively). In our study, mean height was observed to be significantly higher in the higher socio-economic groups (1.63 m in the higher versus 1.59 m in the lower, $P < 0.001$), perhaps due to genetic or nutritional factors. It has recently been reported that the diets of the less affluent are less healthy (National Nutrition Surveillance Centre, 1999*a*).

Old age is associated with a loss in weight which, according to the literature, occurs beyond seventy-five years in females but at sixty-five years in males (Master *et al.* 1960; Lehmann *et al.* 1996). As with height, mean weight in this study was similar to that found in the British National Diet and Nutrition Survey of people aged 65 years and over (Finch *et al.* 1998) (77.7 kg in Irish males, 76.5 kg in British males; 65.1 kg in Irish females and 64.9 kg in British females), and comparable to the Health Survey for England, 1995 (Prescott-Clarke & Primatesta, 1997) (78.2 kg for males and 67.9 kg for females). Weight decreased significantly ($P < 0.01$) with age in both sexes in this study.

In those aged seventy-five years or more, Irish males and females were heavier than their free-living Edinburgh counterparts (males, 75.6 kg in Dublin versus 71.5 kg in Edinburgh; females, 62.2 kg in Dublin versus 60.6 kg in Edinburgh). In our study, mean weight was similar in both the higher and lower socio-economic groups.

Body mass index is normally considered the best age-independent index of obesity or underweight with values below 20 kg/m^2 (more recently 18.5 kg/m^2) indicative of undernutrition and values $\geq$ 30 kg/m^2 consistent with obesity. The mean BMI of the Irish survey participants was similar to that found in the British survey (males, 26.8 kg/m^2 in Dublin versus 26.5 kg/m^2 in Britain; females, 26.7 kg/m^2 in Dublin versus 26.8 kg/m^2 in Britain). For those aged seventy-five years or more, the Irish BMI data were similar to those found in free-living elderly aged over seventy-five years in Edinburgh (see **Table 6.18**). In the Edinburgh study, height was calculated from knee height. Calculated stature was then used to calculate BMI. Using this method, the elderly in Edinburgh were reported to be significantly shorter than their English counterparts from Nottingham ($P < 0.05$ for men and $P < 0.01$ in women). No direct comparison of height could be made between Dublin and Edinburgh as both studies used different methods to obtain results for height. It may be that the population of Edinburgh is both shorter and lighter than their Dublin counterparts and, therefore, BMI values are similar. It was also observed that body mass index measurements were significantly lower for both males and females ($P < 0.01$) in the older Welsh data (Burr & Phillips (1984) than the body mass index measurements calculated from our Irish data (see **Table 6.19**). We also noted that mean body mass index measurements were significantly higher in the lower socio-economic groups (27.1 kg/m^2 in the lower versus 26.2 kg/m^2 in the higher groups, $P = 0.002$). As there was no difference between mean weights in the two socio-economic groups, this difference was due to the significantly higher ($P < 0.001$) mean height in the higher socio-economic group. A correlation between lower socio-economic group and less time spent in active leisure was also observed ($P < 0.05$). It has also been recently noted that the diets of the less affluent are less healthy (National Nutrition Surveillance Centre, 1999*a*). The very high rate of overweight and obesity we observed (68.5 % in males and 61 % in females) is likely to be nationally representative as approximately the same proportion of the higher socio-economic groups as the national average were represented in our survey (national

average, 37%, our survey, 41 %). The results of the clinical examination of approximately 600 respondents to the SLAN survey should either confirm or dispute the high prevalence of overweight and obesity.

The loss of muscle and fat with age followed a similar pattern as found in the study of Burr & Phillips (1984). Their study reported a tendency, in both sexes, for BMI to decline with age after seventy years and for mid-arm circumference to decline with age over the whole age span, especially in women. They also reported a particularly marked decline in triceps skinfold thickness with age in women. Both mid-arm muscle circumference and arm muscle area were reported to decline steadily with age and at approximately the same rate in men and in women. Both the Irish study, and the Welsh study of Burr & Phillips (1984), are in contrast to the small English study of McEvoy and James (1982) who reported a decrease in mid-arm muscle circumference and an increase in triceps skinfold measurements in older women and no loss of fat or muscle in older men. In the Irish males also, no significant reduction in fat stores (calculated from triceps skinfold thickness) was observed with increasing age. The decline in BMI in Irish males was only seen after the age of eighty years. This may be as a result of the preservation of fat over muscle. It may also be that the measurement of triceps skinfold thickness is not sufficiently sensitive to detect loss of fat in males. A review on the topic by Mitchell & Lipschitz (1982) concludes that while extremity skinfold measurements (triceps, biceps and thigh) may be more accurate in elderly females, skinfold measurements on the trunk (subscapular and supra-iliac) may be more appropriate in elderly males. In the Irish study, muscle reserves (calculated from mid arm muscle circumference and from calf circumferences (left and right) declined significantly ($P < 0.01$) with age in both sexes.

Skinfold thickness measurements estimate fat. For comparative and clinical use, reference values are required. In elderly people, body fat distribution changes and the accuracy and reproducibility of skinfold measurements can be reduced because of lax skin, greater compressibility of skinfolds, dehydration or oedema. In this study, these difficulties were minimised by attention to measurement technique, by using the same trained research dietitian and instruments for data collection and by the recruitment of healthy, elderly individuals. Percentiles for triceps skinfold thickness have been

compiled for ages sixty-five to seventy-four years in the United States (Bishop *et al.* 1981; Frisancho, 1984; Falciglia *et al.* 1988), for ages sixty-five or more years in the United Kingdom (Burr & Phillips, 1984) and for ages ninety or more years in Northern Ireland (Rea *et al.* 1997). In our study, elderly women of all age groups had increased subcutaneous fat compared to men of the same age. A higher mean triceps skinfold thickness in females aged over eighty years was observed in our study by comparison to that reported from Northern Ireland in females aged over ninety years (18.3 (SD 5.7) mm versus 12.3 (SD 4.5) mm), whereas the mean value for triceps skinfold thickness in both male populations was similar (10.4 (SD 3.1) mm in our study versus 11.7 (SD 4.1) mm in the Northern Irish study), supporting the hypothesis that fat may be preserved in healthy, elderly men. It is well recognised that reduced subcutaneous fat compromises temperature regulation and increases the risk of hypothermia in the elderly (Fellows *et al.* 1985) and that elderly females are particularly vulnerable to this condition.

When our Irish data for those aged seventy-five years or more were compared with the recent data on elderly people aged seventy-five years or more from Edinburgh (Bannerman *et al.* 1997), Irish males had similar measurements for mid-arm circumference, mid-arm muscle circumference and triceps skinfold thickness. In contrast, significant differences were observed between Irish females and those from Edinburgh (see **Table 6.18**). These differences represent significantly higher fat stores and significantly lower muscle stores in Irish women aged over seventy-five years in comparison with their Scottish counterparts and could explain the similarity in BMI measurements. Higher fat stores could possibly be due to a lower rate of participation by older Irish females in active leisure with only 47 % of those aged seventy-five years or more reporting taking part in active leisure activities for a minimum of twenty minutes at least four times weekly and 17 % never participating. This finding is in keeping with the results of the National Health and Lifestyles Survey (SLAN) (1999*b*) where it was reported that 27 % of women aged fifty-five years or more took no exercise at all. On the other hand, in our survey, 70 % of Irish males aged seventy-five years and over reported participating in active leisure at least four times weekly, a figure higher than that reported in the SLAN survey (National Nutrition Surveillance centre, 1999*b*).

In our survey, both males and females aged sixty-five years and over recorded significantly lower values ($P < 0.01$) for hand-grip dynamometry than the free-living group in the UK (Finch *et al.* 1998). Only mid-arm circumference was measured in the UK survey so it is not possible to decide if this difference was due to lower muscle mass in the Irish group compared with the UK group. As commented upon above, comparison of our data with that from Edinburgh shows that Irish females aged over seventy-five years have significantly lower mid-arm muscle circumference than their counterparts from Edinburgh so the possibility of lower muscle stores in the elderly Irish cannot be out-ruled. However, the same was not true for males aged over seventy-five years. It is probably most likely that the differences observed in hand-grip strength are due to differences in the equipment used. The UK study used an electronic hand-grip dynamometer designed and built by the Department of Medical Physics at the Queen's Medical Centre, Nottingham, whereas the hand-grip dynamometer used for our study was a Japanese model purchased from Chasmors Weighing Equipment Limited in London.

In the British National Diet and Nutrition Survey of people aged sixty-five years and over (Finch *et al.* 1998), undernutrition was defined as a BMI of 20 kg/m^2 or less. When the same criteria are applied to this Irish survey a similar proportion of those surveyed were classified as undernourished (3 % of males in both the UK and Ireland; 6.5 % of Irish females versus 6 % of UK females). No males, and less than 1 % of females had a BMI below 18.5 kg/m^2. The Northern Irish study of elderly aged over ninety years reported that no male subjects, but 10 % of females had a BMI below 18.5 kg/m^2. Undernutrition in the elderly is recognised as a risk factor for medical, mental and functional decline and needs to be recognised and treated (Morley, 1997; Morley, 1998; Rea *et al.* 1997). In light of the low prevalence of a BMI below 20 kg/m^2, particularly in males, it may be more appropriate to define undernutrition using a threshold value below the 15th percentile for age and sex of the current healthy population.

In contrast to the small number of undernourished subjects, 68.5 % of males and 61 % of females were either overweight or obese (i.e. a BMI of $\geq$ 25 kg/m^2). These figures are little different to that found in other recent studies on the elderly. The recent

data from the UK (Finch *et al.* 1998) reported that, in their free living group, 67 % of men and 63 % of women had a BMI over 25 kg/m^2. A BMI of over 30 kg/m^2 was recorded in 17 % of men and 23 % of women in the UK. Our Irish study found that 17 % of men and 20 % of women had a BMI $\geq$ 30 kg/m^2. The Irish National Nutrition Survey in 1990 (Lee & Cunningham, 1990) reported BMI data for 166 elderly individuals aged sixty or more years (82 males, 84 females). The mean BMI was similar to that recorded for both males (25.6 kg/m^2 in the INDI survey versus 26.8 kg/m^2 in the present study) and females (26.4 kg/m^2 in the INDI survey, 26.7 kg/m^2 in this study). No figures are given for the proportion of those aged over 60 years with a BMI over 25 kg/m^2 or a BMI $\geq$ 30 kg/m^2. The Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA) reported a prevalence of obesity among elderly people aged 70 - 75 years, defined as a BMI $\geq$ 30 kg/m^2, in at least 20 % of men in eight centres and women in twelve centres (Van Staveran *et al.* 1995). Although a BMI $\geq$ 30 kg/m^2 in individuals under the age of seventy years may be considered a health risk marker, there is little evidence that older individuals who have remained overweight and who have no pre-existing chronic disease should be advised on other than weight maintenance (World Health Organisation, 1995). Lowest mortality occurred at higher BMI among Finnish men aged over seventy-five years (Rissanen *et al.* 1989). Older Finnish women showed little variation in mortality with BMI and overweight (BMI 27 - 31 kg/m^2) seemed to be protective against death (Rissanen *et al.* 1991). In the Framingham Heart Study in the USA, there was a positive relationship between BMI and mortality in non-smoking men and women over sixty-five years of age in follow-up studies of from one year to twenty-three years (Harris *et al.* 1988). Survival was lower among individuals in the 70th percentile for BMI (28.5 kg/m^2 for men and 28.7 kg/m^2 for women) than among thinner individuals with moderate BMI. Those who were overweight at sixty-five but not at fifty-five years of age were at lower risk of death than those who gained 0 - 9 % BMI, and those who lost 10 % of BMI were at almost twice the risk. In the Northern Irish study of elderly over ninety years (Rea *et al.* 1997), 11 % of females and 2 % of males had a BMI of 30 kg/m^2 or more.

Both overweight and thinness appear to carry risk for mortality, but in the elderly, thinness carries a greater risk than overweight. For individuals with pre-existing disease, weight control associated with overall clinical management is recommended.

All groups should be encouraged to increase both physical activity and nutrient density in order to maintain or augment lean body mass (World Health Organisation, 1995). The percentage of Irish adults aged fifteen years and over who report no involvement in any physical activity is 14 % (Institute of European Food Studies, 1999). In our elderly group the corresponding figure for elderly males was 7 %, and for elderly females, 13 %. It would appear that after retirement, healthy elderly men increase their time spent in active leisure, perhaps to replace some of the time normally spent at work. However, this observation in older Irish men conflicts with recent data from the UK (Health Survey for England, 1998) where it was reported that only 17 % of elderly males aged sixty-five to seventy-four years meet the current guidelines for physical activity (i.e. moderate intensity of at least 30 minutes duration at least five times per week). Among Irish women it would appear that there is no increase in the proportion involved in exercise as they get older and initiatives to encourage younger women to participate in active leisure should be encouraged. It is widely acknowledged that lack of physical activity increases the risk of cardiovascular disease, osteoporosis and other chronic diseases (European Heart Network, 1999; National Dairy Council, 2000).

The study of Launer & Harris (1996) which examined weight, height and BMI in nineteen geographically and ethnically varied samples of community dwelling elderly people reported a prevalence of obesity (BMI $\geq$ 30 kg/m^2) in males of between 0 % in the Asian and West African samples to 35 % in the Greek sample. In females, the prevalence of obesity ranged from 2.5 % in the Hong Kong sample to 53.5 % in the Barbados sample. Underweight (BMI < 20 kg/m^2) was found in less than 5 % of males in all three Northern European samples and in less than 5 % of females in Holland, Italy and Finland. A higher rate of underweight (15 %) was seen in the Swedish female sample, which may be related to its small size (*n* 51). Among elderly white Americans, the prevalence of obesity was 11 % in men and 17 % in women while underweight was found in 7 % of men and 11 % of women.

Table 6.18. Current Irish and Scottish† anthropometric data for persons aged seventy-five years or more

	Males		Females	
Anthropometric variable	Irish (*n* 95)	Scottish (*n* 59)	Irish (*n* 188)	Scottish (*n* 128)
Body mass index (kg / m^2)	26.5	25.6	26.3	25.9
Mid-arm circumference (cm)	28.7	28.7	28.4*	29.3
Triceps skinfold thickness (mm)	11.1	10.3	18.9**	16.3
Mid-arm muscle circumference (cm)	25.2	25.8	22.5**	24.2

Significant differences were observed between Irish and Scottish females for mid-arm circumference, triceps skinfold thickness and mid-arm muscle circumference

*P < 0.05; **P < 0.01

†Bannerman *et al.* (1997).

Table 6.19. Current Irish and older Welsh† anthropometric data for persons aged sixty-five years or more

	Males		Females	
Anthropometric variable	Irish (*n* 276)	Welsh (*n* 298)	Irish (*n* 598)	Welsh (*n* 526)
‡Body mass index (kg / m^2)	26.8**	24.0	26.7**	25.6
Mid-arm circumference (cm)	29.6**	24.6	29.2**	24.5
Triceps skinfold thickness (mm)	11.6**	7.2	20.8**	14.5
Mid-arm muscle area (mm^2)	5352**	3916	4147**	3102
Mid-arm muscle circumference (cm)	25.8**	22.0	22.7**	19.6

Significant differences were observed between Irish and Welsh males and between Irish and Welsh females for body mass index, mid-arm circumference, triceps skinfold thickness, mid-arm muscle area and mid-arm muscle circumference; **$P < 0.01$

†Burr & Phillips (1984).

‡Body mass index in Welsh study, Males: *n* 533; Females: *n* 920.

6.8 Conclusions

These data represent a set of anthropometric measurements which can be easily referred to by health professionals assessing elderly patients in various settings. The data do not represent all elderly aged over sixty-five years but are a set of data representing the healthy elderly. The data suggest that BMI declines with increasing age in both male and females and that this is due to a decline in both height and weight. Although cross-sectional data may not be representative of longitudinal change, recent work demonstrates how closely cross-sectional studies mirror change in longitudinal studies (Lehmann *et al.* 1996).

In summary, the data demonstrate a high prevalence of overweight and obesity among reasonably active elderly Irish people who report themselves as being healthy. It is clear that the use of old British (Burr & Phillips, 1984) (see **Table 6.19**) and American (which is only applicable to those aged 65 to 74 years) (Bishop *et al.* 1981) reference data to define the nutritional status of sick Irish elderly people is inappropriate and will result in the incorrect classification of many patients. In view of the potential health benefits, strategies should be implemented to encourage greater participation, particularly among women, in active leisure activities.

Chapter 7

Assessing nutritional status of elderly patients in hospital

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7.1 Summary

Our existing data on 218 elderly patients on admission to hospital was re-analysed using new reference data derived from locally measured healthy elderly people. Defining undernutrition as a body mass index plus a mid-arm muscle circumference or a triceps skinfold thickness below the 15th percentile of the local healthy population, a higher prevalence of undernutrition (28 %) was observed compared with the 10 % we had previously reported (see **Chapter 3**). The earlier study used a body mass index below 20 kg/m^2 plus a mid-arm muscle circumference or a triceps skinfold thickness below the 15th percentile of the reference data published by Burr & Phillips in 1984. Using the older Welsh reference data, only seven (22 %) of elderly patients with a pre-admission weight loss greater than 10 % of their usual body weight were defined as undernourished, whereas sixteen (50 %) of such patients were defined as undernourished using the new data. Elderly patients on admission to hospital had significantly lower body mass index measurements than their healthy counterparts. With the secular increase in body mass index in the population, defining undernutrition as a body mass index below 20 kg/m^2 or using anthropometric measurements related to older normative data will not detect all elderly patients with weight loss or who are at nutritional risk. For most patients to achieve a body mass index below 20 kg/m^2 requires considerably more than 10 % weight loss. Although it is useful for nutritional epidemiologists to know the proportion of different populations with a body mass index below 20 kg/m^2, in clinical practice we need to know how the patient on admission compares to the healthy individual in the community. This is particularly so in the elderly where early nutritional intervention appears to be of greater benefit than when given after considerable nutritional deterioration has occurred.

7.2 Introduction

The proportion of elderly is expected to rise to 13.6 % of the Irish population by the year 2011 and analysis of data on hospital admissions shows that 35 - 40 % of all admissions to hospital are aged 65 years or more (Hospital In-patient Enquiry, 1995). It is likely, that as the proportion of elderly in the population increases, the proportion of the hospital population aged over sixty-five years will also increase. This group is known to be nutritionally vulnerable. It is important for comparative purposes, when assessing the nutritional status of the elderly on admission to hospital, that we have data on the nutritional status of their healthy counterparts.

Anthropometry has been widely and successfully applied to the assessment of health and nutritional risk, especially in children (World Health Organisation, 1995; see **Chapter 6**). It would seem the ideal approach in assessing the nutritional status of older persons as it is inexpensive, readily available and easily applied. However, the anthropometric reference data available for use in the elderly are scarce (see **Chapter 6.2**). The remarkable differences between the data collected in Dundee (McWhirter & Pennington, 1994), and the results of our study in Dublin (see **Chapter 3**) (both examining the prevalence of undernutrition on admission to hospital), led us to question the validity of the American and Welsh anthropometric reference data, which were used in both studies, for the clinical assessment of undernutrition in patients admitted to hospital. It has previously been suggested that local anthropometric data should be collected in older age groups (World Health Organisation, 1995). The elderly comprise the largest section of the hospital population, so as part of this research work, anthropometric measurements in 874 healthy elderly Irish people were recorded and compiled into percentile tables (see **Chapter 6**). This reference data could then be used to assess the nutritional status of our hospitalised population with reference to their healthy counterparts. The data would also be useful as a baseline for planning future nutritional or health strategies for the increasing Irish elderly population.

7.3 Aims and objectives

The aims and objective of this study were to re-assess the existing hospital admission data from the sub-group of elderly patients (collected for the survey reported in **Chapter 3**) using the newly compiled reference data from healthy elderly Irish people reported in **Chapter 6**.

7.4 Patients and methods

Anthropometric measurements and hand-grip strength of 874 healthy adults (276 men and 598 women), aged 65 years or more, were recorded in a cross-sectional study designed to provide reference data on a group of healthy elderly Irish people (see **Chapter 6**). The study was carried out in the greater Dublin area. All subjects were recruited through activity groups for the active retired between June 1998 and February 1999 and reported themselves as being healthy; anyone who had arthritis of the hand was excluded from the hand grip measurements; anyone with protruding varicose veins, or who needed to wear support stockings was excluded from the calf measurements. All measurements were carried out by the same trained research dietitian.

Existing data on 218 elderly hospital inpatients were re-analysed using the new reference data. Undernutrition was defined as a body mass index and a triceps skinfold or mid-arm muscle circumference below the 15th percentile of the healthy elderly Irish population. The cut-off of the 15th percentile was chosen as this was the threshold used in the large study from Dundee (McWhirter & Pennington, 1994) on which our first study (see **Chapter 3**) was based.

7.5 Statistical analysis

All measurements had been entered into the Statistical package for the Social Sciences for Windows version 6.0.1 (SPSS for Windows) SPSS Inc., Chicago) for the

purposes of analysis for **Chapter 3** and **Chapter 6**. Independent *t* tests were used to test for a difference in BMI between the healthy Irish elderly population and the elderly on admission to hospital. Chi-squared analysis was used to test for differences between body mass index categories, for differences between male and female gender, summer and winter season, higher and lower socio-economic group, and to identify associations between unintentional weight loss before admission and undernutrition on admission. P values of less than 0.05 were considered to indicate statistical significance.

7.6 Results

By comparison with the healthy elderly population, elderly hospital patients had significantly lower ($P < 0.001$) measurements for body mass index. This observation applied to each category of BMI although the significance of the difference did vary within each category (see **Table 7.1**). Using the criteria of McWhirter & Pennington, only 10 % of elderly patients were defined as undernourished although 16 % had a body mass index below 20 kg/m^2 (see **Table 7.2**). When undernutrition was defined as below the 15th percentile for both body mass index and the anthropometric measurements (MAMC and TSF) of the local healthy population, a higher prevalence of undernutrition than we reported previously was observed, with 28 % of elderly patients defined as undernourished (see **Table 7.2**). When the sub-group of patients aged sixty-five years and over, admitted under Medicine for the Elderly (*n* 24) were analysed separately, a greater number were undernourished regardless of the definition of undernutrition. However, this difference was not significant. This was possibly because of the small number admitted under Medicine for the Elderly and analysis of a larger group admitted under this speciality is necessary to see if a true difference would appear.

Thirty-two (15 %) of the elderly patients had lost more than 10 % body weight in the six months before admission to hospital of whom only seven (22 %) were classified as undernourished using the body mass index threshold of 20 kg/m^2 and relating the anthropometric data to the older Welsh reference data (McWhirter & Pennington criteria). Using the classification of undernutrition as below the 15th percentile of the new reference data both for BMI and the anthropometric data, sixteen (50 %) of the

patients with more than 10 % weight loss over the six months before admission were defined as undernourished, thirteen (81 %) defined as moderately (BMI and TSF / MAMC below the 10th percentile) or severely (BMI and TSF / MAMC below the 5th percentile) undernourished. An additional sixteen (7 %) patients had lost more than 5 % of their usual weight in the one month before admission to hospital. Using the McWhirter & Pennington definition of undernutrition, 26 % of undernourished elderly patients had more than 10 % weight loss in the six months and 26 % had more than 5 % weight loss in the one month before admission to hospital. In contrast, only 10.5 % of the well nourished elderly for whom we had data on weight six months before admission (*n* 153) had more than 10 % weight loss in the six months, and 8.8 % of the 147 on whom we had data from the month before admission had more than 5 % weight loss in this month. Those elderly patients who are most undernourished, presumably the sickest, have the greatest pre-admission weight loss.

No difference in the prevalence of undernutrition was observed between male and female sex, summer and winter seasons, or higher versus lower socio-economic groups.

Table 7.1. Nutritional status of healthy elderly compared with elderly patients on admission to hospital

	Body mass index (kg / m^2)			
	< 18.5	18.5 - 24.9	25.0 - 29.9	≥ 30
Healthy elderly population (*n* 873)	0.6	36	44	19.6
Hospital elderly population (*n* 218)	6.4	48	33	12.4
Significance of difference	*P* <0.0001	*P* <0.01	*P* <0.01	*P* <0.05

Values are percentages of *n*

Table 7.2. Percentages of elderly patients categorised as undernourished using three definitions of undernutrition

	Undernutrition		
	BMI <20kg/m^2	BMI <20kg / m^2 + MAMC / TSF <15th percentile*	BMI + MAMC / TSF <15th percentile†
Hospital elderly population (*n* 218)	16	10	28
Medicine for the Elderly (*n* 24)	21	17	33

Values are percentages of *n*

BMI, body mass index; MAMC, mid-arm muscle circumference; TSF, triceps skinfold thickness

*using reference data from Burr & Phillips (1984)

†using new Irish reference data

7.7 Discussion

The well-recognised fact that the elderly are a nutritionally vulnerable sub-group of the population is evidenced by the fact that 15 % had lost more than 10 % of their usual body weight in the six months, and a further 7 % had lost more than 5 % of their usual body weight in the one month, before admission to hospital. It has been argued by some authors (Beck & Oveson, 1998) that any weight loss in an elderly person is clinically significant, and that any such person should be given nutritional advice or intervention as appropriate. Using the criteria of McWhirter & Pennington (1994), only 10 % of all patients admitted to hospital aged sixty-five years or more were classified as undernourished. Significantly more patients were classified as undernourished using the new reference data and a threshold for body mass index below the 15th percentile of the healthy Irish population. However, this threshold of the 15th percentile did not detect all those with weight loss of more than 10 % in the six months before admission to hospital. It is probable with the secular increase in body mass index in the population that the cut-off values used to define those who are at risk of nutrition-related complications may increase, certainly if future work confirms that any weight loss in an elderly person is detrimental. We know that the mean body mass index in the elderly in both the UK and Ireland is almost 27 kg/m^2. Therefore, for the majority of elderly people to attain a BMI below 20 kg/m^2 would require far greater than 10 % loss of their usual body weight. From the most recent evidence in the UK, it seems that any weight loss in an elderly person is detrimental (Wannamethee *et al.* 2000).

There will always be a need to know the proportions of a population with a body mass index within the currently accepted values (Garrow, 1981). However, much further work is required on defining optimal body mass index for health in different sub-groups of the population. Currently, all sections of the population with a body mass index above 25 kg/m^2 are defined as overweight. From the data previously discussed in detail in **Chapter 6** this may not be appropriate for the older sections of the population. Certainly weight loss does not appear to benefit this group of individuals.

7.8 Conclusions

Open discussion among nutritionists / dietitians and doctors is urgently required so that a definition of undernutrition can be established and accepted widely as discussed in **Chapter 1.2.6**. It is also necessary to establish guidelines as to what sets of normative data should be used for comparative purposes, or indeed, if they should be used at all when defining nutritional status. When we relate this discussion to the elderly, the questions are even more pertinent. For the elderly, is a BMI threshold of 20 kg/m^2 appropriate to define undernutrition regardless of how this compares with the distribution of BMI within the normal healthy elderly population? In the elderly, what degree of weight loss should we accept as detrimental? Can earlier nutritional intervention really prevent nutritional deterioration, or will this occur only in some elderly persons?

The only fact that is really clear is that we need further research assessing the clinical outcomes of the elderly with weight loss and those who fall at the lower end of the anthropometric profile of the healthy elderly population. Unless we can obtain data showing that nutritional intervention can make a difference, patients who are at risk of nutritional deterioration will continue to be both unrecognised and untreated.

Chapter 8
General discussion and conclusions

Nutritional status on admission to hospital is known to be an important determinant of clinical outcome. Allowing a patients' nutritional state to deteriorate adversely affects outcome related to nosocomial infection, multiple organ dysfunction, wound healing and functional recovery (McClave *et al.* 1999). However, the assessment of nutritional status in the clinical setting remains problematic. It has been argued that nutrition screening on admission to hospital is worthwhile to allow early identification of those who would benefit most from nutrition intervention (Lennard-Jones, 1992; Reilly *et al.* 1995) and that a policy designed to identify undernutrition at its early stage and to treat it by simple means may prevent some patients losing weight to the point where more expensive forms of artificial nutrition become necessary (Allison, 1995). The large number of patients who lose weight, lean body mass and muscle function in hospital, and the fact that those at highest risk lose most, means that research into the use of nutrition screening tools should continue to be promoted.

Our studies have highlighted the difficulties that occur in defining nutritional status and shown the variability that can occur between centres. In particular, we feel that the use of anthropometry to assess nutritional status, in conjunction with older reference data, is inappropriate. The secular trends occurring in the population mean that a review of the anthropometric criteria to assess nutritional status is now mandatory. Factors such as weight loss in conjunction with functional impairment should be investigated as a more precise indicator of the need for nutritional intervention. It has

been recommended recently (McClave *et al.* 1999) that the concept of risk for nutritional nutrition deterioration should replace the term "protein calorie malnutrition". However, in general, the clinical nutrition literature only supports nutritional intervention in malnourished patients. If nutritional screening is to be considered essential in patient management, so that those at risk of nutritional deterioration also receive intervention, simple methods to measure the changes in clinical outcome, functional status and quality of life of those patients who receive nutritional intervention as a result of using these procedures must be developed and evaluated. Finally, further studies are required to determine the effects of nutritional assessment and intervention during the various stages of a patient's illness.

During the course of this work, we have produced a set of anthropometric measurements which can be easily referred to by health professionals assessing elderly patients in various settings. These data represent the healthy elderly and are similar to recent data from the UK (Finch *et al.* 1998). They demonstrate a high prevalence of overweight and obesity among reasonably active elderly Irish people who report themselves as being healthy. It is clear that the use of old British (Burr & Phillips, 1984) and American (which is only applicable to those aged 65 to 74 years) (Bishop *et al.* 1981) reference data to define the nutritional status of sick Irish elderly people is inappropriate and will result in the incorrect classification of many patients. However, we need further research assessing the clinical outcomes of the elderly with weight loss and those who fall at the lower end of the anthropometric profile of the healthy elderly population.

Finally, open discussion among nutritionists / dietitians and doctors is urgently required so that a definition of undernutrition can be established and accepted widely. It is also necessary to establish guidelines as to what sets of normative data should be used for comparative purposes, or indeed, if they should be used at all when defining nutritional status. Unless we can obtain data showing that nutritional intervention can make a difference, patients who are at risk of nutritional deterioration will continue to be both unrecognised and untreated.

References

Abbasi AA & Rudman D (1993) Observations on the prevalence of protein-calorie undernutrition in VA nursing homes. *Journal of the American Geriatric Society* **41,** 117-121.

Abbasi AA, Basu SN & Rudman D (1994) Observations concerning the tube feeding of nursing home residents. In: *Handbook of Nutrition in the Aged,* pp 135-144. [RR Watson, editor]. London: CRC Press.

Abbasi AA, Basu SN, Parsa A, Alverno L & Rudman D (1993) Nutritional problems in the nursing home population: opportunities for clinical interventions. In: *Improving Care in the Nursing Home,* pp. 195-215 [LZ Rubinstein & D Wieland, editors]. London: Sage Publications.

Agarwal N, Acevedo F, Leighton LS, Cayten CG & Pitchumoni CS (1988): Predictive ability of various nutritional variables for mortality in elderly people. *American Journal of Clinical Nutrition* **48,** 1173-1178.

Age & Opportunity (1998) *Financial planning for retirement.* Dublin: Age and Opportunity.

Alarcon T, Barcena A, Gonzalez-Montalvo JI, Penalosa C & Salgado A (1999) Factors predictive of outcome on admission to an acute geriatric ward. *Age and Ageing* **28,** 429-432.

Allen-Mersh TG (1996) In *Surgical Oncology* [TG Allen-Mersh, editor]. London: Chapman & Hall.

Allison SP (1992) The uses and limitations of nutritional support. *Clinical Nutrition* **11,** 319-330.

Allison SP (1995) Cost-effectiveness of nutritional support in the elderly. *Proceedings of the Nutrition Society* **54,** 693-699.

Allison SP (1996) Which are the relevant end points of nutritional support? In *ESPEN Congress Proceedings* September 8-11, Geneva, Switzerland.

American Dietetic Association (1993) Position of the American Dietetic Association: nutrition, ageing and the continuum of health care. *Journal of the American Dietetic Association* **93,** 80-82.

American Society for Parenteral and Enteral Nutrition (1993) Rationale for adult nutrition support guidelines. *Journal of Parenteral and Enteral Nutrition* **17,** 5S-11S.

American Society for Parenteral and Enteral Nutrition (1995) Standards for nutrition support: hospitalized patients. *Nutrition in Clinical Practice* **10,** 208-219.

Andres R (1985) Mortality and obesity: the rationale for age-specific height-weight tables. In *Principles of Geriatric Medicine* [R Andres, EL Bierman, WR Hazzard, editors]. New York: McGraw-Hill.

Anker SD, Ponikowski P, Varney S, Chua TP, Clark AL, Webb-Peploe KM, Harrington D, Kox WJ, Poole Wilson PA & Coats AJS (1997) Wasting as independent risk factor for mortality in chronic heart failure. *Lancet* **349,** 1050-1053.

Arora NS & Rochester DF (1982) Respiratory muscle strength and maximal voluntary ventilation in undernourished patients. *American Review of Respiratory Diseases* **126,** 5-8.

Arrowsmith H (1999) A critical evaluation of the use of nutrition screening tools by nurses. *British Journal of Nursing* **8,** 1483-1490.

Astrand PO (1992) Physical activity and fitness. *American Journal of Clinical Nutrition* **55,** 1231-1236S.

Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J, Langer B & Jeejeebhoy K (1982) Nutritional assessment: a comparison of clinical judgement and objective measurements. *New England Journal of Medicine* **306,** 969-972.

Bannerman E, Chapman N, Cowan S, Reilly JJ, Kirk T, Maclennon WJ & Pender F (1996) Evaluation of the use of knee height to estimate stature in individuals > 75 years

living in Edinburgh: implications for the determination of body mass index. *Proceedings of the Nutrition Society* **55,** 249A.

Bannerman E, Reilly JJ, MacLennon WJ, Kirk T & Pender F (1997) Evaluation of validity of British anthropometric reference data for assessing nutritional state of elderly people in Edinburgh: cross sectional study. *British Medical Journal* **315**, 338-341.

Bardram L, Funch-Jensen P, Jensen P, Crawford ME & Kehlet H (1995) Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation. *Lancet* **345,** 763-764.

Bashir Y, Graham TR, Torrance A, Gibson GJ & Corris PA (1990) Nutritional state of patients with lung cancer undergoing thoracotomy. *Thorax* **45,** 183-186.

Bastow MD, Rawlings J & Allison SP (1983) Benefits of supplementary tube feeding after fractured neck of femur: a randomised controlled trial. *British Medical Journal* **287,** 1589-1592.

Beattie AH, Baxter JP, Prach AT & Pennington CR (1998) An evaluation of the use of enteral nutritional supplements post operatively in malnourished surgical patients. *Proceedings of the Nutrition Society* **58,** 112A.

Beck AM & Ovesen L (1998) At which body mass index and degree of weight loss should hospitalised elderly patients be considered at nutritional risk? *Clinical Nutrition* **17,** 195-198.

Beier-Holgersen R & Boesby S (1996) Influence of postoperative enteral nutrition on postsurgical infections. *Gut* **39,** 833-835.

Bellantone R, Doglietto GB, Bossola M, Pacelli F, Negro F & Crucitti F (1990) Properative parenteral nutrition in malnourished high-risk surgical patients. *Nutrition* 6, 168-170.

Benjamin DR (1989) Laboratory tests and nutritional assessment. Protein-energy status. *Paediatric Clinics of North America* **36,** 139-161.

Bermon S, Hebuterne X, Peroux J-L, Marconnet P & Rampal P (1997) Correction of protein-energy malnutrition in older adults: effects of a short-term aerobic training program. *Clinical Nutrition* **16,** 291-298.

Berzon RA (1998) Understanding and using health-related quality of life instruments within clinical research studies. In *Quality of Life Assessment in Clinical Trials: Methods and Practice,* pp. 3-15 [MJ Staquet, RD Hays and PM Fayers, editors]. Oxford: Oxon University Press.

Bettany EA & Powell-Tuck J (1995) Malnutrition: incidence, diagnosis, causes, effects and indications for nutritional support. *European Journal of Gastroenterology and Hepatology* **7,** 494-500.

Bishop CW, Bowen PE & Ritchley SI (1981) Norms for nutritional assessment of American adults by upper arm anthropometry. *American Journal of Clinical Nutrition* **34,** 2530-2539.

Bistrian BR, Blackburn GL, Hallowell E & Heddle R (1974) Protein status of general surgical patients. *Journal of the American Medical Association* **230,** 858-860.

Bistrian BR, Blackburn GL, Vitale J, Cochran D & Naylor J (1976) Prevalence of malnutrition in general medical patients. *Journal of the American Medical Association* **253,** 1567-1570.

Bistrian BR (1977) Interaction of nutrition and infection in the hospital setting. *American Journal of Clinical Nutrition* **30,** 1228-1235.

Bistrian BR (1990) Recent advances in parenteral and enteral nutrition: A personal perspective. *Journal of Parenteral and Enteral Nutrition* **14,** 329-334.

Bjorntorp P & Evans W (1992) The effect of exercise on body composition. In *Body composition: the measure and meaning of changes with ageing* [J Watkins, R Roubenoff, IH Rosenberg, editors]. Boston: Foundation for Nutritional Advancement.

Blackburn GL, Bistrian BR, Maini BS, Schlamm HT & Smith MS (1977) Nutritional and metabolic assessment of the hospitalized patient. *Journal of Parenteral and Enteral Nutrition* **1,** 11-22.

Blackburn GL & Thornton PA (1979) Nutritional assessment of the hospitalized patient. *Medical Clinics of North America* **63,** 1103-1115.

Borkan GA, Hults DE, Gerzof SG, Robbins AH, Silbert CK (1983) Age changes in body composition revealed by computed tomography. *Journal of Gerontology* **38,** 673-677.

Bower RH, Cerra FB, Bershadski B, Licari JJ, Hoyd DB, Jensen GL, Van Buren CT, Rothkopf MM, Daly JM & Adelsberg BR (1995) Early enteral administration of a formula (Impact) supplemented with arginine, nucleotides, and fish oil in intensive care unit patients: results of a multicenter, prospective, randomised, clinical trial. *Critical Care Medicine* **23,** 436-449.

Bowling A (1997) *Measuring Health: A Review of Quality of Life Measurement Scales*, 2nd ed. Buckingham: Open University Press.

Braun SR, Dixon RM & Keim NL (1984) Predictive clinical value of nutritional assessment factors in COPD. *Chest* **85,** 353-357.

Braun JV, Wykle MH & Cowling WR (1988) Failure to thrive in older persons: a concept derived. *Gerontologist* **28,** 809-812.

Breslow RA, Hallfrisch J, Guy DG, Crawley B & Goldberg AP (1993) The importance of dietary protein in healing pressure ulcers. *Journal of the American Geriatric Society* **41,** 357-362.

British Heart Foundation (2000) *European Cardiovascular Disease Statistics*. London: British Heart Foundation.

Bruun LI, Bosaeus I, Bergstad I & Nygaard K (1999) Prevalence of malnutrition in surgical patients: evaluation of nutritional support and documentation. *Clinical Nutrition* **18,** 141-147.

Brynes AE, Stratton RJ, Wright L & Frost GS (1998) Energy intakes fail to meet requirements on texture modified diets. *Proceedings of the Nutrition Society* **57,** 117A.

Burr ML & Phillips KM (1984) Anthropometric norms in the elderly. *British Journal of Nutrition* **51,** 165-169.

Busby GP, Mullen JL, Mathews DC, Hobbs CL & Rosato EF (1980) Prognostic nutritional index in gastrointestinal surgery. *American Journal of Surgery* **139,** 160-167.

Busby GP, Knox LS, Crosby LO, Eisenberg JM, Haakenson CM, McNeal GE, Page CP, Peterson DL, Reinhardt GF & Williford WO (1988) Study protocol: a randomised clinical trial of total parenteral nutrition in malnourished surgical patients. *American Journal of Clinical Nutrition* **47,** 366S-381S.

Butler RN (1997) Population ageing and health. *British Medical Journal* **315,** 1082-1084.

Butterworth CE (1974) The skeleton in the hospital closet. *Nutrition Today* **9,** 4-8.

Buttriss J (1999) Nutrition in older people - the findings of a national survey. *Journal of Human Nutrition and Dietetics* **12,** 461-466.

Campbell AJ, Spears GFS, Brown JS, Busby WJ & Borrie MJ (1990) Anthropometric measurements as predictors of mortality in a community population aged 70 years and over. *Age and Ageing* **19,** 131-135.

Campos ACL & Meguid MM (1992) A critical appraisal of the usefulness of peri-operative nutritional support. *American Journal of Clinical Nutrition* **55,** 117-130.

Cardiovascular Health Strategy Group (1999) *Building Healthier Hearts - The Report of the Cardiovascular Health Strategy Group*. Dublin: The Stationery Office.

Carr CS, Eddie Ling KD, Boulos P & Singer M (1996) Randomised trial of safety and efficacy of immediate postoperative enteral feeding in patients undergoing gastrointestinal resection. *British Medical Journal* **312,** 869-871.

Cederholm T, Jagren C, Hellstrom K (1993) Nutritional status and performance capacity in internal medical patients. *Clinical Nutrition* **12,** 8-14.

Cella DF & Tulsky DS (1990) Measuring quality of life today: methodological aspects. *Oncology* **4,** 29-38.

Central Statistics Office (1986) *The National Census of Ireland.* Cork: Central Statistics Office.

Central Statistics Office (1996) *The National Census of Ireland.* (Personal Communication).

Central Statistics Office (1997) *Census 96 - Volume 2, Principal Demographic Results.* Cork: Central Statistics Office.

Central Statistics Office (1999) *Census 96 - Volume 7, Occupations.* Cork: Central Statistics Office.

Chandra RK (1992) Effect of vitamin and trace-element supplementation on immune response and infection in elderly people. *Lancet* **340,** 1124-1127.

Chandra RK (1997) Nutrition and the immune system: an introduction. *American Journal of Clinical Nutrition* **66,** 460S-463S.

Charles R (1998) Nutritional assessment methods for the older Irish adult in the clinical and community settings. *Proceedings of the Nutrition Society* **57,** 599-602.

Charney P (1995) Nutrition Assessment in the 1990s: Where are we now? *Nutrition in Clinical Practice* **10,** 131-139.

Chiarelli A, Enzi G, Casadei A, Baggio B, Valerio A & Mazzoleni F(1990) Very early nutrition supplementation in burned patients. *American Journal of Clinical Nutrition* **51,** 1035-1039.

Chicago Society of Actuaries (1959) *Build and Blood Pressure Study*, vols. 1 and 11. Chicago, IL.: Chicago Society of Actuaries.

Christensen T, Bendix T & Kehlet H (1982) Fatigue and cardiorespiratory function following abdominal surgery. *British Journal of Surgery* **69,** 417-419.

Christou N (1990) Perioperative nutritional support: immunologic defects. *Journal of Parenteral and Enteral Nutrition* **14,** 186S-192S.

Chumlea WC, Roche AF & Webb P (1984) Body size, subcutaneous fatness and total body fat in older adults. *International Journal of Obesity* **8,** 311-317.

Chumlea WC, Roche AF & Steinbaugh ML (1985) Estimating stature from knee height for persons 60-90 years of age. *Journal of the American Geriatric Society* **33,** 116-120.

Chumlea WC, Steinbaugh ML, Roche AF, Mukherjee D, Gopalaswamy N (1985) Nutritional anthropometric assessment in elderly persons 65 to 90 years of age. *Journal of Nutrition in the Elderly* **4,** 39-51.

Chumlea WC, Roche AF & Mukherjee D (1986) Some anthropometric indices of body composition for elderly adults. *Journal of Gerontology* **41,** 36-39.

Chumlea WC, Roche AF & Mukherjee D (1987) *Nutritional Assessment of the Elderly Through Anthropometry*. Columbus, OH: Ross Laboratories.

Church JM, Choong SY & Hill GL (1984) Abnormalities of muscle metabolism and histology in malnourished patients awaiting surgery: effects of a course on intravenous nutrition. *British Journal of Surgery* **71,** 563-569.

Clevenger FW & Rodriguez DJ (1995) Decision-making for enteral feeding administration: the why behind where and how. *Nutrition in Clinical Practice* **10,** 104-113.

Coats KG, Morgan SL, Bartolucci AA & Weinsier RL (1993) Hospital-associated malnutrition: a reevaluation 12 years later. *Journal of the American Dietetic Associ*ation **93,** 27-33.

Cohendy R, Gros T, Arnaud-Battandier F, Tran G, Plaze JM & Eledjam J-J (1999) Preoperative nutritional evaluation of elderly patients: the mini nutritional assessment as a practical tool. *Clinical Nutrition* **18,** 345-348.

Cole TJ (1993) The use and construction of anthropometric growth reference standards. *Nutrition Research Reviews* **6,** 19-50.

Congleton J (1999) The pulmonary cachexia syndrome: aspects of energy balance. *Proceedings of the Nutrition Society* **58,** 321-328.

Cornoni-Huntley JC, Harris TB, Everett DF, Albanes D, Micozzi MS, Miles TP & Feldman JJ (1991) An overview of body weight of older persons, including the impact on mortality. The National Health and Nutrition Examination Survey. I - Epidemiologic follow-up study. *Journal of Clinical Epidemiology* **44,** 743-753.

Covinsky KE, Martin GE, Beyth RJ, Justice AC, Sehgal AR & Landefeld CS (1999) The relationship between clinical assessments of nutritional status and adverse outcomes in older hospitalized medical patients. *Journal of the American Geriatric Society* **47,** 532-538.

Daly JM, Redmond HP & Gallagher H (1992) Perioperative nutrition in cancer patients. *Journal of Parenteral and Enteral Nutrition* **16,** 100S-105S.

Daly JM, Weintraub FN, Shou J, Rosato EF & Lucia M (1995) Enteral therapy during multimodality therapy in upper gastrointestinal cancer patients. *Annals of Surgery* **221,** 327-338.

Davies L & Knutson KC (1991) Warning signals for malnutrition in the elderly. *Journal of the American Dietetic Association* **91,** 1413-17.

De Blaauw I, Deutz NEP & von Meyenfeldt MF (1997*a*) Metabolic changes in cancer cachexia - first of two parts. *Clinical Nutrition* **16,** 169-176.

De Blaauw I, Deutz NEP & von Meyenfeldt MF (1997*b*) Metabolic changes of cancer cachexia - second of two parts. *Clinical Nutrition* **16,** 223-228.

de Fine Olivarius N, Andreasen AH & LØken J (1997) Accuracy of 1-, 5- and 10-year body weight recall given a standard questionnaire. *International Journal of Obesity* **21,** 67-71.

De Groot CPGM, Beck AM, Schroll M & Van Staveren WA (1998) Evaluating the DETERMINE your nutritional health checklist and the mini nutritional assessment as tools to identify nutritional problems in elderly Europeans. *European Journal of Clinical Nutrition* **52,** 877-883.

De Groot CPGM, Van den Broek T & Van Staveren W (1999) Energy intake and micronutrient intake in elderly Europeans: seeking the minimum requirement in the SENECA study. *Age and Ageing* **28,** 469-474.

De Jong PCM, Wesdorp RICO, Volovics A, Rouffart M, Greep JM & Soeters PB (1985) The value of objective measurements to select patients who are malnourished. *Clinical Nutrition* **4,** 61-66.

Delarue J, Constans T, Malvy D, Pradignac A, Court C & Lamas F (1994) Anthropometric values in an elderly French population. *British Journal of Nutrition* **71,** 295-302.

Delmi M, Rapin C-H, Bengoa J-M, Delmas PD, Vasey H & Bonjour J-P (1990) Dietary supplementation in elderly patients with fractured neck of femur. *Lancet* **335,** 1013-1016.

DelPrete LR, Caldwell M, English C, Banspach SW & Lefebvre C (1992) Self-reported and measured weights and heights of participants in community-based weight loss programs. *Journal of the American Dietetic Association* **92,** 1483-1486.

Dempsey DT, Mullen JL & Busby GP (1988). The link between nutritional status and clinical outcome: can nutritional intervention modify it? *American Journal of Clinical Nutrition* **47,** 352-356.

Department of Health (1979) *Report on Health and Social Subjects: 15. Recommended Daily Amounts of Food energy and Nutrients for groups of People in the United Kingdom.* London: The Stationery Office.

Department of Health (1992) *Report on Health and Social Subjects: 43. The Nutrition of Elderly People.* London: The Stationery Office.

Department of Health (1994) *Nutritional Aspects of Cardiovascular Disease. Report of the Cardiovascular Review Group committee on medical aspects of food policy.* London: The Stationery Office.

Department of Health (1999) *Health Survey for England: Cardiovascular Disease 1998.* London: The Stationery Office.

Detsky AS, Baker JP, Mendelson RA, Wolman SL, Wesson DE & Jeejeebhoy KN (1984) Evaluating the accuracy of nutritional assessment techniques applied to hospitalized patients: methodology and comparisons. *Journal of Parenteral and Enteral Nutrition* **8,** 153-160.

Detsky AS, Baker JP, O'Rourke K, Johnston N, Whitwell J, Mendelson RA & Jeejeebhoy KN (1987*a*) Predicting nutrition-associated complications for patients undergoing gastrointestinal surgery. *Journal of Parenteral and Enteral Nutrition* **11,** 440-446.

Detsky AS, Mc Laughlin JR, Baker JP, Johnson N, Whittaker S, Mendelson RA & Jeejeebhoy KN (1987*b*) What is subjective global assessment of nutritional status? *Journal of Parenteral and Enteral Nutrition* **11,** 8-13.

Detsky AS & Smalley PS (1994) Is this patient malnourished? *Journal of the American Medical Association* **271,** 54-58.

De Wys WD, Begg C, Lavin PT, Band PR, Bennett JM, Bertino JR, Cohen MH, Douglass HO Jr., Engstrom PF, Ezdinli EZ, Horton J, Johnson GJ, Moertel CG, Oken MM, Perlia C, Rosenbaum C, Silverstein MN, Skeel RT, Sponzo RW & Tormey DC (1980) Prognostic effect of weight loss prior to chemotherapy in cancer patients. Eastern Cooperative Oncology Group. *American Journal of Medicine* **69,** 491-497.

Dionigi R, Cremaschi RE, Jemos V, Dominioni L & Monico R (1986) Nutritional assessment and severity of illness classification systems: a critical review on their clinical relevance. *World Journal of Surgery* **10,** 2-11.

Donahoe M, Rogers RM, Wilson DO & Pennock BE (1989) Oxygen consumption of the respiratory muscles in normal and in malnourished patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease* **140,** 385-391.

Doshi MK, Lawson R, Ingoe LE, Colligan JM, Barton JR & Cobden I (1998) Effect of nutritional supplementation on clinical outcome in post-operative orthopaedic patients. *Clinical Nutrition* **17,** 30A.

Dougherty D, Bankhead R, Kushner R, Mirtallo J & Winkler M (1995) Nutrition care given new importance in JCAHO standards. *Nutrition in Clinical Practice* **10,** 26-31.

Doweiko J & Nompleggi D (1991) Role of albumin in human physiology and pathophysiology. *Journal Of Parenteral and Enteral Nutrition* **15,** 207-211.

Dowling HJ & Pi-Sunyer FX (1993) Race-dependent health risks of upper body obesity. *Diabetes* **42,** 537-543.

Doyle M, Corish C, Flood P & Kennedy NP (1998) Can patients' knowledge of their own weight and height be used to replace measured weight and height in the calculation of BMI. *Proceedings of the Nutrition Society* **57,** 165A.

Durnin JVGA & Womersley J (1974) Body fat assessed from total body density and its estimation from skinfold thickness. *British Journal of Nutrition* **32,** 77-97.

Durnin JVGA & Lean MEJ (1992) Nutrition - consideration for the elderly. In *Textbook of Geriatric Medicine and Gerontology*, pp. 592-611 [JC Brocklehurst, RC Tallis and HM Fillit, editors]. London: Churchill Livingstone.

Dwyer JT, Coleman A, Krall E, Yang GA, Scanlan M, Galper L, Winthrop E & Sullivan P (1987): Changes in relative weight among institutionalised elderly patients. *Journal of Gerontology* **42,** 246-251.

Dwyer JT, Gallo JJ & Reichel W (1993) Assessing nutritional status in elderly patients. *American Family Physician* **47,** 613-620.

Edington J, Kon P & Martyn CN (1996) Prevalence of malnutrition in general practice. *Clinical Nutrition* **15,** 60-63.

Edington J, Kon P & Martyn CN (1997) Prevalence of malnutrition after major surgery. *Journal of Human Nutrition and Dietetics* **10,** 111-116.

Efthimiou J, Fleming J, Gomes C & Spiro SG (1988) The effect of supplementary oral nutrition in poorly nourished patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease* **137,** 1075-1082.

Ek AC & Bjurulf P (1987) Interrater variability in a modified Norton Scale. *Scandinavian Journal of Caring Sciences* **1,** 99-102.

Ek AC, Larsson F, von Schenck H, Thorslund S, Unosson M & Bjurulf P (1990) The correlation between anergy, malnutrition and clinical outcome in an elderly hospital population. *Clinical Nutrition* **9,** 185-189.

Elia M (1995) Changing concepts of nutrient requirements in disease: implications for artificial nutritional support. *Lancet* **345,** 1279-1284.

Elmore MF, Wagner DR, Knoll DM, Eizember L, Oswalt MA, Glowinski EA & Rapp PA (1994) Developing an effective adult nutrition screening for a community hospital. *Journal of the American Dietetic Association* **94,** 1113-1118.

European Heart Network (1999) *Physical Activity and Cardiovascular Disease Prevention in the European Union.* Brussels: European Heart Network.

Eveleth PB & Tanner JM (1990) *Worldwide Variation in Human Growth*, 2nd ed. Cambridge: Cambridge University Press.

Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults (1998) Clinical guidelines on the identification, evaluation, and treatment of overweight in adults. *American Journal of Clinical Nutrition* **68,** 899-917.

Falciglia G, O'Connor J & Gelding E (1988) Upper arm anthropometric norms in elderly white subjects. *Journal of the American Dietetic Association* **88,** 569-574.

Fellows IW, Macdonald IA, Bennett T & Allison SP (1985) The effect of undernutrition on thermoregulation in the elderly. *Clinical Science* **69,** 525-523.

Fenton J, Eves A, Kipps M, O'Donnell CC (1995) The nutritional implications of food wastage in continuing care wards for elderly patients with mental health problems. *Journal of Human Nutrition and Dietetics* **8,** 239-248.

Fergusan RP, O'Connor P, Crabtree B, Batchelor A, Mitchell J & Coppola D (1993) Serum albumin and prealbumin as predictors of clinical outcomes of hospitalised elderly nursing home residents. *Journal of the American Geriatric Society* **41,** 545-549.

Ferro-Luzzi A & James WPT (1996) Adult malnutrition: simple assessment techniques for use in emergencies. *British Journal of Nutrition* **75,** 3-10.

Fiatarone MA, Marks EC, Ryan ND, Meredith CN, Lipsitz LA & Evans WJ (1990) High intensity strength training in nonagenarians. Effects on skeletal muscle. *Journal of the American Medical Association* **263,** 3029-3034.

Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, Nelson ME, Roberts SB, Kehayias JJ, Lipsitz LA & Evans WJ (1994) Exercise training and nutritional supplementation for physical frailty in very elderly people. *New England Journal of Medicine* **330,** 1769-1775.

Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G & Clarke PC (1998) *National Diet and Nutrition Survey: People Aged 65 years and Over. Vol. 1: Report of the Diet and Nutrition Survey.* London: The Stationery Office.

Fischer JE (1982) Nutritional assessment before surgery. *American Journal of Clinical Nutrition* **35,** 1128-1131.

Fischer J & Johnson MA (1990) Low body weight and weight loss in the aged. *Journal of the American Dietetic Association* **90,** 1697-1706.

Fitzpatrick R, Fletcher A, Gore S, Jones D, Spiegelhalter D & Cox D (1992) Quality of life measures in health care. Part 1: applications and issues in assessment. *British Medical Journal* **305,** 1074-1077.

Flegal KM, Carroll MD, Kuczmarski RJ & Johnson CL (1998) Overweight and obesity in the United States: prevalence and trends, 1960-1994. *International Journal of Obesity Related Metabolic Disorders* **22,** 39-47.

Fletcher A, Gore S, Jones D, Fitzpatrick R, Spiegelhalter D & Cox D (1992) Quality of life measures in health care. Part 2: design, analysis, and interpretation. *British Medical Journal* **305,** 1145-1148.

Fogarty J & Nolan G (1992) Assessment of the nutritional status of rural and urban elderly living at home. *Irish Medical Journal* **85,** 14-16.

Food Safety Authority of Ireland (1999) *Recommended Dietary Allowances for Ireland.* Dublin: Food Safety Authority of Ireland.

Forse RA & Shizgal HM (1980) The assessment of malnutrition. *Surgery* **88,** 17-24.

Fowler HW & Fowler FG (1991) In *The Concise Oxford Dictionary of Current English,* [RE Allan, editor]. London: Oxford University Press.

Friedmann JM, Jensen GL, Smiciklas-Wright H & McCamish MA (1997) Predicting early nonelective hospital readmission in nutritionally compromised older adults. *American Journal of Clinical Nutrition* **65,** 1714-1720.

Fries JF (1980) Ageing, natural death and the compression of morbidity. *New England Journal of Medicine* **313,** 407-428.

Fries JF (1996) Physical activity, the compression of morbidity and the health of the elderly. *Journal of the Royal Society of Medicine* **89,** 64-68.

Frisancho AR (1981) New norms of upper limb fat and muscle areas for assessment of nutritional status. *American Journal of Clinical Nutrition* **34,** 2540-2545.

Frontera WR, Hughes VA, Lutz KJ & Evans WJ (1991) A cross-sectional study of muscle stength and mass in 45 to 78 year old men and women. *Journal of Applied Physiology* **71,** 644-650.

Gall MJ, Grimble GK, Reeve NJ and Thomas SJ (1998*a*) Providing fortified meals and between-meal snacks significantly increases energy intake of hospital patients. *Proceedings of the Nutrition Society* **57,** 95A.

Gall MJ, Grimble GK, Reeve NJ and Thomas SJ (1998*b*) Effect of providing fortified meals and between meal snacks on energy and protein intake of hospital patients. *Clinical Nutrition* **17,** 259-264.

Gallagher-Allred CR, Coble Voss C, Finn SC, McCamish MA (1996) Malnutrition and clinical outcomes: the case for medical nutrition therapy. *Journal of the American Dietetic Association* **96,** 361-366, 369.

Galuska DA, Serdula M, Pamuk E, Siegel PZ & Byers T (1996) Trends in overweight among US adults from 1987 to 1993: a multistate telephone survey. *American Journal of Public Health* **86,** 1729-1735.

Gariballa SE, Parker SG, Taub N & Castleden M (1998*a*) Nutritional status of hospitalized acute stroke patients. *British Journal of Nutrition* **79,** 481-487.

Gariballa SE, Parker SG, Taub N & Castleden CM (1998*b*) Influence of nutritional status on clinical outcome after acute stroke patients. *American Journal of Clinical Nutrition* **68,** 275-281.

Gariballa SE & Sinclair AJ (1998) Nutrition, ageing and ill health. *British Journal of Nutrition* **80,** 7-23.

Garofalo JA & Hynak-Hankinson MT (1995) New Jersey's screening initiative: activities and results. *Journal of the American Dietetic Association* **95,** 1422-1424.

Garrow JS (1981) *Treat Obesity Seriously-A Clinical Manual.* London: Churchill Livingstone.

George L (1994) Screen patients on admission (Letter). *British Medical Journal* **308,** 1369.

Giampaoli S, Ferrucci L, Cecchi F, Noce CL, Poce A, Dima F, Santaquilani A, Vescio MF & Menotti A (1999) Hand-grip strength predicts incident disability in non-disabled older men. *Age and Ageing* **28,** 283-288.

Gianotti L, Braga M, Radaelli G, Mariani L, Vignali A & Carlo VD (1995) Lack of improvement of prognostic performance of weight loss when combined with other parameters. *Nutrition* **11,** 12-16.

Giner M, Laviano A, Meguid MM & Gleason JR (1996) In 1995 a correlation between malnutrition and poor outcome still exists. *Nutrition* **12,** 23-29.

Granieri E (1990) Nutrition and the older adult. *Dysphagia* **4,** 196-201.

Grant JP, Custer PB & Thurlow J (1981) Current techniques of nutritional assessment. *Surgical Clinics of North America* **61,** 437-463.

Gray-Donald K, Gibbons L, Shapiro SH & Martin JG (1989) Effects of nutritional state on exercise performance in patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease* **140,** 1544-1548.

Green CJ (1999) Existence, causes and consequences of disease-related malnutrition in the hospital and the community, and clinical and financial benefits of nutritional intervention. *Clinical Nutrition* **18,** 3-28.

Gregory J, Foster K, Tyler H & Wiseman M (1990) *The Dietary and Nutritional Survey of British Adults*. London: HM Stationery Office.

Guigoz Y, Vellas B & Garry PJ (1994) Mini nutritional assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology*, pp. 15-60. Paris: Serdi.

Guigoz Y, Vellas B & Garry PJ (1996) Assessing the nutritional status of the elderly: the mini nutritional assessment as part of the geriatric assessment. *Nutrition Reviews* **54,** 59S-65S.

Guo SS, Zeller C, Chumlea CC & Siervogel RM (1999) Ageing, body composition, and lifestyle: the Fels Longitudinal Study. *American Journal of Clinical Nutrition* **70,** 405-411.

Haboubi NY, Hudson PR & Pathy MS (1990) Measurement of height in the elderly. *Journal of the American Geriatric Society* **38,** 1008-1010.

Hammerlid E, Wirblad B, Sandin C, Mercke C, Edstrom S, Kaasa S, Sullivan M & Westin T (1998) Malnutrition and food intake in relation to quality of life in head and neck cancer patients. *Head and Neck* **20,** 540-548.

Hamwi GJ (1964) Therapy: changing dietary concepts. In *Diabetes Mellitus: Diagnosis and treatment*, pp. 73-78 [TS Danowski, editor]. New York: American Diabetes Association Inc.

Han TS & Lean ME (1996) Lower leg length as an index of stature in adults. *International Journal of Obesity Related Metabolic Disorders* **20,** 21-27.

Hanger HC, Smart EJ, Merrilees MJ & Frampton CM (1999) The prevalence of malnutrition in elderly hip fracture patients. *New Zealand Medical Journal* **112,** 88-90.

Hankey CR, Summerbell J & Wynne HA (1993) The effect of dietary supplementation in continuing care elderly people. *Journal of Human Nutrition and Dietetics* **6,** 317-322.

Harris T, Cook EF, Garrison R, Higgins M, Kannel W & Goldman L (1988) Body mass index and mortality among nonsmoking older persons. The Framingham Heart Study. *Journal of the American Medical Association* **259,** 1520-1524.

Harvey KB, Moldawer LL, Bistrian BR & Blackburn GL (1981) Biological measures for the formulation of a hospital prognostic index. *American Journal of Clinical Nutrition* **34,** 2013-2022.

Haydock DA & Hill GL (1986) Impaired wound healing in surgical patients with varying degrees of malnutrition. *Journal of Parenteral and Enteral Nutrition* **10,** 550-554.

Haydock DA & Hill GL (1987) Improved wound healing response in surgical patients receiving intravenous nutrition. *British Journal of Surgery* **74,** 320-323.

Heber D, Blackburn GL & Go VLW (1999) In *Nutritional Oncology* [Heber D, Blackburn GL & Go VLW, editors]. London: Academic Press.

Heffernan A & Moloney M (2000) Patient satisfaction and food wastage in a private hospital - a comparison with two public hospitals. *Proceedings of the Nutrition Society* (In the Press).

Heslin MJ, Latkany L, Leung D, Brooks AD, Hochwald SN, Pisters PWT, Shike M & Brennan MF (1997) A prospective randomised trial of early enteral feeding after resection of upper gastrointestinal malignancy. *Annals of Surgery* **226,** 567-580.

Heymsfield SB, Bethel RA, Ansley JD, Gibbs DM, Felner JM & Nutter DO (1978) Cardiac abnormalities in cachectic patients before and during nutritional repletion. *American Heart Journal* **95,** 584-593.

Heymsfield SB, McManus C, Stevens V & Smith J (1982*a*) Muscle mass: reliable indicator of protein-energy malnutrition severity and outcome. *American Journal of Clinical Nutrition* **35,** 1192-1199.

Heymsfield SB, McManus C, Smith J, Stevens V & Nixon DW (1982*b*) anthropometric measurements of muscle mass: revised equations for calculating bone free arm muscle area. *American Journal of Clinical Nutrition* **36,** 680-690.

Heys SD, Gough DB & Eremin O (1996) Is nutritional support in patients with cancer undergoing surgery beneficial? *European Journal of Surgical Oncology* **22,** 292-297.

Heys SD, Walker LG & Eremin O (1997) The value of peri-operative nutrition in the sick patient. *Proceedings of the Nutrition Society* **56,** 443-457.

Hickson M, Nicholl C, Bulpitt C, Fry M, Frost G & Davies L (1999) The design of the feeding support trial - does intensive feeding support improved nutritional status and outcome in acutely ill older in-patients. *Journal of Human Nutrition and Dietetics* **12,** 53-59.

Hill GL, Blackett RL, Pickford I, Birkenshaw L, Young GA, Warren JB, Schorah CG & Morgan DB (1977) Malnutrition in surgical patients: an unrecognised problem. *Lancet* **i,** 689-692.

Hill GL (1992) Body composition research: implications for the practice of clinical nutrition. *Journal of Parenteral and Enteral Nutrition* **16**, 197-218.

Hill AA, Plank LD, Finn PJ, Whalley GA, Sharpe N, Clarke MA & Hill GL (1997) Massive nitrogen loss in critical surgical illness. Effect on cardiac mass and function. *Annals of Surgery* **226,** 191-197.

Hodkinson HM (1973) Non-specific presentation of illness. *British Medical Journal* **4,** 94-96.

Hofman A, Grobbee DE, de Jong PTVM & Van den Ouweland FA (1991) Determinants of disease and disability in the elderly: the Rotterdam elderly study. *European Journal of Epidemiology* **7,** 403-422.

Hogarth MB, Marshall P, Lovat LB, Palmer AJ, Frost GS, Fletcher AE, Nicholl CG & Bulpitt CJ (1996) Nutritional supplementation in elderly medical in-patients: a double-blind placebo-controlled trial. *Age Ageing* **25,** 453-457.

Hospital In-patient Enquiry (1995) *St. James's and Meath Hospitals.* (Personal Communication).

Hunt SM, McKenna SP, McEwen J, Beckett EM Williams J & Pape E (1980) A quantitative approach to perceived health status: a validation study. *Journal of Epidemiology and Community Health* **34,** 281-286.

Hunter AMB (1996) Nutrition management of patients with neoplastic disease of the head and neck treated with radiation therapy. *Nutrition in Clinical Practice* **11,** 157-169.

Hurson M, Corish C & Sugrue S (1997) Dietary intakes in Ireland of a healthy elderly population. *Irish Journal of Medical Science* **166,** 220-224.

Hwang T-L, Lue M-C, Nee Y-J, Jan Y-Y & Chen M-F (1994) The incidence of diarrhoea in patients with hypoalbuminaemia due to acute or chronic malnutrition during enteral feeding. *American Journal of Gastroenterology* **89,** 376-378.

Incalzi RA, Gemma A, Capparella O, Cipriani L, Landi F & Carbonin P (1996) Energy intake and in-hospital starvation. A clinically relevant relationship. *Archives of Internal Medicine* **156,** 425-429.

Ingenbleek Y & Carpentier YA (1985) A prognostic inflammatory and nutritional index scoring critically ill patients. *International Journal of Vitamin Nutrition Research* **55,** 91-101.

Institute of European Food Studies (1999) *A Pan-EU Survey on Consumer Attitudes to Physical Activity, Body-weight and Health.* Dublin: Institute of European Food Studies.

Intersociety Professional Nutrition Education Consortium (1998) Bringing physician nutrition specialists into the mainstream: rationale for the Intersociety Professional Nutrition Education Consortium. *American Journal of Clinical Nutrition* **68,** 894-898.

Jackson AA (1996) Nutrition in the undergraduate medical curriculum. *Proceedings of the Nutrition Society* **55,** 775-781.

James WP, Mascie-Taylor GC, Norgan NG, Bistrian BR, Shetty PS & Ferro-Luzzi A (1994) The value of arm circumference measurements in assessing chronic energy deficiency in Third World adults. *European Journal of Clinical Nutrition* **48,** 883-894.

Jamieson CP, Norton B, Day T, Lakeman M & Powell-Tuck J (1997) The quantitative effect of nutrition support on quality of life in outpatients. *Clinical Nutrition* **16,** 25-28.

Jebb SA (1999) Obesity: from molecules to man. *Proceedings of the Nutrition Society* **58**, 1-14.

Jeejeebhoy KN (1988) The functional basis of assessment. In *Nutrition and Metabolism in Patient Care,* pp.739-751[JM Kinney, KN Jeejeebhoy, GL Hill and OE Owen, editors]. Philadelphia: WB Saunders.

Jeejeebhoy KN, Detsky AS & Baker JP (1990) Assessment of nutritional status. *Journal of Parenteral and Enteral Nutrition.* **14,** 193-196S.

Jeejeebhoy KN (1995) Functional studies; state of the art. *American Society for Parenteral and Enteral Nutrition,* 151-155.

Jensen GL, Kita K, Fish J, Heydt D & Frey C (1997) Nutrition risk screening characteristics of rural older persons: relation to functional limitations and health care charges. *American Journal of Clinical Nutrition* **66,** 819-828.

Jensen MB & Hessov I (1997) Randomization to nutritional intervention at home did not improve postoperative function, fatigue or well-being. *British Journal of Surgery* **84,** 113-118.

Jones L (1999) The nutrition of elderly people. *Journal of Human Nutrition and Dietetics* **12,** 483.

Kawerk N, Succari-Aderschlag M & Foglietti MJ (1991) Microheterogeneity of alpha-1 glycoprotein in healthy elderly subjects: patterns obtained by crossed affino-immunoelectrophoresis. *Clinica Chimica Acta* **202,** 65-72.

Keele AM, Bray MJ, Emery PW, Duncan HD & Silk DBA (1997) Two phase randomised controlled clinical trial of postoperative oral dietary supplements in surgical patients. *Gut* **40,** 393-399.

Keller HH (1993) Malnutrition in institutionalized elderly: how and why? *Journal of the American Geriatric Society* **41,** 1212-1218.

Kenler AS, Swails WS, Driscoll DF, DeMichele SJ, Daley B, Babineau TJ, Peterson MB & Bistrian BR (1996) Early enteral feeding in postsurgical cancer patients. *Annals of Surgery* **223,** 316-333.

Khaw K-T (1997) Healthy ageing. *British Medical Journal* **315,** 1090-1096.

Kilkenny Health Project (1992) *A Pilot Programme for Coronary Heart Disease Prevention in Ireland 1985-1990.* Kilkenny: Kilkenny Health Project.

Kinosian B, Hooper F & al-Ibrahim M (1994). Assessing the risk of malnutrition-associated complications (NACs) among elderly medical inpatients. *Nutrition* **10,** 481A.

Klein S (1990) The myth of serum albumin as a measure of nutritional status. Gastroenterology **99,** 1845-1851.

Klein S, Kinney J, Jeejeebhoy K, Alpers D, Hellerstein M, Murray M & Twomey P (1997) Nutrition support in clinical practice: review of published data and recommendations for future research directions. Summary of a conference sponsored by the National Institutes of Health, American Society for Parenteral and Enteral Nutrition,

and American Society for Clinical Nutrition. *American Journal of Clinical Nutrition* **66,** 683-706.

Klidjian AM, Foster KJ, Kammerling RM, Cooper A & Karran SJ (1980) Relation of anthropometric and dynamometric variables to serious postoperative complications. *British Medical Journal* **281,** 899-901.

Knowles JB, Fairburn MS, Wiggs BJ, Chan-Yan C & Pardy R (1988) Dietary supplementation and respiratory muscle performance in COPD. *Chest* **93,** 977-983.

Kovacevich DS, Boney AR, Braunschweig CL, Perez A & Stevens M (1997) Nutrition risk classification: a reproducible and valid tool for nurses. *Nutrition in Clinical Practice* **12,** 20-25.

Kudsk KA (1994) Gut mucosal nutrition support - enteral nutrition as primary therapy after multiple system trauma. *Gut* **51,** 552-554.

Kwok T & Whitelaw MN (1991) The use of armspan in nutritional assessment of the elderly. *Journal of the American Geriatric Society* **39,** 492-496.

Landi F, Zuccala G, Gambassi G, Incalzi RA, Manigrasso L, Pagano F, Carbonin P & Bernabei R (1999) Body mass index and mortality among older people living in the community. *Journal of the American Geriatric Society* **47,** 1072-1076.

Lansey S, Waslien C, Mulvihill M & Fillit H (1993) The role of anthropometry in the assessment of malnutrition in the hospitalized frail patient. *Gerontology* **39,** 346-353.

Larsson J, Unosson M, Ek AC, Nilsson L, Thorslund S & Bjurulf P (1990) Effect of dietary supplement on nutritional status and clinical outcome in 501 geriatric patients-a randomised study. *Clinical Nutrition* **9,** 179-184.

Larsson J, Akerlind I, Permerth J & Hornvist JO (1994) The relation between nutritional state and quality of life in surgical patients. *European Journal of Surgery* **160,** 329-334.

Latin RW, Johnson SC & Ruhling RO (1987) An anthropometric estimation of body composition of older men. *Journal of Gerontology* **42,** 24-28.

Launer LJ & Harris T (1996) Weight, height and body mass index distribution in geographically and ethnically diverse samples of older persons. *Age and ageing* **25,** 300-306.

Lee P & Cunningham K (1990) *Irish National Nutrition Survey*. Dublin: Irish Nutrition and Dietetic Institute.

Lehmann AB, Bassey EJ, Morgan K & Dalosso HM (1991) Normal values for weight, skeletal size and body mass indices in 890 men and women aged over 65 years. *Clinical Nutrition* **10,** 18-22.

Lehmann AB & Bassey EJ (1996) Longitudinal weight changes over four years and associated health factors in 629 men and women aged over 65. *European Journal of Clinical Nutrition* **50,** 6-11.

Lennard-Jones JE (1992) *A Positive Approach to Nutrition as a Treatment. Report of a Working Party on the Role of Enteral and Parenteral Feeding in Hospital and at Home.* London: Kings Fund Centre.

Lennard-Jones JE (1998) *Ethical and Legal Aspects of Clinical Hydration and Nutritional Support. A report for the British Association for Enteral and Parenteral Nutrition.* Maidenhead: BAPEN.

Lennard-Jones JE, Arrowsmith H, Davison C, Denham AF & Micklewright A (1995) Screening by nurses and junior doctors to detect malnutrition when patients are first assessed in hospital. *Clinical Nutrition* **14,** 336-340.

Lewis MI, Sieck GC, Fournier M & Belman MJ (1986) Effect of nutritional deprivation on diaphragm contractility and muscle fibre size. *Journal of Applied Physiology* **60,** 596-603.

Lin HC & Van Citters GW (1997) Stopping enteral feeding for arbitrary gastric residual volume may not be physiologically sound: results of a computer simulation model. *Journal of Parenteral and Enteral Nutrition* **21,** 286-289.

Lindsted K, Tonstad S & Kuzma JW (1991) Body mass index and patterns of mortality among Seventh-day Adventist men. *International Journal of Obesity* **15,** 397-406.

Lipschitz DA, Ham RJ & White JV (1992) An approach to nutrition screening for older Americans. *American Family Physician* **45,** 601-608.

Lipski PS, Torrance A, Kelly PJ & James OF (1993) A study of nutritional deficits of long-stay geriatric patients. *Age and Ageing* **22,** 244-255.

Lumbers M, Driver LT, Howland RJ, Older MWJ & Williams CM (1996) Nutritional status and clinical outcome in elderly female surgical orthopaedic patients. *Clinical Nutrition* **15,** 101-107.

Lupo L, Pannarale O, Altomare D, Memeo V & Rubino M (1993) Reliability of clinical judgement in evaluation of the nutritional status of surgical patients. *British Journal of Surgery* **80,** 1553-1556.

McAleese P & Odling-Smee W (1994) The effect of complications on length of stay. *Annals of Surgery* **220,** 740-744.

McClave SA, Snider HL, Lowen CC, McLaughlin AJ, Greene LM, McCombs RJ, Rodgers L, Wright RA, Roy TM, Schumer MP & Pfeifer MA (1992) Use of residual volume as a marker for enteral feeding intolerance: prospective blinded comparison with physical examination and radiographic findings. *Journal of Parenteral and Enteral Nutrition* **16,** 99-105.

McClave SA, Snider HL & Spain DA (1999) Preoperative issues in clinical nutrition. *Chest* **115,** 64S-70S.

McDonald W, Sharpe C & Deitch E (1991) Immediate enteral feeding in burn patients is safe and effective. *Annals of Surgery* **213,** 177-183.

McEvoy AW & James OFW (1982) Anthropometric indices in normal elderly subjects. *Age and Ageing* **11,** 97-100.

McGlone PC, Dickerson JWT & Davies GJ (1995) The feeding of patients in hospital: a review. *Journal of the Royal Society of Health* **115,** 282-288.

Mc Glone PC, Davies GJ, Murcott A, Powell-Tuck J & Dickerson JWT (1997) Foods consumed by a Bengali population in a British hospital. *Proceedings of the Nutrition Society* **56,** 28A.

McLaren SM, Dickerson JWT & Wright J (1997) Nutrition support offered to stroke patients at mealtimes: a direct, non-participant observation study. *Proceedings of the Nutrition Society* **56,** 255A.

McWhirter JP, Hill K & Pennington CR (1994) The nutritional status of patients with gastrointestinal disease. *Nutrition* **10,** 495A.

McWhirter JP & Pennington CR (1994) Incidence and recognition of malnutrition in hospital. *British Medical Journal* **308,** 945-948.

Madden MA, Mc Cormick PA, Davidson B, Rolles K, Burroughs AK & Morgan MY (1994) Nutritional status and survival of patients after liver transplant. *Nutrition* **10,** 504A.

Maffulli N, Dougal TW, Brown MTF & Golden MHN (1999) Nutritional differences in patients with proximal femoral fractures. *Age and Ageing* **28,** 458-462.

Manandhar MC (1995) Functional ability and nutritional status of free-living elderly people. *Proceedings of the Nutrition Society* **54,** 677-691.

Manson JE, Stampfer MJ, Hennekens CH & Willett WC (1987) Body weight and longevity. A reassessment. *Journal of the American Medical Association* **257,** 353-358.

Marshall P, Hogarth MB, Frost GS, Martin S, Bartlett F, Bulpitt CJ, Nicholl CG & Lovat LB (1994) Energy intake in hospitalised elderly patients. *Proceedings of the Nutrition Society* **53,** 74A.

Martin, AL (1994) The nutrition support team. Surviving and thriving in an era of reform. *Nutrition in Clinical Practice* **9,** 226-232.

Marton KI, Sox HC & Krupp JR (1981) Involuntary weight loss: Diagnostic and prognostic significance. *Annals of Internal Medicine* **95,** 568-574.

Master AM, Lasser RP & Beckman BA (1960) Tables of average weight and height of Americans aged 65 to 94 years. *Journal of the American Medical Association* **172,** 658-662.

Mattila K, Haavisto M & Rajala S (1986) Body mass index and mortality in the elderly. *British Medical Journal* **292,** 867-868.

Mazolewski P, Turner JF, Baker M, Kurtz T & Little AG (1999) The impact of nutritional status on the outcome of lung volume reduction surgery: a prospective study. *Chest* **116,** 693-696.

Meguid MM, Campos ACL, Meguid V, Debonis D & Terz JJ (1988) IONIP, a criterion of surgical outcome and patient selection for perioperative nutrition support. *British Journal of Clinical Practice* **63,** 8-14.

Mercadente S (1996) Nutrition in cancer patients. *Support Care Cancer* **4,** 10-20.

Micozzi MS & Harris TM (1990) Age variations in the relation of body mass indices to estimates of body fat and muscle mass. *American Journal of Physical Anthropology* **81,** 375-379.

Mitchell CO & Lipschitz DA (1982) Detection of protein-calorie malnutrition in the elderly. *American Journal of Clinical Nutrition* **35,** 398-406.

Moore FA, Moore EE, Jones TN, McCroskey BL & Peterson VM (1989) TEN versus TPN following major abdominal trauma - reduced septic morbidity. *Journal of Trauma* **29,** 916-922.

Moore EE & Moore FA (1991) Immediate enteral nutrition following multisystem trauma: a decade perspective. *Journal of the American College of Nutrition* **10,** 633-648.

Moore FA, Feliciano DV, Andrassy RJ, McArdle AH, Booth FV, Morgenstein-Wagner TB, Kellum JM Jr., Welling RE & Moore EE (1992) Early enteral feeding compared with parenteral reduces postoperative septic complications: The results of a meta-analysis. *Annals of Surgery* **216,** 172-183.

Moore AA & Siu AL (1996) Screening for common problems in ambulatory elderly: clinical confirmation of a screening instrument. *The American Journal of Medicine* **100,** 438-443.

Moran BJ & Jackson AA (1993) Perioperative nutritional support. *British Journal of Surgery* **80,** 4-5.

Morgan DB, Hill GL & Burkinshaw L (1980) The assessment of weight loss from a single measurement of body weight: the problems and limitations. *American Journal of Clinical Nutrition* **33,** 2101-2105.

Morley JE, Mooradian AD, Silver AJ, Heber D & Alfin-Slater RB (1988) Nutrition in the elderly. *Annals of Internal Medicine* **109,** 890-904.

Morley JE & Silver AJ (1995) Nutritional issues in nursing home care. *Annals of Internal Medicine* **123,** 850-859.

Morley JE (1998) Protein-energy malnutrition in older subjects. *Proceedings of the Nutrition Society* **57,** 587-592.

Mowat EA, Thomas S, Hyatt R, Maxwell JD & Whitelaw MN (1992) A comparison of nutritional intake, functional status and muscle strength between elderly day hospital and day centre attenders in South London. *Journal of Human Nutrition and Dietetics* **5,** 35-51.

Mowe M, Bohmer T & Kindt E (1994) Reduced nutritional status in an elderly population (>70 y) is probable before disease and possibly contributes to the development of disease. *American Journal of Clinical Nutrition* **59,** 317-324.

Muhlethaler R, Stuck AE, Minder CE & Frey BM (1995) The prognostic significance of protein energy malnutrition in geriatric patients. *Age and Ageing* **24,** 193-197.

Mullen JL, Gertner MH, Busby GP, Goodhart GL & Rosato EF (1979) Implications of malnutrition in the surgical patient. *Archives of Surgery* **114,** 121-125.

Murray CJL & Lopez AD (1997*a*) Regional patterns of disability-free life expectancy and disability-adjusted life expectancy: global burden of disease study. *Lancet* **349,** 1347-1352.

Murray CJL & Lopez AD (1997*b*) Alternative projections of mortality and disability by cause 1990-2020: global burden of disease study. *Lancet* **349,** 1498-1504.

Naber THJ, Schermer T, de Bree A, Nusteling K, Eggink L, Kruimel JW, Bakkeren J, van Heereveld H & Katan MB (1997) Prevalence of malnutrition in nonsurgical hospitalized patients and its association with disease complications. *American Journal of Clinical Nutrition* **66**, 1232-1239.

National Dairy Council (2000) *Guidelines for the Treatment of Osteoporosis*. Dublin: National Dairy Council.

National Nutrition Surveillance Centre (1999*a*) *Annual Report: Dietary Habits of the Irish Population: Results from SLAN*. Galway: Centre for Health Promotion Studies.

National Nutrition Surveillance Centre (1999*b*) *The National Health and Lifestyle Surveys. Results from SLAN (Survey of Lifestyle, Attitude and Nutrition and HBSC (Health Behaviour in School-Aged Children).* Galway: Centre for Health Promotion Studies.

Nightingale JMD, Walsh N, Bullock ME & Wicks AC (1996) Three simple methods of detecting malnutrition on medical wards. *Journal of the Royal Society of Medicine* **89,** 144-148.

Nightingale JMD & Reeves J (1999) Knowledge about the assessment and management of undernutrition: a pilot questionnaire in a UK teaching hospital. *Clinical Nutrition* **18,** 23-27.

Nordenstrom J & Thorne A (1994) Benefits and complications of parenteral nutrition support. *European Journal of Clinical Nutrition* **48,** 531-537.

Norgan NG (1994) Population differences in body composition in relation to the body mass index. *European Journal of Clinical Nutrition* **48,** 10S-25S.

Norton B, Homer-Ward M, Donnelly DM, Long RG & Holmes GK (1996) A randomised prospective comparison of percutaneous endoscopic gastrostomy and nasogastric tube feeding after acute dysphagic stroke. *British Medical Journal* **312,** 13-16.

Odlind Olin A, Osterberg P, Hadell K, Armyr I, Jerstrom S & Ljunungqvist MD (1996) Energy-enriched hospital food to improve energy intake in elderly patients. *Journal of Parenteral and Enteral Nutrition* **20,** 93-97.

O' Neill D, McKiernan M, Gibney M, Walsh JB & Coakley D (1990) Dietary and anthropometric measures in mild to moderate senile dementia of the Alzheimer type (SDAT). *Journal of Human Nutrition and Dietetics* **3,** 177-181.

Organisation for Economic Co-operation and Development (1999) In *OECD Economic Surveys 1996-1997* pp. 116-151. Dublin: Organisation for Economic Co-operation and Development.

O'Toole S (1998) Measurement of body composition in elderly adults with peripheral vascular disease. BSc Thesis, University of Dublin, Trinity College.

Pattison R, Corr J, Ogilvie M, Farquhar D, Sutherland D, Davidson HIM & Richardson RA (1999) Reliability of a qualitative screening tool versus physical measurements in identifying undernutrition in an elderly population. *Journal of Human Nutrition and Dietetics* **12,** 133-140.

Paul AA, Cole TJ, Ahmed EA & Whitehead RG (1998) The need for revised standards for skinfold thickness in infancy. *Archives of Disease in Childhood* **78,** 354-358.

Payne-James JJ, de Gara CJ, Grimble GK, Bray MJ, Rana SK Kapadia D & Silk DBA (1992) Artificial nutrition support in hospitals in the United Kingdom-1991: Second national survey. *Clinical Nutrition* **11,** 187-192.

Payne-James JJ, deGara CJ, Grimble GK & Silk DBA (1995) Artificial nutrition support in hospitals in the United Kingdom-1994: Third national survey. *Clinical Nutrition* **14,** 329-335.

Peake HJ, Evans S, Chambers A, Riches C & Frost GS (1998) Nutritional supplementation: how much do people drink. *Proceedings of the Nutrition Society* **57,** 94A.

Pennington CR (1996) Malnutrition in hospital practice. *Nutrition* **12,** 56-57.

Pichard C, Hoshino E, Allard JP, Charlton MP, Atwood HL & Jeejeebhoy KN (1991) Intracellular potassium and membrane potential in rat muscles during malnutrition and subsequent refeeding. *American Journal of Clinical Nutrition* **54,** 489-498.

Pironi L, Ruggeri E, Tanneberger S, Giordani S, Pannuti F & Miglioli M (1997) Home artificial nutrition in advanced cancer: a 6-year survey in an Italian Health District. *Journal of the Royal Society of Medicine* **90,** 597-603.

Posner BM, Jette AM, Smith KW & Miller DR (1993) Nutrition and health risks in the elderly: the Nutrition Screening Initiative. *American Journal of Public Health* **83,** 972-978.

Posthauer ME, Dorse B, Foiles RA, Escott-Stump S, Lysen L & Balogun L (1994) Identifying patients at risk: ADA definitions for nutrition screening and nutrition assessment. *Journal of the American Dietetic Association* **8,** 838-839.

Posthauer ME & Russell C (1997) Ensuring optimal nutrition in long-term care. *Nutrition in Clinical Practice* **12,** 247-255.

Potter J, Klipstein K, Reilly JJ & Roberts M (1995) The nutritional status and clinical course of acute admissions to a geriatric unit. *Age and Ageing* **24,** 131-136.

Potter J, Langhorne P & Roberts M (1998*a*) Routine protein energy supplementation in adults: systematic review. *British Medical Journal* **17,** 495-501.

Potter JM, Roberts MA, Reilly JJ & McColl JH (1998*b*) An evaluation of protein energy supplementation in medically ill patients to a geriatric unit. *Proceedings of the Nutrition Society* **57,** 88A.

Prentice AM & Jebb SA (1995) Obesity in Britain: gluttony or sloth? *British Medical Journal* **311,** 437-439.

Prescott-Clarke P & Primatesta P (1997) Health Survey for England 1995. [Prescott-Clarke P & Primatesta P, editors]. London: The Stationery Office.

Quill TE (1992) Utilisation of nasogastric feeding tubes in a group of chronically ill, elderly patients in a community hospital. *Dysphagia* **7,** 64-70.

Rajala SA, Kanto AJ, Haavisto MV, Kaarela RH, Koivunen MJ & Heikinheimo RJ (1990) Body weight and the three year prognosis in very old people. *International Journal of Obesity* **14,** 997-1003.

Rea IM, Gillen S & Clarke E (1997) Anthropometric measurements from a cross-sectional survey of community dwelling subjects aged over 90 years of age. *European Journal of Clinical Nutrition* **51,**102-6.

Reeves SL, Varakamin C & Henry CJK (1996) The relationship between arm-span measurement and height with special reference to gender and ethnicity. *European Journal of Clinical Nutrition* **50,** 398-400.

Reilly JJ, Hull SF, Albert N, Waller A & Bringardener S (1988) Economic impact of malnutrition: a model system for hospitalised patients. *Journal of Parenteral and Enteral Nutrition* **12,** 371-376.

Reilly HM, Martineau JK, Moran A & Kennedy H (1995) Nutritional screening-evaluation and implementation of a simple nutrition risk score. *Clinical Nutrition* **14,** 269-273.

Reilly HM (1996) Screening for nutritional risk. *Proceedings of the Nutrition Society* **55,** 841-853.

Reissman P, Teoh T-A, Cohen SM, Weiss E, Nogueras JJ & Wexner SD (1995) Is early oral feeding safe after elective colorectal surgery? *Annals of Surgery* **222,** 73-77.

Reuben DB, Greendale GA & Harrison GG (1995) Nutrition screening in older persons. *Journal of the American Geriatric Society* **43,** 415-425.

Reynolds JV, O'Farrelly C, Feighery C, Murchan P, Leonard N, Fulton G, O'Morain C, Keane FBV & Tanner WA (1996) Impaired gut barrier function in malnourished patients. *British Journal of Surgery* **83,** 1288-1291.

Reynolds JV, Kanwar S, Welsh FKS, Windsor ACJ, Murchan P, Barclay GR & Guillou PJ (1997) Does the route of feeding modify gut barrier function and clinical outcome in patients after major upper gastrointestinal surgery? *Journal of Parenteral and Enteral Nutrition* **21,** 196-201.

Riley RH & Burke V (1997) Prevalence of obesity in surgical patients: a comparative survey in the United States and Australia. *Journal of Quality in Clinical Practice* **17,** 147-154.

Rissanen A, Heliovaara M, Knekt P, Aromaa A, Reunanen A & Maatela J (1989) Weight and mortality in Finnish men. *Journal of Clinical Epidemiology* **42,** 781-789.

Rissanen A, Knekt P, Heliovaara M, Aromaa A, Reunanen A & Maatela J (1991) Weight and mortality in Finnish women. *Journal of Clinical Epidemiology* **44,** 787-795.

Rossnagel K, Friel S, Nolan G & Kelleher C (2000) Survey of Lifestyle, Attitudes and Nutrition (SLAN): Food habits of those aged 65 years and over. *Proceedings of the Nutrition Society* (In the Press).

Roubenoff R & Wilson P (1993) Advantage of knee height over height as an index of stature in expression of body composition in adults. *American Journal of Clinical Nutrition* **57,** 609-613.

Rowland ML (1990) Self-reported weight and height. *American Journal of Clinical Nutrition* **52,** 1125-1133.

Rudman D & Feller AG (1989) Protein-calorie undernutrition in the nursing home. *Journal of the American Geriatric Society* **37,** 173-183.

Rush D (1993) Evaluating the Nutrition Screening Initiative. *American Journal of Public Health* 83, 944-945.

Rushe F & Moloney M (1998) Patient satisfaction, nutrient content and actual intake of food served in two Dublin teaching hospitals. *Proceedings of the Nutrition Society* **57,** 166A.

Sagar PM & MacFie J (1994) Effect of preoperative nutritional status on the outcome of cardiac valve replacement. *Nutrition* **10,** 490A.

Sarkisian CA & Lachs MS (1996) 'Failure to thrive' in older adults. *Annals of Internal Medicine* **124,** 1072-1078.

Sauleda J, Gea J, Orozco-Levi M, Corominas J, Minguella J, Aguar C, Broquetas J & Agusti AG (1998) Structure and function relationships of the respiratory muscles. *European Respiratory Journal* **11,** 906-911.

Savage SAH, Reilly JJ, Edwards CA & Durnin JVGA (1999) Adequacy of standards for assessment of growth and nutritional status in infancy and early childhood. *Archives of Disease in Childhood* **80**, 121-124.

Sayer AA & Cooper C (1997) Undernutrition and ageing. *Gerontology* **43,** 203-205.

Schalkwijk CG, Poland DC, van Dijk W, Kok A, Emeiss JJ, Drager AM, Doni A, van Hinsbergh VW & Stehouwer CD (1999) Plasma concentration of C-reactive protein is increased in type 1 diabetic patients without clinical macroangiopathy and correlates with markers of endothelial dysfunction: evidence for chronic inflammation. *Diabetologia 42,* 351-357.

Schols AMWJ, Mostert R, Soeters PB & Wouters EFM (1991) Body composition and exercise performance in patients with chronic obstructive pulmonary disease. *Thorax* **46,** 695-699.

Schols AMWJ, Soeters P, Dingemans AMC, Mostert R, Frantzen PJ & Wouters EFM (1993) Prevalence and characteristics of nutritional depletion in patients with stable COPD eligible for pulmonary rehabilitation. *American Review of Respiratory Disease* **147,** 1151-1156.

Seidell JC, Andres R, Sorkin JD Muller DC (1994) The sagittal waist diameter and mortality in men: the Baltimore Longitudinal Study on Ageing. *International Journal of Obesity and Related Metabolic Disorders* **18,** 61-67.

Seltzer MH, Bastidas JA, Cooper DM, Engler P, Slocum B & Fletcher HS (1979) Instant nutritional assessment. *Journal of Parenteral and Enteral Nutrition* **3,** 157-159.

Shaw-Stiffel TA, Zarney LA, Pleban WE, Rosman DD, Rudolf RA & Bernstein LH (1993) Effect of nutrition status and other factors on length of hospital stay after major gastrointestinal surgery. *Nutrition* **9,** 140-145.

Shenkin A, Cederblad G, Elia M & Isaksson B (1996) Laboratory assessment of protein-energy status. *Clinica Chimica Acta* **253,** 1-56.

Shenkin A (1997) Impact of disease on markers of macronutrient status. *Proceedings of the Nutrition Society* **56,** 433-441.

Shenkin A (1998) Micronutrients in adult nutritional support: requirements and benefits. *Current Opinion in Clinical Nutrition and Metabolic Care* **1,** 15-19.

Shimokata H, Tobin JD, Muller DC, Elahi D, Coon PJ & Andres R (1989) Studies in the distribution of body fat: I. Effects of age, sex and obesity. *Journal of Gerontology* **44,** 66-73.

Shirley R & Moloney M (2000) A comparison of energy, food and nutrient intakes between a private and two public hospitals. *Proceedings of the Nutrition Society* (In the Press).

Sikora SS, Ribeiro U, Kane JM, Landreneau RJ, Lembersky B & Posner MC (1998) Role of nutrition support during induction chemoradiation therapy in esophageal cancer. *Journal of Parenteral and Enteral Nutrition* **22,** 18-21.

Simopoulos A (1985) Dietary control of hypertension and obesity and body weight standards. *Journal of the American Dietetic Association* **85,** 419-422.

Sizer T, Russell CA, Wood S, Irwin P, Allison S, Wheatley C & Whitney S (1996) *Standards and Guidelines for Nutritional Support of Patients in Hospital. A Report of a BAPEN Working Party.* Maidenhead, Berks.: BAPEN.

Smith LC & Mullen JL (1991) Nutritional assessment and indications for nutritional support. *Surgical Clinics of North America* **71,** 449-457.

Sologub VK, Zaets TL, Tarasov AV, Mordkovitch MR, Yashib AY (1992) Enteral hyperalimentation of burned patients: the possibility of correcting metabolic disorders by the early administration of prolonged high calorie evenly distributed tube feeds. *Burns* **18,** 245-249.

Spiekerman AM, Rudolf RA & Bernstein HH (1993) Determination of malnutrition in hospitalized patients with the use of a group-based reference. *Archives of Pathology Laboratory Medicine* **117,** 184-186.

Stack JA, Babineau TJ & Bistrian BR (1996) Assessment of nutritional status in clinical practice. *The Gastroenterologist* **4,** 8S-15S.

Starer P & Libow LS (1992) Medical care of the elderly in the nursing home. *Journal of General Internal Medicine* **7,** 350-362.

Steen B, Lundgren BK & Isaksson B (1985) Body composition at age 70, 75, 79 and 81 years: a longitudinal population study. In *Nutrition, immunity and illness in the elderly* [RK Chandra, editor]. New York: Pergamon.

Steinbaugh ML, Chumlea WC, Guo S & Roche AF (1986) Estimating body weight for the non ambulatory elderly, abstracted. American Dietetic Association 69th Annual Meeting, Las Vegas, October 27-31.

Stephen AD, Beigg CL, Elliot ET, MacDonald IA & Allison SP (1998) A recipe for improving the nutritional intake in elderly patients. *Proceedings of the Nutrition Society* **57,** 89A.

Strain NC, Wright CE, Ward K, Shaffer JL (1998) Can the true prevalence of malnutrition be assessed on admission to hospital? *Proceedings of the Nutrition Society* **58,** 112A.

Studley HO (1936) Percentage of weight loss. A basic indicator of surgical risk in patients with chronic peptic ulcer. *Journal of the American Medical Association* **106,** 458-460.

Sullivan DH, Patch GA, Baden AL & Lipschitz DA (1989) An approach to assessing the reliability of anthropometrics in elderly patients. *Journal of the American Geriatric Society* **37,** 607-613.

Sullivan DH, Patch GA, Walls RC & Lipschitz DA (1990) Impact of nutritional status on morbidity and mortality in a select population of geriatric rehabilitation patients. *American Journal of Clinical Nutrition* **51,** 749-758.

Sullivan DH, Walls RC & Lipschitz DA (1991) Protein-energy undernutrition and the risk of mortality within 1y of hospital discharge in a select population of geriatric rehabilitation patients. *American Journal of Clinical Nutrition* **53,** 599-605.

Sullivan DH, Sun S & Walls RC (1999) Protein-energy undernutrition among elderly hospitalised patients. A prospective study. *Journal of the American Medical Association* **281,** 2013-2019.

Symreng T (1983) Arm anthropometry in a large reference population and in surgical patients. *Clinical Nutrition* **1**, 211-219.

Tanner JM & Whitehouse RH (1975) Revised standards for triceps and subscapular skinfolds in British Children. *Archives of Disease in Childhood* **42**, 61-67.

Taren DC & Schler S (1990) The nutritional assessment of the successfully aged. *Clinical Nutrition* **9**, 7-16.

Tayback M, Kumanyika S & Chee E (1990) Body weight as a risk factor in the elderly. *Archives of Internal Medicine* **150**, 1065-1072.

Tessier S, Kelly IE, Cahill A, Morris SE, Crumley A, Mclaughlin D, McKee RF & Lean MEJ (1999) Still hungry in hospital: identifying malnutrition in acute hospital admissions. *Proceedings of the Nutrition Society* (In the Press).

Thompson MP & Morris LK (1991) Unexplained weight loss in the ambulatory elderly. *Journal of the American Geriatric Society* **39**, 497-500.

Thurnham D (1997) Impact of disease on markers of micronutrient status. *Proceedings of the Nutrition Society* **56**, 421-431.

Townsend, S, Palmer D & MacFie, J (1997) Inadequate oral intake in surgical patients: a rational indication for nutritional support. *Journal of Human Nutrition and Dietetics* **10**, 193-195.

Tucker HN & Miguel SG (1996) Cost containment through nutrition intervention. *Nutrition Reviews* **54**, 111-121.

Ulijaszek SJ & Kerr DA (1999) Anthropometric measurement error and the assessment of nutritional status. *British Journal of Nutrition* **82**, 165-177.

Unosson M, Larsson J, Ek AC & Bjurulf P (1992) Effects of dietary supplement on functional condition and clinical outcome measured with a modified Norton scale. *Clinical Nutrition* **11**, 134-139.

Vanek VW (1998) The use serum albumin as a prognostic or nutritional marker and the pros and cons of IV albumin therapy. *Nutrition in Clinical Practice* **13**, 110-122.

Van Itallie TB (1996) Prevalence of obesity. *Endocrinology and Metabolism Clinics of North America* **25**, 887-905.

Van Staveren WA, de Groot LCPGM, Burema J & de Graaf C (1995) Energy balance and health in SENECA participants. *Proceedings of the Nutrition Society* **54,** 617-629.

Vellas B, Conceicao J, LaFont C, Fontan B, Garry PJ, Adoue D & Albarede JL (1990) Malnutrition and falls (Letter). Lancet 336, 1447.

Vellas B, Albarede JL & Garry PJ (1992) Disease and ageing: patterns of morbidity with age; relationship between ageing and age-associated diseases. *American Journal of Clinical Nutrition* **55,** 1225S-1230S.

Vellas BJ, Hunt WC, Romero LJ, Koehler KM, Baumgartner RN & Garry PJ (1997) Changes in nutritional status and patterns of morbidity among free-living elderly persons: 10-year longitudinal study. *Nutrition* **13,** 515-519.

Veterans Affairs Total Parenteral Nutrition Cooperative Study Group (1991) Perioperative total parenteral nutrition in surgical patients. *New England Journal of Medicine* **325,** 525-532.

Vetta F, Ronzoni S, Taglieri G & Bollea MR (1999) The impact of malnutrition on the quality of life in the elderly. *Clinical Nutrition* **18,** 259-267.

Vir SC & Love AH (1979) Nutritional status of institutionalized and noninstitutionalized aged in Belfast, Northern Ireland. *American Journal of Clinical Nutrition* **32,** 1934-1947.

Vlaming S, Biehler A, Chattopadhyay S, Jamieson C, Cunliffe A, Powell-Tuck J (1998) Nutritional status of patients on admission to acute services of a London teaching hospital. *Proceedings of the Nutrition Society* **58,** 119A.

Von Meyenfeldt MF, Meijerink WJHJ, Rouflart MMJ, Buil-Maassen MTHJ & Soeters PB (1992) Perioperative nutritional support: a randomised clinical trial. *Clinical Nutrition* **11,** 180-186.

Wallace JI, Schwartz RS, La Croix AZ, Uhlman RF & Pearlman RA (1995) Involuntary weight loss in older outpatients: Incidence and clinical significance. *Journal of the American Geriatric Society* **43,** 329-337.

Wang ZM, Pierson RN & Heymsfield SB (1992) The five-level model: a new approach to organising body-composition research. *American Journal of clinical Nutrition* **56,** 19-28.

Wannamethee SG, Shaper AG, Whincup PH & Walker M (2000) Losing weight in older age: why is there no apparent benefit? *Proceedings of the Nutrition Society* (In the Press).

Watters JM, Clancey SM, Moulton SB, Briere KM & Zhu J-M (1993) Impaired recovery of strength in older patients after major abdominal surgery. *Annals of Surgery* **218,** 380-393.

Webb AR, Newman LA, Taylor M & Keogh JB (1989) Hand grip dynamometry as a predictor of postoperative complications : reappraisal using age standardised grip strengths. *Journal of Parenteral and Enteral Nutrition* **13,** 30-33.

Weekes E (1998) The incidence of malnutrition in medical patients admitted to a hospital in south London. *Proceedings of the Nutrition Society* **58,** 126A.

Welle S, Thornton C, Totterman S & Forbes G (1996) Utility of creatinine excretion in body-composition studies of healthy men and women older than 60 y. *American Journal of Clinical Nutrition* **63,** 151-156.

Wellman NS (1994) The nutrition screening initiative. *Nutrition Reviews* **52,** 44S-47S.

Welsh FKS, Farmery SM, Ramsden C, Guillou PJ & Reynolds JV (1996) Reversible impairment in monocyte major histocompatibility complex class 11 expression in malnourished surgical patients. *Journal of Parenteral and Enteral Nutrition* **20**, 344-348.

Weinsier RL, Hunker EM, Krumdieck CL Butterworth CE (1979) Hospital malnutrition: a prospective evaluation of general medical patients during the course of hospitalization. *American Journal of Clinical Nutrition* **32,** 418-426.

Werther G (1998) Measuring height: to stretch or not to stretch? *Lancet* **351,** 309-310.

Wesley JR (1995) Nutrition support teams: past, present, and future. *Nutrition in Clinical Practice* **10,** 219-228.

White JV, Lipschitz DA, Dwyer JT & Wellman NS (1991) Consensus of the Nutrition Screening Initiative: risk factors and indicators of poor nutritional status in older Americans. *Journal of the American Dietetic Association* **91,** 783-787.

White JV, Dwyer JT, Posner BM, Ham RJ, Lipschitz DA & Wellman NS (1992) Nutrition screening initiative: development and implementation of the public awareness checklist and screening tools. *Journal of the American Dietetic Association* **92,** 163-167.

White H, Pieper C, Schmader K & Fillenbaum G (1996) Weight change in Alzheimer's Disease. *Journal of the American Geriatric Society* **44,** 265-272.

Williams CM, Driver LT, Older J & Dickerson JW (1989) A controlled trial of sip-feed supplements in elderly orthopaedic patients. *European Journal of Clinical Nutrition* **43,** 267-274.

Wilson D & Benedict J (1996) Nevada's elderly: Nutrition screening, risk, and interventions. *Nutrition Reviews* **54,** 45S-47S.

Windsor JA & Hill GL (1988) Weight loss with physiologic impairment. A basic indicator of surgical risk. *Annals of Surgery* **207,** 290-296.

Windsor JA, Knight GS & Hill GL (1988) Wound healing response in surgical patients: recent food intake is more important than nutritional status. *British Journal of Surgery* **75,** 135-137.

Wolinsky FD, Coe RM, McIntosh WMA, Kubena KS, Prendergast JM, Chavez MN, Miller DK, Romeis JC & Landmann WA (1990) Progress in the development of a Nutritional Risk Index. *Journal of Nutrition* **120,** 1549-1553.

Woo J, Ho SC, Mak YT, Law LK & Cheung A (1994) Nutritional status of elderly patients during recovery from chest infection and the role of nutritional supplements. *Age and Ageing* **23,** 40-48.

World Health Organisation (1995) *Physical Status: The Use and Interpretation of Anthropometry. World Health Organisation Technical Report* no.854. Geneva: WHO.

World Health Organisation International Obesity Task Force (1998) *Obesity: Preventing and Managing the Global Epidemic.* Geneva: WHO.

Yeh S-S & Schuster MW (1999) Geriatric cachexia: the role of cytokines. *American Journal of Clinical Nutrition* **70,** 183-197.

Young VR, Marchini JS & Cortiella J (1990) Assessment of protein nutritional status. *Journal of Nutrition* **120,** 1496-1502

Zemel BS, Riley EM & Stallings VA (1997) Evaluation of methodology for nutritional assessment in children: anthropometry, body composition, and energy expenditure. *Annual Reviews in Nutrition* **17**, 211-235.

Appendix 1

Requirements for future research in the use of anthropmetry in the elderly

(World Health Organisation, 1995)

Body composition

1. Establishing determinants of changes in body composition in the elderly.
2. Determining the best methods of measuring body composition in the elderly.
3. Determining the relationship between body composition and morbidity and mortality in the elderly.
4. Investigating and validating different methods of determining body composition, such as bioelectrical impedance.
5. In populations of short stature and stocky build, BMI values may indicate relative affluence and adequate nutrition. Conversely, in populations with relatively long legs compared with the trunk, BMI may indicate undernutrition in individuals who are in fact healthy. It is therefore important to determine whether different cut-off points for BMI should be used in such populations, or whether a different measurement or index should be used.
6. Determining what, other than nutritional interventions, can be done to alter body composition and reduce loss of fat-free mass.
7. Evaluating the use of ultrasound to measure fat in areas that cannot be measured by anthropometric means.
8. Determining why muscle mass is lost with age and the types of muscle changes that occur.
9. Carrying out prospective studies of the abdomen: hip circumference ratio, which is an important predictor of morbidity in the elderly.
10. Determining whether undernutrition is a greater health problem than overweight in the elderly, and whether the health risk changes with age.

11. Determining the prevalence of low (BMI below 18.5 kg/m^2) and high (BMI 30 kg/m^2 or above) in the elderly.

Body size

1. Determining whether height is the best measurement in the elderly, in view of its age-related decrease, and whether another measurement would give better information on body length. Also determining whether a better index (than BMI) would be one in which body weight is related to some parameter other than height.
2. Determining whether the side of the body (left or right) on which measurements a re taken makes a difference in the elderly.
3. Determining whether arm span is as valid a measurement as knee height as a surrogate for height and whether it can reliably be measured in bed-fast individuals.
4. Assessing whether current height or young adult height should be used in deriving indices such as BMI.
5. Determining the age-related changes in BMI and BMI distribution in different populations and assessing whether BMI has the same meaning in every population.
6. Determining whether tall individuals lose height more rapidly than short individuals.

Value of anthropometry

1. Assessing how accurately body composition in the elderly can be estimated by anthropometric methods.
2. Determining what further information anthropometry can yield on health risk and disability.
3. Determining the role of anthropometry in measuring increased function after exercise training.

4. Establishing the different contributions of environmental factors and lifestyle throughout life and of genetic factors to the geographical and ethnic variations in height, weight, and BMI across populations. Determining the extent to which much of the variation across populations is the result of differences in disease and health status. Determining whether population-specific or universal reference data should be used to assess nutritional and health status in the elderly.
5. Identifying the situations in which health status can be evaluated by anthropometry and assessing what anthropometry can reveal about specific health outcomes in the elderly.
6. Determining what factors can be identified in early adulthood that might be markers for risk of mortality later in life.
7. longitudinal studies of BMI and its components - fat-free mass and fat mass. Determining whether fat distribution provides a better indicator of cardiovascular morbidity and mortality in the elderly, and whether the increase of intra-abdominal fat indicates an increased risk of morbidity or whether it is protective. Data are also needed on lean body mass other than shortly before death as a predictor of long-range morbidity or mortality.
8. If high BMI is a protective factor with regard to total mortality in the elderly, determining the relative contributions to this of fat and lean body mass.

Appendix 2

Ethical approval for the following studies was sought and approval given, subject to informed consent. Copies the research protocols, the patient information leaflets and the consent forms for the first two studies below are included.

Determination of the incidence and distribution of undernutrition in patients admitted to St. James's and the Meath Hospitals (see **Chapters 3** and **4**).

Determination of the effects of current nutritional intervention on the nutritional status and outcome of undernourished patients admitted to St. James's and the Meath Hospitals (see **Chapter 5**).

Establishment of anthropometric reference standards for elderly people (see **Chapter 6**).

Federated Dublin Voluntary Hospitals and St. James's Hospital
Joint Research Ethics Committee

Confidential Research Protocol, 1995 Edition.

This protocol was developed based on general principles of medical ethics, the Control of Clinical Trials Acts 1987 and 1990, and European Guidelines of Good Clinical Practice. Please read the attached introductory notes, then complete the protocol in typescript. All relevant sections must be fully completed. Place an "X" or _ after the appropriate response in the boxed areas. NA is an abbreviation for Not Applicable.

1. **Title of research project:** Determination of the incidence and distribution of undernutrition in patients admitted to St James's and the Meath Hospitals.

2. **Name of local project supervisor/s** (ordinarily a hospital consultant):
Dr. N.P. Kennedy, Ms. P. Flood and Ms. S. Mulligan.

3. **What are the objectives of the research project?:**
a) To assess the nutritional status of patients on admission to hospital.
b) To determine the degree of undernutrition where it occurs.
c) To assess the extent of deterioration or improvement in nutritional status over the course of the hospital stay.
d) To determine the rate of referral for dietetic/clinical nutrition support.

4a. **Does the design of the study allow a statistically significant conclusion to be reached?:**
YES X NO

4b. **Has statistical advice been sought?:**
YES X NO

5. **Will the conduct of the project conform to the principles of the Declaration of Helsinki (Recommendations guiding Medical Doctors in Biomedical Research involving Human Subjects)?:**
YES X NO

If not, elucidate:

6. Please itemise here any ethical problems which you perceive to be associated with the research project:

None.

SECTION A

Details of project

7. **Background:**

A. What person or organisation devised this project?:

Collaborative project devised by Dr. N. P. Kennedy, Ms. P. Flood and Ms. S Mulligan.

B. Has a detailed research protocol been drawn up? (If so, such documentation must be submitted to the Committee.)

YES NO X

C. Has the investigator who will present the project to the Committee studied all the documentation drawn up for the project, and will the documentation be studied by all the investigators before the project begins?

YES X NO

D. Briefly describe the scientific rationale for the project:

Studies carried out, both in the United Kingdom and in the United States of America, have shown a significant incidence of undernutrition occurs among patients admitted to hospital and that deterioration in nutritional status continues during the period of hospitalisation. Pilot studies carried out in Dublin hospitals have shown similiar results. Nutritional status has been shown to affect outcome in hospitalised patients. Determination of the incidence of undernutrition will allow for the provision of a service which minimises the deterioration in nutritional status and improves outcome.

8. **Planning and organisational structure (briefly outline the study methods, the various treatment groups, what parameters will be studied, how often and for how long, and what outcome measures or end points will be used to assess the efficacy of the project, for each subject):**

Six hundred patients in total, two hundred in St. James's Hospital and one hundred in the Meath Hospital, in a winter and a summer season, will be nutritionally assessed. This assessment will be comprised of anthropometric, functional and routine biochemical measurements. Similiar measurements will be made prior to patient discharge. A screening tool designed for routine evaluation of nutritional status of patients on admission to hospital will be validated against the full nutritional assessment.

9. **What is the nature and extent of the medical examination that participants and controls are to undergo before participating in this project?:**

None.

10. **How will the health of the participants and controls be monitored during and after the trial? (list clinical, laboratory and other examinations):**

All patients will be undergo the normal hospitalisation procedure with routine referral for dietetic/clinical nutrition support.

11. **Will participants or controls undergo independent medical examination, before, during or after the trial?:**

YES NO N/A X

12. If a placebo group is to be used, will the group receive the best standard therapy?:
YES NO N/A X

13. If the project involves the use of radioactive substances or of laser therapy has the approval of the Head of Medical Physics been obtained?:
YES NO NA X
If not, elucidate:

SECTION B

Investigators and Facilities

14. Name, qualification and position of each person associated with this project:

Name	Qualification	Position
a) Ms. C. Corish	Dipl. Diet. and Nutr., Dipl. Legal Studies	Research Dietitian
b) Dr. N. P. Kennedy	M.A., M.D.	Lecturer in Clinical Medicine/Nutrition, T.C.D.
c) Ms. P.Flood	Dipl.Diet.	Principal Dietitian/Clinical Nutritionist, S.J.H.
d) Ms. S. Mulligan	Dipl. Diet . and Nutr.	Principal Dietitian/Clinical Nutritionist, Meath Hospital.

15. Is each investigator a registered medical practitioner?

YES NO X

If not, elucidate: A research dietitian (C.C.) is carrying out the nutritional assessments.

16. Is each investigator a member of a major medical defence body?

YES NO X

If not, elucidate: (NPK, project supervisor is a member of a major defence body)

17. What payments, monetary or otherwise, if any, are to be made to any of the investigators (include payments to any institution or research facility)?:

The research dietitian is being paid a postgraduate studentship from a research grant.

18. What payments, whether monetary or otherwise, if any, are to be made to any person or institution providing facilities to be used for the purpose of the clinical trial?:

None

19. In which hospital or facility will the project take place?:

St. James's and Meath Hospitals.

20. If the services of the Central Pathology Laboratory are being used has the Pathology Funding Proposal Form (attached) been completed?

YES NO X NA

If not, elucidate:

Results of routine investigations carried out in the Central Pathology Laboratory will be used.

SECTION C

Participants

21. How many subjects from this centre are expected to participate in this project?:

Number 600.

22. How many controls (in this centre)?:

Number None.

23. If this is a multicentre trial please indicate:

a) the expected overall number of subjects: Number N/A

b) the number and geographical distribution of the centres involved in the study:

N/A

24. What criteria are to be used for the selection of participants?:

a) Admission to either St. James's or Meath Hospitals during a summer and a winter period.

25. Are women of childbearing potential excluded from participating?

YES NO NA X

If not, indicate what contraceptive precautions will be imposed:

26. State any other exclusion criteria (age, other illness, other medications etc.):

Acute admissions to the Intensive Care Units, Coronary Care Units and day wards in St. James's and the Meath Hospitals, acute admissions to the Burns Unit and Bone Marrow Transplant Unit in St. James's Hospital and children under the age of sixteen years admitted to either St. James's or the Meath Hospitals.

27. What are the proposed methods by which participants and controls are to be recruited?

Direct request to every tenth patient admitted to St. James's Hospital and every fifth patient admitted to the Meath Hospital during the study periods.

28. What inducements or rewards, whether monetary or otherwise, are to be offered to participants and controls?

None.

If no, elucidate:

29. What arrangements exist to provide compensation to each participant who may suffer injury or loss as a result of this research project?

(Note that medical malpractice insurance provides cover only where negligence or malpractice can be proved. Subjects involved in sponsored drug trials must receive a higher level of cover by which they are compensated for misadventure without having to prove that it was due to negligence on the part of the investigator. Non-sponsored trials

which involve comparison of standard methods of therapy must make it clear in the patient information leaflet if such additional insurance is not available. Non-sponsored trials involving investigation or therapy which would not be used in conventional medical practice (including exposing normal control subjects to potential risks such as anaphylactic shock or misadventure following biopsy) may require the provision of extra insurance at the investigator's expense.)

N/A

30. Have you submitted to the committee, with this form, a patient information leaflet and consent form prepared by a sponsor or other external group, or a patient information leaflet and consent form based on the committee's guidelines (attached to this form) to be given to each participant and control?

YES NO X

If no, elucidate: N/A

31. What criteria are to be used to ensure that the identity of each participant and control remains confidential?

"Only the investigator's group within the institution will know the identity of the subjects; codes will be used to conceal identities in all external communications (but the sponsor or official regulatory agencies may be given access to the case notes to ensure that the trial has been conducted legitimately)."

YES X NO

If no, indicate the criteria used.

32. Give details of any risks to subjects or to controls from investigative or therapeutic procedures or from withholding of therapy?

NOTE: for the protection of both the investigator and the subject this list must be comprehensive and must also appear in full in the patient information leaflet.

No risks to patients are associated with this study.

33. Indicate how adverse events are to be notified and evaluated:

No adverse events are expected with this clinical audit.

St. James's Hospital and Federated Dublin Voluntary Hospitals

Patient Information Leaflet

1. Title of study:
Assessment of nutritional status of patients admitted to St. James's and the Meath Hospitals.

2. Introduction:
Studies from other countries have shown that many people lose weight prior to admission into hospital and that they continue to lose more weight whilst in hospital. We do not know if this is the situation in Ireland. To take part in this study, I need to make some simple measurements of your fat and muscle stores and ask you some questions regarding your appetite and weight. The measurements will be made both on admission to hospital, and on discharge, if you are in for more than 5 days. It will take me approximately 20-30 minutes to take the measurements. There is no discomfort involved.

3. Confidentiality:
Your identity will remain confidential. Your name will not be published or disclosed to anyone outside this hospital.

4. Permission:
This study has been approved by the hospital ethics committee.

5. Further information:
You can get more information about the study from:

Clare Corish (Research Dietitian) **Telephone: 6082478**
The Unit of Nutrition and Dietetic Studies,
Trinity Centre for Health Sciences,
St. James's Hospital,
James's St,
Dublin 8

St. James's Hospital and Federated Dublin Voluntary Hospitals
Joint research ethics committee

CONSENT FORM

Title of research study:

Assessment of nutritional status of patients admitted to St. James's and the Meath hospitals.

This study and this consent form have been explained to me. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I have received a copy of this agreement.

PARTICIPANT'S NAME:

PARTICIPANT'S SIGNATURE:

DATE:

Statement of investigator's responsibility:

I have explained the nature, purpose and procedures involved in this research study. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Investigator's signature:
Date:

Federated Dublin Voluntary Hospitals and St. James's Hospital

Joint Research Ethics Committee

Confidential Research Protocol, 1995 Edition.

This protocol was developed based on general principles of medical ethics, the Control of Clinical Trials Acts 1987 and 1990, and European Guidelines of Good Clinical Practice. Please read the attached introductory notes, then complete the protocol in typescript. All relevant sections must be fully completed. Place an "X" or _ after the appropriate response in the boxed areas. NA is an abbreviation for Not Applicable.

1. Title of research project: Determination of the effects of current nutritional intervention on the nutritional status and outcome of undernourished patients admitted to St James's and the Meath Hospitals.

2. Name of local project supervisor/s (ordinarily a hospital consultant):
Dr. N.P. Kennedy, Ms. P. Flood and Ms. S. Mulligan.

3. What are the objectives of the research project?:
a) To assess the nutritional status of patients on admission to hospital.
b) To document the methods of nutritional intervention currently in use.
c) To assess the reasons for, and extent of, deterioration or improvement in nutritional status over the course of the hospital stay.
d) To determine if a relationship between nutritional status, current nutritional intervention and outcome exists both during the course of hospitalisation and post discharge.

4a. Does the design of the study allow a statistically significant conclusion to be reached?:
YES X NO

4b. Has statistical advice been sought?:
YES X NO

5. Will the conduct of the project conform to the principles of the Declaration of Helsinki (Recommendations guiding Medical Doctors in Biomedical Research involving Human Subjects)?:
YES X NO

If not, elucidate:

6. Please itemise here any ethical problems which you perceive to be associated with the research project:

None.

SECTION A

Details of project

7. Background:

A. What person or organisation devised this project?:
Collaborative project devised by Dr. N. P. Kennedy, Ms. P. Flood and Ms. S Mulligan.

B. Has a detailed research protocol been drawn up? (If so, such documentation must be submitted to the Committee.)
YES **NO X**

C. Has the investigator who will present the project to the Committee studied all the documentation drawn up for the project, and will the documentation be studied by all the investigators before the project begins?
YES X **NO**

D. Briefly describe the scientific rationale for the project:
A significant incidence of undernutrition among patients admitted to hospital has been reported in a number of studies. Poor nutritional status is known to affect outcome adversely in hospitalised patients. Studies on the effects of nutritional intervention have been confined to the effects of particular nutritional therapies on specific patient groups. This study is intended to determine the adequacy of current nutritional support practices.

8. Planning and organisational structure (briefly outline the study methods, the various treatment groups, what parameters will be studied, how often and for how long, and what outcome measures or end points will be used to assess the efficacy of the project, for each subject):
Three hundred patients in total, two hundred in St. James's Hospital and one hundred in the Meath Hospital will be monitored. Monitoring will comprise anthropometric, functional and routine biochemical measurements. Outcome measures will include changes in body weight and composition, changes in muscle function, length of stay and readmission rates, mortality and morbidity.

9. What is the nature and extent of the medical examination that participants and controls are to undergo before participating in this project?:
None.

10. How will the health of the participants and controls be monitored during and after the trial? (list clinical, laboratory and other examinations):
All patients will undergo normal hospital procedure with routine referral for dietetic/clinical nutrition support.

11. Will participants or controls undergo independent medical examination, before, during or after the trial?:
YES **NO** **N/A X**

12. If a placebo group is to be used, will the group receive the best standard therapy?:
YES NO N/A X

13. If the project involves the use of radioactive substances or of laser therapy has the approval of the Head of Medical Physics been obtained?:
YES NO NA X
If not, elucidate:

SECTION B

Investigators and Facilities

14. Name, qualification and position of each person associated with this project:

Name	Qualification	Position
a) Ms. C. Corish	Dipl. Diet. and Nutr., Dipl. Legal Studies	Research Dietitian
b) Dr. N. P. Kennedy	M.A., M.D.	Lecturer in Clinical Medicine/Nutrition, T.C.D.
c) Ms. P.Flood	Dipl.Diet.	Principal Dietitian/Clinical Nutritionist, S.J.H.
d) Ms. S. Mulligan	Dipl. Diet . and Nutr.	Principal Dietitian/Clinical Nutritionist, Meath Hospital.

15. Is each investigator a registered medical practitioner?
YES NO X
If not, elucidate: A research dietitian (C.C.) is carrying out the nutritional assessments.

16. Is each investigator a member of a major medical defence body?
YES NO X
If not, elucidate: (NPK, project supervisor is a member of a major defence body)

17. What payments, monetary or otherwise, if any, are to be made to any of the investigators (include payments to any institution or research facility)?:
The research dietitian is being paid a postgraduate studentship from a research grant.

18. What payments, whether monetary or otherwise, if any, are to be made to any person or institution providing facilities to be used for the purpose of the clinical trial?:
None

19. In which hospital or facility will the project take place?:
St. James's and Meath Hospitals.

20. If the services of the Central Pathology Laboratory are being used has the Pathology Funding Proposal Form (attached) been completed?
YES NO X NA
If not, elucidate:
Results of routine investigations carried out in the Central Pathology Laboratory will be used.

SECTION C

Participants

21. How many subjects from this centre are expected to participate in this project?:

Number 300.

22. How many controls (in this centre)?:

Number N/A

23. If this is a multicentre trial please indicate:

a) the expected overall number of subjects: **Number** N/A

b) the number and geographical distribution of the centres involved in the study:

N/A

24. What criteria are to be used for the selection of participants?:

a) Admission to either St. James's or Meath Hospitals.

25. Are women of childbearing potential excluded from participating?

YES NO NA X

If not, indicate what contraceptive precautions will be imposed:

26. State any other exclusion criteria (age, other illness, other medications etc.):

Acute admissions to the Intensive Care Units, Coronary Care Units and day wards in St. James's and the Meath Hospitals, acute admissions to the Burns Unit and Bone Marrow Transplant Unit in St. James's Hospital and children under the age of sixteen years admitted to either St. James's or the Meath Hospitals.

27. What are the proposed methods by which participants and controls are to be recruited?

Direct request to patients admitted to St. James's and the Meath hospitals during the study period.

28. What inducements or rewards, whether monetary or otherwise, are to be offered to participants and controls?

None.

If no, elucidate:

29. What arrangements exist to provide compensation to each participant who may suffer injury or loss as a result of this research project?

(Note that medical malpractice insurance provides cover only where negligence or malpractice can be proved. Subjects involved in sponsored drug trials must receive a higher level of cover by which they are compensated for misadventure without having to

prove that it was due to negligence on the part of the investigator. Non-sponsored trials which involve comparison of standard methods of therapy must make it clear in the patient information leaflet if such additional insurance is not available. Non-sponsored trials involving investigation or therapy which would not be used in conventional medical practice (including exposing normal control subjects to potential risks such as anaphylactic shock or misadventure following biopsy) may require the provision of extra insurance at the investigator's expense.)

N/A

30. Have you submitted to the committee, with this form, a patient information leaflet and consent form prepared by a sponsor or other external group, or a patient information leaflet and consent form based on the committee's guidelines (attached to this form) to be given to each participant and control?

YES NO X

If no, elucidate: N/A

31. What criteria are to be used to ensure that the identity of each participant and control remains confidential?

"Only the investigator's group within the institution will know the identity of the subjects; codes will be used to conceal identities in all external communications (but the sponsor or official regulatory agencies may be given access to the case notes to ensure that the trial has been conducted legitimately)."

YES X NO

If no, indicate the criteria used.

32. Give details of any risks to subjects or to controls from investigative or therapeutic procedures or from withholding of therapy?
NOTE: for the protection of both the investigator and the subject this list must be comprehensive and must also appear in full in the patient information leaflet.

No risks to patients are associated with this study.

33. Indicate how adverse events are to be notified and evaluated:

No adverse events are expected with this clinical audit.

St. James's Hospital and Federated Dublin Voluntary Hospitals

Patient Information Leaflet

1. Title of study:
Assessment of the effects of nutritional status and current nutritional practice on the nutritional status and outcome of patients undergoing surgery admitted to St. James's and the Meath Hospitals.

2. Introduction:
Studies have shown that many people lose weight in hospital for many reasons e.g. they fast for tests, have surgery, dislike hospital food etc. We want to see if this occurs in this hospital and the record the reasons why it occurs. If you have any special nutritional treatments we want to see if these treatments help you recover more quickly.

To take part in this study, I need to make some measurements of your weight, fat and muscle stores, keep a record of your appetite and ability to eat and monitor your muscle strength as you get better both while you are in hospital and when you return as an outpatient.

3. Confidentiality:
Your identity will remain confidential. Your name will not be published or disclosed to anyone outside this hospital.

4. Permission:
This study has been approved by the hospital ethics committee.

5. Further information:
You can get more information about the study from:

Clare Corish (Research Dietitian) **Telephone: 6082478**
The Unit of Nutrition and Dietetic Studies,
Trinity Centre for Health Sciences,
St. James's Hospital,
James's St,
Dublin 8.

St. James's Hospital and the Federated Dublin Voluntary Hospitals
Joint research ethics committee

CONSENT FORM

Title of research study:

Assessment of the effects of nutritional status and current nutritional practice on the nutritional status and outcome of patients undergoing surgery admitted to St. James's and the Meath Hospitals.

This study and this consent form have been explained to me. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I have received a copy of this agreement.

PARTICIPANT'S NAME:

PARTICIPANT'S SIGNATURE:

DATE:

Statement of investigator's responsibility:

I have explained the nature, purpose and procedures involved in this research study. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Investigator's signature:
Date:

FEDERATED DUBLIN VOLUNTARY HOSPITALS AND ST. JAMES'S HOSPITAL

JOINT RESEARCH ETHICS COMMITTEE

Confidential Research Protocol, 1997 Edition.

This protocol was developed based on general principles of medical ethics, the Control of Clinical Trials Acts 1987 and 1990, as amended, and European Guidelines of Good Clinical Practice.

Please read the attached introductory notes, then complete the protocol in **typescript.** All relevant sections must be fully completed. Place an "X" or ✓ after the appropriate response in the boxed areas. NA is an abbreviation for Not Applicable.

1. **Title of research project**: Establishment of anthropometric reference standards for elderly people.

2. **Name of local project supervisor(s)** – who should ordinarily be a hospital consultant: Dr. N.P. Kennedy and Ms. P. Flood.

3. **What are the objectives of the research project?**
Establishment of appropriate anthropometric reference tables to allow for correct interpretation of the nutritional status of elderly people in Ireland.

4a. Does the design of the study allow a statistically significant conclusion to be reached?

YES X	NO

4b. Has statistical advice been sought?

YES X	NO

5. **Will the conduct of the project conform to the principles of the Declaration of Helsinki** (Recommendations guiding Medical Doctors in Biomedical Research involving Human Subjects; these are included in the introductory notes)?

YES X	NO

If not, elucidate:

6. **Please itemise here any ethical problems which you perceive to be associated with the research project:**

None

SECTION A

Details of project

7. Background:

A. What person or organisation devised this project?

Clinical Nutrition Research Group of the Department of Clinical Medicine, Trinity College Dublin.

B. Has a detailed research protocol been drawn up? (If so, such documentation must be submitted to the Committee.)

YES	NO X

C. Has the investigator who will present the project to the Committee studied all the documentation drawn up for the project, and will the documentation be studied by all the investigators before the project begins?

YES X	NO

D. Briefly describe the scientific rationale for the project:

A survey of the nutritional status of 600 patients admitted to St. James's and the Meath hospitals, using anthropometric measurements, indicated a lower prevalence of undernutrition than was expected by comparison with that found in other countries (UK, USA etc.) (see attached abstracts). Anthropometric measurements on Irish babies have shown them to be longer and heavier than their United Kingdom counterparts (Tanner, Hoey and Cox, 1986; Freeman (Ph.D thesis), 1996). It is not known if the same applies to other groups of the Irish population. The elderly population is increasing in size and as a larger number of elderly people require medical care, it becomes even more important to have the appropriate data to assess their nutritional status correctly.

7. **Planning and organisational structure** (briefly outline the study methods, the various treatment groups, what parameters will be studied, how often and for how long, and what outcome measures or end points will be used to assess the efficacy of the project, for each subject):

1000-1500 healthy elderly people will have simple anthropometric and functional measurements made. The anthropometric measurements will include height, weight, mid-arm and calf circumferences and triceps skinfold thickness. Functional status will be measured by hand grip dynamometry. Details of age, sex, locality, socioeconomic status and level of activity will be recorded.

8. What is the nature and extent of the medical examination that participants and controls are to undergo before participating in this project?

None.

10. How will the health of the participants and controls be monitored during and after the trial? (list clinical, laboratory and other examinations):

Not applicable.

11. Will participants or controls undergo independent medical examination, before, during or after the trial?

YES	NO X	NA

12. If a placebo group is to be used, will the group receive the best standard therapy?

YES	NO	NA X

13. If the project involves the use of radioactive substances or of laser therapy has the approval of the Head of Medical Physics been obtained?

YES	NO	NA X

If not, elucidate:

SECTION B

Investigators and Facilities

14. Name, qualification and position of each person associated with this project:

	Name	Qualification	Position
a)	Ms. C. Corish	Dipl. Diet. and Nutr. Dipl. Legal Studies	Research Dietitian
b)	Dr. N.P. Kennedy	M.A., M.D.	Lecturer in Clinical Medicine/Nutrition, T.C.D.
c)	Ms. P. Flood	Dipl. Diet.	Principal Clinical Nutritionist, S.J.H.

15. Is each investigator a registered medical practitioner?

YES	NO X

If not, elucidate: A research dietitian (C.C.) is carrying out the nutritional assessments.

16. Is each investigator a member of a major medical defence body?

YES	NO X

If not, elucidate: N.P.K. is a member of a major defence body. C.C. and P.F. have professional indemnity insurance obtained through their professional organisation.

17. What payments, monetary or otherwise, if any, are to be made to any of the investigators (include payments to any institution or research facility)?
The research dietitian is being paid a postgraduate studentship from a research grant.

18. What payments, whether monetary or otherwise, if any, are to be made to any person or institution providing facilities to be used for the purpose of the clinical trial?
None.

19. In which hospital or facility will the project take place?
Various locations in the community setting.

SECTION C

Participants

20. How many subjects and controls from this centre are expected to participate in this project?

Number

Subjects: 1000-1500 Controls: Not applicable

21. If this is a multicentre trial please indicate:

a) the expected overall number of subjects:

Number

Not applicable

b) the number and geographical distribution of the centres involved in the study:

22. What criteria are to be used for the selection of participants?

Healthy volunteers ≥ 65 years.

23. Are women of childbearing potential included?

YES	NO X	NA

If so, does the protocol/patient information sheet address the 8 points in the committee's checklist for studies involving women of childbearing potential (1–scientific justification, 2–negative teratogenic studies, 3–warning to subject that fetus may be damaged, 4–initial negative pregnancy test, 5–forms of contraception defined, 6–duration of use to exceed drug metabolism, 7–exclude those unlikely to follow contraceptive advice, 8–notify investigator if pregnancy suspected)?

YES	NO	NA X

24. State the exclusion criteria (age, other illness, other medications etc.):

Institutionalised, hospitalised and immobile elderly people.

25. What are the proposed methods by which participants and controls are to be recruited?

"Direct request to suitable patients attending investigator's clinic"

YES	NO X	NA

If no, elucidate: Groups involved with the Elderly have agreed to notify their member organisations. People will be assessed at pre-arranged gatherings.

26. What inducements or rewards, whether monetary or otherwise, are to be offered to participants and controls?

Occasional prize draws to encourage participation at group events, prizes not to exceed £50 in value.

27. What arrangements exist to provide compensation to each participant who may suffer injury or loss as a result of this research project?

Investigators are covered by TCD public liability insurance.

28. Have you submitted to the committee, with this form, a patient information leaflet and consent form prepared by a sponsor or other external group, or a patient information leaflet and consent form based on the committee's guidelines (attached to this form) to be given to each participant and control?

YES	NOX

If no, elucidate:
Information flyer will be circulated by the individual organisations to their member groups(copy attached for information).

29. What criteria are to be used to ensure that the identity of each participant and control remains confidential?

"Only the investigator's group within the institution will know the identity of the subjects; codes will be used to conceal identities in all external communications (but the sponsor or official regulatory agencies may be given access to the case notes to ensure that the trial has been conducted legitimately)."

YES	NO X

If no, indicate the criteria used.

Personal identity information will not be collected in this survey.

30. Give details of any risks to subjects or to controls from investigative or therapeutic procedures or from withholding of therapy?
NOTE: for the protection of both the investigator and the subject this list must be comprehensive and must also appear in full in the patient information leaflet.

No risks are anticipated with this study.

31. Indicate how adverse events are to be notified and evaluated:

No adverse events are expected.

Appendix 3

Equations for estimating height from knee height in Caucasian elderly (Chumlea *et al.* 1986)*.

Height (men) = (2.08 x knee height) + 59.01

Height (women) = (1.91 x knee height) - (0.17 x age) + 75.00

*Using these equations to estimate height, the standard errors are 7.84 cm for men and 8.82 cm for women.

Appendix 4

Equations for estimating weight from anthropometry in the elderly (Steinbaugh *et al.* 1986)* †.

Weight (men) = (0.98 x calf circumference) + (1.16 x knee height)
+ (1.73 x mid-arm circumference)
+ (0.37 x subscapular skinfold)
- 81.69

Weight (women) = (1.27 x calf circumference) + (0.87 x knee height)
+ (0.98 x mid-arm circumference)
+ (0.4 x subscapular skinfold)
- 62.35

*These equations estimate weight within 95% confidence limits of 8.96 kg and 7.6 kg for men and women respectively.

†.These equations were developed in the USA.

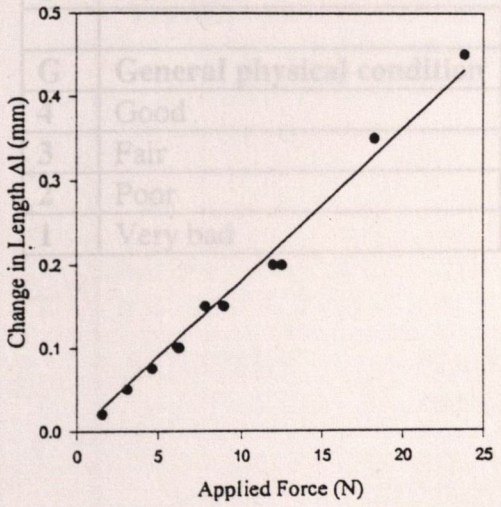
Appendix 5

Report on Elasticity of Plastic Measuring Tape.

Aim: To determine the elasticity and deformation of an elastic measuring tape.

Rationale: Plastic measuring tapes will be utilised in a study where the arm circumference will be measured on a number of occassions. The variation in these readings over time is an important in the study. It has been proposed that this reading may be performed using a plastic measuring tape. If this was subject to large strain values for small applied forces, then the repeatability of the measurements would be questionable. To obtain the necessary information, the stress - strain relationship of the particular tape will be determined. In particular the elastic limit, the point at which large deformations result from additional small applied stresses, will be determined.

Method: Increasing masses were applied to the tape. The resulting change in longitudinal length was measured. The graph below shows the results.



Results: The tape shows a linear elastic relationship up to an applied force of approximately 25 N (2.5 Kg). The represents the elastic limit or yield point. The maximum deformation within the elastic region (0.35 mm) represents a percentage strain of 1% over a length of 35 cm.

Appendix 6

Modified Norton Scale

A	**Mental condition**	B	**Activity**	C	**Mobility**
4	Fully oriented	4	Ambulant	4	Full
3	Occasionally confused	3	Walks with help	3	Slightly limited
2	Cannot answer adequately	2	Chairbound	2	Very limited
1	No contact	1	Bedridden	1	Immobile
D	**Food intake**	**E**	**Fluid intake**	**F**	**Incontinence**
4	Normal	4	Normal	4	None
3	Insufficient	3	Insufficient	3	Occasional
2	Parenteral / Enteral	2	Parenteral	2	Usually urine
1	No intake	1	No intake	1	Double
G	**General physical condition**				
4	Good				
3	Fair				
2	Poor				
1	Very bad				

Appendix 7

Fatigue Scale Model

10	**FATIGUED**	(Cannot cope with daily chore or short walks, pronounced need of sleep)
9		
8		
7	**TIRED**	(Particularly doing house work, gardening or walking stairs, increased need of sleep)
6		
5		
	SLIGHTLY	(Can manage daily chores, occasionally more strenuous tasks)
4		
	TIRED	
3		
2		
1	**FIT**	(Tired only by violent exertion, normal need of sleep)

Appendix 8

Quality Of Life On Admission

The Nottingham Health Profile

Question	*Answer: yes/no*
1. I'm tired all the time	
2. I have pain at night	
3. Things are getting me down	
4. I have unbearable pain	
5. I take pills to make me sleep	
6. I've forgotten what it's like to help myself	
7. I'm feeling on edge	
8. I find it painful to change position	
9. I feel lonely	
10. I can walk about indoors	
11. I find it hard to bend	
12. Everything is an effort	
13. I'm waking up in the early morning hours	
14. I'm unable to walk at all	
15. I'm finding it hard to make contact with people	
16. The days seem to drag	
17. I have trouble getting up and down stairs	
18. I find it hard to reach for things	
19. I'm in pain when I walk	
20. I lose my temper easily these days	
21. I feel there is nobody I am close to	
22. I lie awake for most of the night	
23. I feel as if I'm losing control	
24. I'm in pain when I'm standing	
25. I find it hard to get dressed by myself	
26. I soon run out of energy	
27. I find it hard to stand for long (e.g., at kitchen sink, waiting in a queue)	

Appendix 9

Socio-economic groups
List of constituent occupations

Socio-economic group 0: Farmers, Farmers' Relatives and Farm Managers
Farmers (horse, pig or poultry); Other farmers
Farmers' sons (-in-law) and daughters (-in-law) assisting on the farm
Farmers' other relatives assisting on the farm
Farm managers
Market gardeners and nurserymen (landholders)

Socio-economic group 1: Other Agricultural Occupations and Fishermen
Agricultural labourers; Gardeners - skilled
Groundsmen, gardeners (unskilled) and gardeners' labourers
Livestock (non-farm) workers; Other agricultural workers
Foresters and skilled forestry workers; Forestry labourers and workers
Fishery board agents and inspectors; Fishermen, etc.

Socio-economic group 2: Higher Professional
Valuation surveyors
Physical scientists
Engineers; Architects and town planners
Technologists; Chartered, hydrographic and quantity surveyors
Veterinary pathologists;Bacteriologists, pathologists, pharmacologists, physiologists
Other life scientists; Medical practitioners
Dental practitioners; Veterinary surgeons
Business, economic and marketing consultants, advisors and researchers
Mathematicians, statisticians and actuaries; Accountants
Judges, barristers and solicitors
Professed clergymen and nuns; Other religious occupations
University professors and lecturers
Professional workers not included elsewhere

Socio-economic group 3: Lower Professional
Physical science technicians
Estimators, work study officers, quality control technicians etc.
Life sciences technicians
Pharmacists and dispensers
Health inspectors, cardiographers, nutritionists etc.
Cattle testers and milk inspectors
Nurses; Opticians, therapists, chiropodists, medical X-ray personnel, etc.
Systems analysts and computer programmers

Teachers; Authors, journalists and editors
Painters, sculptors and commercial artists; Industrial designers
Actors, entertainers and musicians
Technical inspectors not included elsewhere
Social workers
Technical and related workers not included elsewhere

Socio-economic group 4: Self-Employed (with Employees) and Managers
Managers of filling stations and garages; Bar or public house managers
Other managers in wholesale or retail trade
Proprietors of filling stations or garages, self-employed, with employees
Publicans, wine merchants, off-licence proprietors etc., self-employed with employees
Managers of hotels, restaurants, hostels, clubs etc.
Working proprietors in catering / lodging services not included elsewhere, self-employed with employees
Garda Siochana (senior ranks); Legislative officials and government administrators
Senior officials in Civil Service and Local Authorities
Managers and company secretaries; Personnel officers

Socio-economic group 5: Salaried Employees
Other transport and communication inspectors and supervisors
Commercial travellers and manufacturers' agents; Insurance agents
Insurance brokers and financial agents - higher professional
Other insurance brokers and financial agents
Auctioneers, valuers and other salesmen
Ships' officers; Aircraft pilots, navigators and flight engineers
Commissioned officers, Armed Forces

Socio-economic group 6: Intermediate Non-Manual Workers
Typists and key-punch operators; Book-keepers, cashiers and related workers
Computing machine operators
Clerical workers not included elsewhere; Clerical supervisors
Proprietors of filling stations or garages, self-employed, without employees
Publicans, wine merchants, off-licence proprietors, etc., self-employed, without employees
Other proprietors in wholesale or retail trade, self-employed, without employees
Shop assistants and related workers; Bar attendants
Working proprietors in catering / lodging services not included elsewhere, self-employed, without employees
Garda sergeants and lower ranks; Government executive officials
Draughtsmen
Armed forces not included elsewhere

Socio-economic group 7: Other Non-Manual Workers
Signalmen and level crossing keepers
Drivers of buses; Drivers of other road passenger vehicles
Drivers of road goods vehicles
Other transport equipment operators; Air and land transport controllers
Ticket checkers, collectors and inspectors (railways); Bus conductors

Postmen and post office sorters; Telephone, telegraph and radio operators
Warehouse and despatch clerks; Roundsmen
Street vendors, hawkers, newspaper sellers
Matrons, superintendents, supervisors of schools, etc.
Waiters and waitresses; Canteen and related workers; Chefs and cooks
Domestic servants and related workers; Caretakers
Barbers, hairdressers and beauty consultants
Watchmen and related workers
Air hostesses or stewards
Dental nurses; Hospital and ward orderlies; hospital porters and attendants
Broadcasting operators, film editors, projectionists
Proprietors in other service industries
Other service workers
Photographers and camera operators
Sportsmen and related workers

Socio-economic group 8: Skilled Manual Workers
Mine and quarry workers; Bog labourers; Other turf workers
Telephone installers, repairers and mechanics; Telecommunications technicians
Linesmen and cable jointers; Electricians and electrical fitters
Electrical and electronics engineering technicians not included elsewhere
Radio and television mechanics; Motor mechanics; Bicycle repairers and mechanics
Fitters and other mechanics; Assemblers of vehicles, motor cycles and bicycles
Other vehicle builders and skilled workers in motor vehicle and cycle assembly
Plumbers and gas fitters; Sheet metal workers; Structural metal and metal plate workers
Welders and cutters; Machine tool setters and operators
Precision instrument and watch and clock makers
Goldsmiths, silversmiths and jewellery makers
Metal casters, moulders, setters, drawers, etc., furnace and smelter workers (metals)
Metal coaters, platers, benders, etc.
Dental, orthopaedic and optical craft workers
Blacksmiths and other metal workers
Wood preparation workers; Cabinet makers; Carpenters and joiners
Woodworking machinists; Wood carvers, finishers and assemblers
Other wood and wooden furniture makers
Tanners, fellmongers and pelt dressers
Boot and shoe makers (factory); semi-skilled; Boot and shoe makers (factory); skilled
Boot and shoe makers and repairers (not factory); Other leather workers
Weavers and related workers; Bleachers, dyers and finishers
Upholsterers and related workers
Tailors and dressmakers; Cutters
Mill workers; semi-skilled; Mill workers; skilled
Bakers, pastry cooks and biscuit makers; Makers of beverages
Compositors, monotype and linotype operators
Printers (so described); Printing machine minders and feeders; Printing press operators
Other paper and printing workers
Glass and ceramic workers; Workers in rubber and rubber products
Craftsmen not included elsewhere; Clerks of works; Builders and contractors
Bricklayers; Masons and stone cutters; Plasterers; Other tradesmen

Interior decorating consultants and designers; Painters and decorators
Crane and hoist operators, riggers and cable splicers
Earth moving and other construction machinery operators
Foremen and supervisors of manual workers
Railway engine drivers and firemen
Sailors; skilled; Other sailors

Socio-economic group 9: Semi-Skilled Manual Workers

Electrical fitters and related workers not included elsewhere
Metal goods inspectors, assemblers and testers
Metal furniture workers, jointers and solderers; Refuellers, oilers and greasers
Spinners, doublers, winders and reelers
Knitters and knitting / hosiery machine operators
Occupations related to spinning, weaving, knitting and dyeing
Sewers, embroiderers and machinists; Clothing workers not included elsewhere
Makers of sugar and chocolate, confectionery, jams and jellies
Milk processors and makers of dairy products
Meat curers, canners and preservers; Other makers of food
Makers of tobacco products
Makers of paper and paperboard; Gas and chemical workers
Workers in plastics; Glass formers, potters and related workers not included elsewhere
Non-metallic mineral product makers; Other production workers
Dock labourers; Packers and bottlers
Stationary engine operators; Lorry drivers' helpers; Messengers
Charwomen and cleaners; Laundry and dry cleaning workers

Socio-economic group 10: Unskilled Manual Workers
Porters working in the transport sector; Other porters
Labourers and unskilled workers not included elsewhere

Socio-economic group 11: Unknown
Gainfully employed but occupation not stated

Appendix 10

Copies of data collection sheets for:

Chapter 3: Prevalence of undernutrition on admission to hospital

Chapter 5: Nutritional status of surgical oncology patients in hospital

Chapter 6: Anthropometric survey of healthy elderly people in Dublin

Patient details

CODING

1 Hospital [ ] [1]

2 Name [ ] [2]

3 Ward [ ] [3]

4 Hospital No [ ] [4]

5 Date of birth [ ] [5]

6 Sex Male [ ] [6]

Female [ ]

7 Date of admission [ ] [7]

8 Date of admission assessment [ ] [8]

9 Reason for admission _____ [9]

_____

10 Past medical history _____ [10]

_____

_____

Functional Status on Admission

11 Occupation [ ] [11]

12 Occupation of spouse [ ] [12]

13 Socioeconomic group [ ] [13]

14 Medical card [ ] [14]

15 Source of admission [ ] [15]

16 Type of admission [ ] [16]

Nutritional Anthropometry on Admission

17 Height (cm) [ ] [17]

18 Knee height (cm) [ ] [18]

19 Calculated stature (cm) [ ] [19]

20 Weight (kg) [ ] [20]

21	Calf circumference (cm)		21
22	S.S.F. (mm)		22
23	S.S.F. (%ile)		23
24	Calculated weight (kg)		24
25	B.M.I. (kg/m^2)		25
26	Weight 6 months ago (kg)		26
27	Weight 1 month ago (kg)		27
28	M.A.C. (mm)		28
29	M.A.C. (%ile)		29
30	M.A.M.C. (mm)		30
31	M.A.M.C. (%ile)		31
32	T.S.F. (mm)		32
33	T.S.F. (%ile)		33
34	S.S.F. + T.S.F. (mm)		34
35	S.S.F. + T.S.F. (%ile)		35

Functional Status on Admission

36	Handgrip dynamometry (kg)		36
37	% normal		37

Fluid Status on Admission

38	Oedema	pulmonary		38
39		peripheral		39
40	4th spacing	ascites		40
41		pleural		41
42	C.C.F.			42

Biochemical Status on Admission

43	Serum albumin (g/l)		43
44	Serum albumin,requested (g/l)		44
45	Haemoglobin (g/dl)		45
46	M.C.V. (fl)		46
47	M.C.H.C. (g/dl)		47
48	W.C.C. ($x10^9$/l)		48
49	T.L.C. (%)		49
50	T.L.C. ($x10^9$/l)		50

Assessment of Symptoms Prior to Admission

	score	A	B	C	D
		<1/52	<1/12	<6/12	>6/12
51 Appetite	0				
	1				
	2				
52 Ability to eat/retain food	0				
	1				
	2				
	3				

51

52

53	**Date of discharge assessment**		53
54	**Length of hospital stay** (days)		54
55	**Surgical intervention**		55
56	**Nutritional intervention**		56
57	**Clinical nutrition/dietetic referral**		57
58	**Discharge destination**		58

Nutritional Anthropometry on Discharge

59	**Weight** (kg)		59
60	**Calf circumference** (cm)		60
61	**S.S.F.** (mm)		
62	**S.S.F.** (%ile)		61
63	**Calculated weight** (kg)		62
64	**B.M.I.** (kg/m^2)		63
65	**M.A.C.** (mm)		64
66	**M.A.C** (%ile)		65
67	**M.A.M.C.** (mm)		66
68	**M.A.M.C.** (%ile)		67
69	**T.S.F.** (mm)		68
70	**T.S.F.** (%ile)		69
71	**S.S.F. + T.S.F.** (mm)		70
72	**S.S.F. + T.S.F.** (%ile)		71
			72

Functional Status on Discharge

73	Handgrip dynamometry (kg)		73
74	% normal		74

Fluid Status on Discharge

75	Oedema	pulmonary	75
76		peripheral	76
77	4th spacing	ascites	77
78		pleural	78
79	C.C.F.		79

Biochemical Status on Discharge

80	Serum albumin (g/l)	80
81	Serum albumin,requested (g/l)	81
82	Haemoglobin (g/dl)	82
83	M.C.V. (fl)	83
84	M.C.H.C. (g/dl)	84
85	W.C.C. ($x10^9$/l)	85
86	T.L.C. (%)	86
87	T.L.C. ($x10^9$/l)	87

Patient details on admission

CODING

1 Patient No [ ] [1]

2 Hospital [ ] [2]

3 Consultant [ ] [3]

4 Name [ ] [4]

5 Address [ ] [5]

6 Phone No [ ] [6]

7 Ward [ ] [7]

8 G.P. [ ] [8]

9 Hospital No [ ] [9]

10 Date of birth [ ] [10]

11 Sex Male [ ]
Female [ ] [11]

12 Date of admission [ ] [12]

13 Date of admission assessment [ ] [13]

14 Reason for admission _____
_____ [14]

15 Past medical history _____
_____
_____
_____
_____ [15]

16 Total number of health problems [ ] [16]

17 Medications on admission

17

18 Total number of medications used

18

19 Source of admission

19

20 Type of admission

20

21 Occupation

21

22 Occupation of spouse

22

23 Socioeconomic group

23

24 Medical card

24

25 Retired

25

26 Unemployed

26

27 Educational level : primary

secondary

third level

27

28 Home circumstances : living alone

living with spouse

living in own home with family

living in home of relatives

28

29 Mental status : oriented in time

oriented in person

oriented in place

29

30 Normal alcohol intake/week

30

31 Normal intake of cigarettes/cigars/pipe/week

31

	score	<1/52	<1/12	<6/12	>6/12
32 Appetite	0				
	1				
	2				
33 Ability to eat/retain food	0				
	1				
	2				
	3				

32

33

34 Presence of dentures ☐ 34

35 Dentures removed to eat ☐ 35

36 Help with feeding required ☐ 36

37 Pain or discomfort while eating ☐ 37

38 Ability to eat lunch : full ☐
less than 1/2 ☐
1/2 to 3/4 ☐
soup &/or dessert ☐ 38

39 Length of time taken to eat lunch main course ☐ 39

40 Perception of hunger compared to normal :
more hungry ☐
less hungry ☐
normal appetite ☐ 40

41 Perception of need to eat compared to normal :
more important ☐
less important ☐
no change ☐ 41

42 Basal energy expenditure ☐ 42

43 Total energy expenditure ☐ 43

44 Protein requirements ☐ 44

Nutritional Anthropometry on Admission

1	**Height** (cm)		1
2	**Knee height** (cm)		2
3	**Calculated stature** (cm)		3
4	**Weight** (kg)		4
5	**Calf circumference** (cm)		5
6	**S.S.F.** (mm)		6
7	**S.S.F.** (%ile)		7
8	**Calculated weight** (kg)		8
9	**B.M.I.** (kg/m^2)		9
10	**Weight 6 months ago** (kg)		10
11	**Weight 1 month ago** (kg)		11
12	**M.A.C.** (mm)		12
13	**M.A.C.** (%ile)		13
14	**M.A.M.C.** (mm)		14
15	**M.A.M.C.** (%ile)		15
16	**T.S.F.** (mm)		16
17	**T.S.F.** (%ile)		17
18	**S.S.F. + T.S.F.** (mm)		18
19	**S.S.F. + T.S.F.** (%ile)		19
20	**Biceps** (mm)		20
21	**Supailiac** (mm)		21
22	**Body fat** (%)		22

Functional Status on Admission

1 **Handgrip dynamometry** (kg) [ ] [ ] [ ] [ ] [1]

2 **% normal** [ ] [2]

3 **Modified Norton Scale**

A	Mental condition	B	Activity	C	Mobility
4	Fully oriented	4	Ambulant	4	Full
3	Occasionally confused	3	Walks with help	3	Slightly limited
2	Cannot answer adequately	2	Chairbound	2	Very limited
1	No contact	1	Bedridden	1	Immobile
D	**Food intake**	**E**	**Fluid intake**	**F**	**Incontinence**
4	Normal	4	Normal	4	None
3	Insufficient	3	Insufficient	3	Occasional
2	Parenteral/Enteral	2	Parenteral	2	Usually urine
1	No intake	1	No intake	1	Double
G	**General physical condition**				
4	Good				
3	Fair				
2	Poor				
1	Very bad				

[3A] [3B] [3C] [3D] [3E] [3F] [3G]

Fluid Status on Admission

1 **Oedema** **pulmonary** [ ] [1]

2 **peripheral** [ ] [2]

3 **4th spacing** **ascites** [ ] [3]

4 **pleural** [ ] [4]

5 **C.C.F.** [ ] [5]

Biochemical Status on Admission

1	**Serum albumin** (g/l)		1
2	**Serum albumin,requested** (g/l)		2
3	**Haemoglobin** (g/dl)		3
4	**M.C.V.** (fl)		4
5	**M.C.H.C.** (g/dl)		5
6	**W.C.C.** ($x10^9$/l)		6
7	**T.L.C.** (%)		7
8	**T.L.C.** ($x10^9$/l)		8
9	**Serum glucose** (mmols/l)		
	a. normal throughout day		9a
	b. no. of high levels/24 hours post admission		9b
10	**Serum B_{12}**		10
11	**Serum folate**		11
12	**C.R.P.**		12
13	**Creatinine** (mmols/l)		13
14	**Urea** (mmols/l)		14

DAILY MONITORING RECORDS

Date :

Name :

Patient No :

Hospital No :

1. Basal energy expenditure : 1

2. Total energy expenditure : 2

3. Special diet 3

4. Type of special diet 4

5. Normal diet 5

6. Light diet 6

7. Nutritional supplements 7

8. Type of supplements 8

9. Numbers of supplements taken 9

10. Reasons for supplements not being taken 10

11. Enteral feeding ☐ 11

12. Route of enteral feeding 12

13. Type of enteral feeding 13

14. Type of enteral feed 14

15. Prescribed energy intake from enteral feed 15

16. Actual energy intake from enteral feed 16

17. Reasons for enteral feed prescription not being fulfilled

17

18. Parenteral feeding ☐ 18

19. Route of parenteral feeding 19

20. Parenteral feeding regimen 20

21. Reasons for parenteral feeding regimen not being fulfilled

22. Fasting

21
22

23. Reason(s) for fasting

23

24. Length of fast period

24

25. Consuming full diet

25

23. Consuming less than half diet

24. Reason(s) for inability to consume diet

25. Change(s) to drug regimen

ANTHROPOMETRIC REFERENCE STANDARDS STUDY

CODING

Subject details

1. Recruitment group :

2. Gender : Male :

Female :

3. Age (years) :

4. Locality :

5. Occupation, or if retired or unemployed, last occupation :

6. If working solely in the home, occupation of spouse:

7. Socio-economic group:

8. Is your level of physical activity at work and/or during leisure time mainly

Low : Medium : High :

9. How many times do you spend in *ACTIVE LEISURE* of at least 20 minutes weekly?
(active leisure e.g. : mowing lawn, cleaning windows, walking, jogging, cycling, swimming, dancing, playing sports)

4 or more
2 - 3
once
less than once
never

Anthropometric measurements

1. Height (cm) [ ] [1]

2. Weight (kg) [ ] [2]

3. B.M.I. (kg/m^2) [ ] [3]

4. Left M.A.C. (mm) [ ] [4]

5. Left M.A.M.C. (mm) [ ] [5]

6. Left M.A.M.A. (mm) [ ] [6]

7. Left T.S.F. (mm) [ ] [ ] [ ] [ ] [7]

8. Left calf circumference (cm) [ ] [8]

9. Right calf circumference (cm) [ ] [9]

10. Hand-grip dynamometry (kg) (non-dominant arm) [ ] [ ] [ ] [ ] [10]

11. % normal [ ] [11]

HIGH ACTIVITY

cycling, swimming, playing sports, skipping, walking the dog,

MEDIUM ACTIVITY

walking, washing the car, house work, gardening

LOW ACTIVITY

sitting, watching TV, writing, reading

Appendix 11

Summary of changes in carbohydrate, lipid and nitrogen metabolism in cancer
(de Blaauw *et al.* 1997)

	Effect
Carbohydrate metabolism	
Arterial glucose	decreased, unchanged
Glucose pool size	decreased
Glucose turnover	increased
Gluconeogenesis	increased
Glucose tolerance	decreased
Cori cycle activity	increased
Protein metabolism	
Nitrogen balance	decreased
Protein turnover	increased
Muscle	
protein synthesis	increased
Protein breakdown	increased
Ammonia and amino acid metabolism	
Ammonia concentrations	increased
Glutamine concentrations	decreased
Alanine turnover	increased
Glutamine turnover	increased
Muscle glutamine production	increased-decreased
Liver glutamine consumption	increased-decreased
PDV glutamine turnover	increased
Lipid metabolism	
Triglyceride concentrations	increased
Lipoprotein lipase activity	decreased
Glycerol turnover	increased, unchanged
FFA turnover	increased, unchanged

Appendix 12

Diagnosis and timing of patient assessments.

Patient study number	Type of Cancer	Pre-operative		Post-operative										Post-discharge	
		1	2	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56	Day 63	Day 70	6 weeks	12 weeks
1	Lung	Yes		Yes*											Yes
2	Ovarian	Yes		Yes*										Yes	Yes
3	Lung	Yes		Yes*											
4	Bowel	Yes		Yes	Yes*										
5	H+N	Yes		Yes	Yes	Yes	Yes†								
6	OES	Yes		Yes	Yes†										
7	H+N	Yes		Yes	Yes		Yes	Yes		Yes	Yes		Yes*	Yes	Yes
8	Lung	Yes		Yes	Yes*									Yes	Yes
9	H+N	Yes†													
10	H+N	Yes		Yes	Yes	Yes		Yes		Yes		Yes*		Yes	Yes
11	OES	Yes		Yes	Yes	Yes*								Yes	
12	PAN	Yes		Yes					Yes		Yes	Yes	Yes*	Yes	Yes
13	H+N	Yes		Yes*											
14	Bowel	Yes		Yes	Yes	Yes	Yes*							Yes	Yes
15	Bowel	Yes		Yes	Yes*										
16	OES	Yes		Yes	Yes	Yes		Yes*						Yes	
17	H+N	Yes		Yes*										Yes	
18	Lung	Yes†													
19	Lung	Yes*													
20	H+N	Yes		Yes	Yes	Yes	Yes*							Yes	
21	H+N	Yes		Yes	Yes	Yes	Yes*								
22	Bowel	Yes		Yes*										Yes	Yes
23	Bowel	Yes	Yes	Yes	Yes*									Yes	Yes
24	Bowel	Yes		Yes*										Yes	Yes
25	Bowel	Yes		Yes*										Yes	
26	OES	Yes†													

27	OES	Yes		Yes	Yes	Yes*								Yes	Yes
28	Bowel	Yes		Yes*										Yes	
29	Lung	Yes		Yes	Yes†										
30	Lung	Yes	Yes	Yes	Yes*									Yes†	
31	Lung	Yes	Yes	Yes*										Yes	
32	H+N	Yes	Yes	Yes	Yes	Yes*								Yes	
33	Bowel	Yes		Yes		Yes	Yes*							Yes	
34	Bowel	Yes		Yes*										Yes	
35	H+N	Yes		Yes	Yes	Yes*								Yes	Yes
36	H+N	Yes		Yes	Yes	Yes*									
37	OES	Yes			Yes*									Yes	Yes
38	Lung	Yes*													
39	Lung	Yes		Yes	Yes*									Yes	
40	H+N	Yes		Yes	Yes	Yes*								Yes	Yes
41	Ovarian	Yes		Yes	Yes	Yes*								Yes	
43	Lung	Yes		Yes*										Yes	
44	Gastric	Yes		Yes*											
45	OES	Yes							Yes	Yes	Yes	Yes*		Yes	Yes
47	Bowel	Yes			Yes†										
48	OES	Yes		Yes	Yes	Yes	Yes†								
49	Gastric	Yes		Yes	Yes*										
50	Bowel	Yes		Yes	Yes*									Yes	
51	PAN	Yes		Yes	Yes	Yes*								Yes	Yes
52	Lung	Yes		Yes*											
53	Lung	Yes		Yes*										Yes	Yes
54	OES	Yes			Yes	Yes		Yes	Yes*					Yes	Yes
56	Lung	Yes		Yes	Yes*									Yes	Yes
57	H+N	Yes	Yes	Yes	Yes	Yes*									
58	Ovarian	Yes		Yes*										Yes	Yes
59	Lung	Yes		Yes*										Yes	Yes
60	Ovarian	Yes†													
61	OES	Yes	Yes	Yes*										Yes	Yes
62	Lung	Yes†													

*Discharged at this point, no further assessments in hospital; †RIP post-operatively.
H+N, head and neck; OES, oesophageal; PAN, pancreatic.

Appendix 13

National organisations of older people in Ireland

Age Action Ireland

30-31 Camden St. Dublin 8.

Tel: 353 1 6779892; E-mail:ageact@indigo.ie

Age and Opportunity

St. Joseph's Building, The Marino Institute of Education, Griffith Avenue, Dublin 9.

Tel: 353 1 8370570; E-mail: ageandop@indigo.ie

Federation of Active Retirement Associations

Shamrock Chambers, 59/61 Dame Street, Dublin 2.

Tel: 353 1 6792142.

Irish Association of Older People

Room G02, University College Dublin, Earlsfort Terrace, Dublin 2.

Tel: 353 1 4750013.

The Irish Senior Citizens National Parliament

32 Parnell Square, Dublin 1.

Tel: 353 1 8782541.

National Council on Ageing and Older People

22 Clanwilliam Square, Grand Canal Quay, Dublin 2.

Tel: 353 1 6766484.

Appendix 14

The Retired Workers Committee (Irish Congress of Trade Unions)

Amalgamated Transport and General Workers Union
Association of Higher Civil Servants
Association of Secondary School Teachers of Ireland
Bray and District Council of Trade Unions
Burmah Castrol Pensioners Association
CIE Salaries Pensioners Association
Communication Managers Union
Cork Council of Trade Unions
Cork Operative Butchers Society
Dublin Council of Trade Unions
ESB Officers Association
Garda Siochana Pensioners Association
Graphical, Paper and Media Union
Guinness
Irish Congress of Trade Unions
IMPACT
Irish National Teachers Organisation
Irish National Painters and Decorators Trade Group
Irish Print Union
Limerick Council of Trade Unions
Mandate
Marine, Port and General Workers Union
MSF (Manufacturing Science Finance)
National Federation of Pensioners Associations
National Union of Journalists
Operative Plasterers Allied Trade Society of Ireland
Public Service Executive Union
Retired Civil Servants Association
Royal Liver Superannuitants
Sales, Marketing and Administrative Union of Ireland
SIPTU
Teachers Union of Ireland
Transport Salaried Staff Association
Union of Construction Allied Trades and Technicians
Waterford Glass