Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

DUBLIN DENTAL
UNIVERSITY HOSPITAL
OSPIDÉAL DÉADACH
OLLSCOILE ÁTHA CLIATH

Oral Health Data Analysis in National Child Cohort Surveys

A thesis submitted to the University of Dublin, Trinity College for the Degree of Doctor of Philosophy

Vinay Sharma

Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, University of Dublin, Trinity College, Lincoln Place, Dublin 2

September 2024

Volume II

Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or another university and it is entirely my own work.

I agree to deposit this thesis in the University's open access institutional repository or allow the library to do so on my behalf, subject to Irish Copyright Legislation and Trinity College Library conditions of use and acknowledgement.

I consent to the examiner retaining a copy of the thesis beyond examining period, should they so wish (EU GDPR May 2018)

Vinay Sharma

September 2024

Table of Contents

Appendix A 1
Supplementary file S1 1
Supplementary file S2 12
Supplementary file S3 31
Supplementary file S4 37

Appendix B 44
Supplementary file S1 44
Supplementary file S2 52
Supplementary file S3 158

Appendix C 217
Behavioural factors and socioeconomic (SES) measures 217
Material factors and socioeconomic (SES) measures 225
Psychosocial factors and socioeconomic (SES) measures 233

Appendix D 257

Appendix A

Supplementary file S1

Search Strategy

1) **Table S1. Database: Embase (with key words: All fields) search output**

No.	Query	Results
#1	'dental disease assessment'/exp	6,306
#2	'tooth disease'/exp	256,612
#3	'dental health'/exp	4,337
#4	'oral health status'/exp	13
#5	#1 OR #2 OR #3 OR #4	259,680
#6	'dental caries' OR (dental AND caries) OR ((dental OR tooth) NEAR/6 decay) OR 'carious' OR 'white spot*' OR ('dmf*' NEAR/6 ('index*' OR 'indice*')) OR ((dental OR tooth) NEAR/3 'survey*')	79,739
#7	'periodont*' OR 'gingiv*' OR 'pyorrhea alveolaris' OR 'parodontosis'	193,114
#8	((tooth OR teeth) NEAR/6 (anomalies OR wear OR erosion OR abnormalities OR demineralisation OR demineralization)) OR ((hypoplastic OR hypoplasis OR hypomineralisation) NEAR/6 (enamel OR dental OR 'molar*'))	6,375
#9	'malocclus*' OR 'tooth crowding' OR ('teeth' AND 'crowding') OR 'cross bite*' OR 'angle classification*'	37,310
#10	(('dental' OR 'tooth' OR 'teeth') NEAR/6 'fluorosis') OR 'mottled enamel*'	2,626

Table S1 Continued…

No.	Query	Results
#11	((‘tooth’ OR ‘teeth’ OR ‘pulp*’ OR ‘dent*’) AND (‘injur*’ OR ‘trauma’))	65,885
#12	#5 OR #6 0R #7 OR #8 OR #9 OR #10 OR #11	415,443
#13	'child'/exp	3,091,552
#14	'adolescent'/exp	1,775,911
#15	‘infant’/exp	1,200,575
#16	'child*' OR 'preschool' OR 'paediatr*' OR 'pediatr*' OR 'minor' OR 'pupil*' OR 'toddler*' OR 'adolesc*' OR 'teen*' OR 'young person' OR 'young people' OR 'youth' OR 'infant*’	5,774,710
#17	#13 OR #14 OR #15 OR #16	5,989,145
#18	#12 AND #17	116,245
#19	'ireland'/exp	35,846
#20	'health service executive*' OR hse* OR irish*	64,766
#21	ireland* OR 'republic of ireland' OR eire* OR 'irish free state'	675,197
#22	Leinster OR munster OR Connaught OR connacht OR ulster	82,707
#23	(Carlow OR Cavan OR Clare OR Cork OR Donegal OR Dublin OR Galway OR Kerry OR Kildare OR Kilkenny OR Laois OR Leitrim OR Longford OR Louth OR Mayo OR Meath OR Monaghan OR Offaly OR Roscommon OR Sligo OR Tipperary OR Waterford OR Westmeath OR Wexford OR Wicklow)	491,671
#24	#19 OR #20 OR #21 OR #22 OR #23	1,073,913
#25	#18 AND #24	2,009

2) Table S2. Database: Medline Ovid search output

No.	Query	Results
1)	exp Tooth Diseases/	179,251
2)	exp Oral health/	18,340
3)	exp Dental Health Surveys/	23,382
4)	(dental caries or (dental and caries) or ((dental or tooth) adj3 decay) or carious or white spot* or (dmf*' adj3 (index* or indice*)) or ((dental or tooth) adj3 survey*)).mp	71,737
5)	(periodont* or gingiv* or Pyorrhea Alveolaris or Parodontosis).mp	138,677
6)	(((tooth or teeth) adj3 (anomalies or wear or erosion or abnormalities or demineralisation or demineralization)) or ((hypoplastic or hypoplasis or hypomineralisation) adj3 (enamel or dental or molar*))).mp	14,437
7)	(Malocclus* or tooth crowding or (teeth and crowding) or cross Bite* or Angle classification*).mp	36,045
8)	(((dental or tooth or teeth) adj6 fluorosis) or mottled enamel*).mp	3,204
9)	((tooth or teeth or pulp* or dent*) and (injur* or trauma)).mp	28,816
10)	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9	331,679
11)	exp Adolescent/ or exp Child/ or exp Infant/	3,754,269
12)	(child* or preschool or paediatr* or pediatr* or minor or pupil* or toddler* or adolesc* or teen* or (young person) or (young people) or youth or infant).mp	4,530,112
13)	#11 OR #12	4,530,112
14)	#10 AND #13	93,974
15)	exp Ireland/	19,228
16)	((health service executive*) or hse* or irish*).mp	14,125
17)	(ireland* or (republic of Ireland) or eire* or (irish free state)).mp	35,190
18)	(Leinster or munster or Connaught or connacht or ulster).mp	2,101

Table S2 Continued…

No.	Query	Results
19)	(Carlow or Cavan or Clare or Cork or Donegal or Dublin or Galway or Kerry or Kildare or Kilkenny or Laois or Leitrim or Longford or Louth or Mayo or Meath or Monaghan or Offaly or Roscommon or Sligo or Tipperary or Waterford or Westmeath or Wexford or Wicklow).mp	23,335
20)	#15 OR #16 OR #17 OR #18 OR #19	64,238
21)	#14 AND #20	307

3) Table S3. Database: Pub Med search output

No.	Query	Results
1)	"tooth diseases" [MeSH Terms] OR "Oral Health"[Mesh] OR "Dental Health Surveys"[Mesh] OR ("tooth"[ALL FIELDS] AND "disease"[ALL FIELDS]) OR "tooth diseases"[ALL FIELDS] OR "teeth diseases"[ALL FIELDS] OR "dental diseases"[ALL FIELDS] OR "oral health assessment"[ALL FIELDS] OR “Oral health surveys”[ALL FIELDS] OR “Oral health”[ALL FIELDS] OR “Dental health”[ALL FIELDS]	245,274
2)	"dental caries"[All Fields] OR ("dental"[ALL FIELDS] AND "caries"[ALL FIELDS]) OR "tooth decay"[ALL FIELDS] OR "dental decay"[ALL FIELDS] OR "teeth decay"[ALL FIELDS] OR "white spot*"[ALL FIELDS] "carious"[ALL FIELDS] OR "dental survey"[ALL FIELDS] OR "dmf* index*"[ALL FIELDS] OR "dmf* indice*"[ALL FIELDS]	16,675
3)	"periodont*"[ALL FIELDS] OR "gingiv*"[ALL FIELDS] OR "Pyorrhea Alveolaris"[ALL FIELDS] OR "Parodontosis"[ALL FIELDS]	160,813
4)	"teeth anomalies"[ALL FIELDS] OR "teeth wear"[ALL FIELDS] OR "teeth erosion"[ALL FIELDS] OR "teeth abnormalities"[ALL FIELDS] OR "dental anomalies"[ALL FIELDS] OR "dental wear"[ALL FIELDS] OR "dental erosion"[ALL FIELDS] OR "dental abnormalities"[ALL FIELDS] OR "dental demineralisation"[ALL FIELDS] OR "tooth anomalies"[ALL FIELDS] OR "tooth wear"[ALL FIELDS] OR "tooth erosion"[ALL FIELDS] OR "tooth abnormalities"[ALL FIELDS] OR "tooth demineralisation"[ALL FIELDS] OR "enamel hypoplasia" [ALL FIELDS] OR "dental hypoplasia"[ALL FIELDS] OR "molar hypomineralisation"[ALL FIELDS]	14,905
5)	"malocclus*"[ALL FIELDS] OR "teeth crowding"[ALL FIELDS] OR "cross bite"[ALL FIELDS] OR "dental crowding"[ALL FIELDS] OR "Angle classification*"[ALL FIELDS]	35,841
6)	"enamel fluorosis"[ALL FIELDS] OR "dental fluorosis"[ALL FIELDS] OR "tooth fluorosis"[ALL FIELDS] OR "mottled enamel"[ALL FIELDS]	3,100
7)	"tooth injury"[ALL FIELDS] OR "dental injury"[ALL FIELDS] OR "pulp injury"[ALL FIELDS] OR "teeth injury"[ALL FIELDS] OR "teeth fracture"[ALL FIELDS] OR "tooth fracture"[ALL FIELDS] OR "Enamel fracture"[ALL FIELDS] OR “tooth trauma”[ALL FIELDS] OR “Dental trauma”[ALL FIELDS]	3,167
8)	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7	360,933
9)	"child"[MeSH Terms] OR "adolescent"[MeSH Terms] OR "infant"[MeSH Terms]	3,754,529

Table S3 Continued…

No.	Query	Results
10)	"child*"[ALL FIELDS] OR "preschool"[ALL FIELDS] OR "paediatr*"[ALL FIELDS] OR "pediatr*"[ALL FIELDS] OR "minor"[ALL FIELDS] OR "pupil*"[ALL FIELDS] OR "toddler*"[ALL FIELDS] OR "adolesc*"[ALL FIELDS] OR "teen*"[ALL FIELDS] OR "young person"[ALL FIELDS] OR "young people"[ALL FIELDS] OR "youth"[ALL FIELDS] OR “infant*”[ALL FIELDS]	5,090,088
11)	#9 OR #10	5,090,088
12)	#8 AND #11	105,854
13)	"Ireland"[Mesh]	19,231
14)	"Health Service Executive*"[ALL FIELDS] OR "HSE"[ALL FIELDS]	4,797
15)	"irish*"[ALL FIELDS] OR "Ireland*"[ALL FIELDS] OR "Republic of Ireland"[ALL FIELDS] OR "Eire*"[ALL FIELDS] OR "Irish Free State"[ALL FIELDS]	148,124
16)	"Leinster"[ALL FIELDS] OR "Munster"[ALL FIELDS] OR "Connaught"[ALL FIELDS] OR "Connacht"[ALL FIELDS] OR "Ulster"[ALL FIELDS]	45,947
17)	"Carlow"[ALL FIELDS] OR "Cavan"[ALL FIELDS] OR "Clare"[ALL FIELDS] OR "Cork"[ALL FIELDS] OR "Donegal"[ALL FIELDS] OR "Dublin"[ALL FIELDS] OR "Galway"[ALL FIELDS] OR "Kerry"[ALL FIELDS] OR "Kildare"[ALL FIELDS] OR "Kilkenny"[ALL FIELDS] OR "Laois"[ALL FIELDS] OR "Leitrim"[ALL FIELDS] OR "Longford"[ALL FIELDS] OR "Louth"[ALL FIELDS] OR "Mayo"[ALL FIELDS] OR "Meath"[ALL FIELDS] OR "Monaghan"[ALL FIELDS] OR "Offaly"[ALL FIELDS] OR "Roscommon"[ALL FIELDS] OR "Sligo"[ALL FIELDS] OR "Tipperary"[ALL FIELDS] OR "Waterford"[ALL FIELDS] OR "Westmeath"[ALL FIELDS] OR "Wexford"[ALL FIELDS] OR "Wicklow"[ALL FIELDS]	259,923
18)	#13 OR #14 OR #15 OR #16 OR #17	357,342
19)	#12 AND #18	1,031

4) Table S4. Database: Cochrane (with key words: Title and abstract) search output

No.	Query	Results
1)	MeSH descriptor: [Oral Health] explode all trees	466
2)	MeSH descriptor: [Dental Health Surveys] explode all trees	3273
3)	MeSH descriptor: [Tooth Diseases] explode all trees	11,480
4)	(dental AND caries) OR ((dental OR tooth) NEAR/6 decay) OR carious OR "white spot*" OR (dmf* NEAR/6 (index* OR indice*)) OR ((dental OR tooth) NEAR/3 survey*)	6,729
5)	periodont* OR gingiv* OR "Pyorrhea Alveolaris" OR "Parodontosis"	16,394
6)	((tooth OR teeth) NEAR/6 (anomalies OR wear OR erosion OR abnormalities OR demineralisation OR demineralization)) OR ((hypoplastic OR hypoplasis OR hypomineralisation) NEAR/6 (enamel OR dental OR 'molar*'))	993
7)	Malocclus* OR "tooth crowding" OR (teeth AND crowding) OR "cross Bite*" OR "Angle classification*"	1,721
8)	((dental OR tooth OR teeth) NEAR/6 fluorosis) OR mottled enamel*	123
9)	((tooth OR teeth OR pulp* OR dent*) AND (injur* OR trauma))	1,681
10)	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9	29,620
11)	MeSH descriptor: [Child] explode all trees	58,731
12)	MeSH descriptor: [infant] explode all trees	33,554
13)	MeSH descriptor: [Adolescent] explode all trees	107,314
14)	child* OR preschool OR paediatr* OR pediatr* OR minor OR pupil* OR toddler* OR adolesc* OR teen* OR (young person) OR (young people) OR infant*	325,152
15)	#11 OR #12 OR #13 OR #14	325,152
16)	#10 AND #15	7,656
17)	MeSH descriptor: [Ireland] explode all trees	316
18)	"Health Service Executive*" OR HSE*	166
19)	irish* OR Ireland* OR "Republic of Ireland" OR Eire* OR "Irish Free State"	3,563
20)	Leinster OR Munster OR Connaught OR Connacht OR Ulster	317

Table S4 Continued…

No.	Query	Results
21)	Carlow OR Cavan OR Clare OR Cork OR Donegal OR Dublin OR Galway OR Kerry OR Kildare OR Kilkenny OR Laois OR Leitrim OR Longford OR Louth OR Mayo OR Meath OR Monaghan OR Offaly OR Roscommon OR Sligo OR Tipperary OR Waterford OR Westmeath OR Wexford OR Wicklow	6,962
22)	#17 OR #18 OR #19 OR #20 OR #21	10,451
23)	#16 AND #22	111

5) Table S5. Database: Scopus (TITLE-ABS-KEY) search output

	Query	Results
1)	(dental AND caries) OR ((dental OR tooth OR teeth) w/6 decay) OR carious OR white spot* OR (dmf* w/6 (index* OR indice*)) OR ((dental OR tooth) w/3 survey*)	24,966
2)	((tooth diseases) OR (oral health) OR (oral health status) OR (Oral health diseases) Or (dental diseases) or (oral health assessment) OR (oral health survey) Or (dental health survey))	305,007
3)	(periodont* OR gingiv* OR (Pyorrhea Alveolaris) OR Parodontosis)	177,487
4)	(((teeth OR dental OR tooth) w/6 (anomalies OR wear OR erosion OR abnormalities OR demineralisation OR demineralization)) OR ((hypoplastic OR hypoplasis OR hypomineralisation) w/6 (enamel OR dental OR molar*)))	23,774
5)	(Malocclus* OR (dental AND crowding) OR (cross Bite*) OR (Angle classification*))	62,929
6)	(((tooth OR teeth OR pulp* OR dent*) AND (injur* OR trauma)))	39,828
7)	(((tooth OR teeth OR dental) w/6 fluorosis) OR (mottled enamel*))	4,299
8)	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7	511,332
9)	(child* OR preschool OR paediatr* OR pediatr* OR minor OR pupil* OR toddler* OR adolesc* OR teen* OR (young person) OR (young people) OR youth OR Infant)	5,999,111
10)	#8 AND #9	136,183
11)	(Health Service Executive*) OR HSE* OR irish* OR Ireland* OR (Republic of Ireland) OR Eire* OR (Irish Free State) OR Leinster OR Munster OR Connaught OR Connacht OR Ulster OR Carlow OR Cavan OR Clare OR Cork OR Donegal OR Dublin OR Galway OR Kerry OR Kildare OR Kilkenny OR Laois OR Leitrim OR Longford OR Louth OR Mayo OR Meath OR Monaghan OR Offaly OR Roscommon OR Sligo OR Tipperary OR Waterford OR Westmeath OR Wexford OR Wicklow	346,265
12)	#10 AND #11	876

6) Table S6. Database: Web of Science search output

	Query	Results
1)	**TS=((dental caries OR (dental AND caries) OR ((dental OR tooth) NEAR/6 decay) OR carious OR white spot* OR (dmf* NEAR/6 (index* OR indice*)) OR ((dental OR tooth) NEAR/3 survey*)))**	48,500
2)	**TS=(((tooth diseases) OR (oral health) OR (oral health status) OR (Oral health diseases) Or (dental diseases) or (oral health assessment) OR (oral health survey) Or (dental health survey)))**	117,173
3)	TS=((periodont*) OR (gingiv*) OR (Pyorrhea alveolaris) OR (Parodontosis))	104,199
4)	TS=(((tooth OR teeth OR dental) NEAR/6 (anomalies OR wear OR erosion OR abnormalities OR demineralisation OR demineralization)) OR ((hypoplastic OR hypoplasis OR hypomineralisation) NEAR/6 (enamel OR dental OR molar*)))	12,255
5)	TS=((Malocclus*) OR (dental crowding) OR (tooth crowding) OR (teeth AND crowding) OR (cross Bite*) OR (Angle classification*))	28,601
6)	TS=(((dental OR tooth OR teeth) NEAR/6 fluorosis) OR (mottled enamel*))	2,265
7)	TS=(((tooth OR teeth OR pulp* OR dent*) AND (injur* OR trauma)))	17,782
8)	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7	278,526
9)	TS=((child*) OR preschool OR (paediatr*) OR (pediatr*) OR minor OR (pupil*) OR (toddler*) OR (adolesc*) OR (teen*) OR (young person) OR (young people) OR youth OR Infant)	3,296,910
10)	#8 AND #9	44,270
11)	TS=((Health Service Executive*) OR (HSE*) OR (irish*) OR (Ireland*) OR (Republic of Ireland) OR (Eire*) OR (Irish Free State) OR Leinster OR Munster OR Connaught OR Connacht OR Ulster OR Carlow OR Cavan OR Clare OR Cork OR Donegal OR Dublin OR Galway OR Kerry OR Kildare OR Kilkenny OR Laois OR Leitrim OR Longford OR Louth OR Mayo OR Meath OR Monaghan OR Offaly OR Roscommon OR Sligo OR Tipperary OR Waterford OR Westmeath OR Wexford OR Wicklow)	329,639
12)	#10 AND #11	396

7) **DDUH Library catalogue search:** Child AND Ireland, search results: 69

8) **Lenus Ireland search:** Child AND (Oral Health OR Dental health OR Dental caries OR Oral health survey OR dental health survey OR dental caries survey), search results: 255

Supplementary file S2

Critical Appraisal of Included Studies

Table S7. Critical appraisal of included studies.

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
Medical Research Council of Ireland, 1952[1]	Yes	Yes	No	Yes	Yes	Yes	Unclear	NA	Yes	6
Department of Health, 1961[2]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Department of Health, 1961[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8

Table S7 Continued…

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
Department of Health, 1962[4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Department of Health, 1962[5]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Department of Health, 1962-63[6]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Department of Health, 1964[7]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Department of Health, 1963[8]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Thomas, 1972[9]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Collins and O'Mullane, 1969[10]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8

Table S7 Continued…

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
O'Hickey and Pigott, 1981[11]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
O'Hickey and Pigott, 1983[12]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Lemasney et al., 1984[13]	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	NA	Yes	7
O'Mullane et al., 1986[14]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Western Health Board, 1994[15]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Eastern Health Board, 1994[16]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8

Table S7 Continued…

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
Southern Health Board, 1995[17]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
North Eastern Health Board, 1996[18]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Eastern Health Board, 1997[19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Mid-Western Health Board, 1998[20]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8

Table S7 Continued…

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
North Western Health Board, 1998[21]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
South Eastern Health Board, 1998'99[22]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Whelton et al., 1991[23]								NA		
Daly et al., 1991[24]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Downer et al., 1994[25]	Yes	No	No	Yes	Yes	Yes	Yes	NA	Yes	6

Table S7 Continued…

Reference, Year of study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and settings described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all the participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	Total score
Creedon and O'Mullane, 2001[26]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Bolin, 1997[27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Whelton et al., 2006[28]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Sagheri et al., 2007[29]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
Oral Health Research Center. University College Cork, 2018[30]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8
James et al., 2021[31]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	8

NA: Not Applicable

Table S8. Summary of Included studies.

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*Sample Size for Age Group*				*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
National				***5-years-old***	***8-years-old***	***12-years-old***	***15-years-old***		
Medical Research Council of Ireland, 1953[1] 1952	Cross-sectional survey	Convenience sampling technique	Republic of Ireland	704 (5-6 Y)	803 (7-8 Y)	758 (12-13 Y)		Grade 3 and above lesions* Grade 4 and above lesions*	2, Trained and Calibrated
Department of Health, 1962[3] 1961	Cross-sectional study	Two stage Stratified random sampling	Dublin Kildare Wicklow	575 180 167	726 313 357	616 283 343	257 78 97	Grade 4 and above lesions*	12, Trained and Calibrated
Department of Health, 1962[2] 1961	Cross-sectional study	Two stage Stratified random sampling	Cork Limerick Waterford	590 211 288	634 275 311	577 300 302	258 149 114	Grade 4 and above lesions*	7, Trained and Calibrated
Department of Health, 1963[32] 1962	Cross-sectional survey	Two stage Stratified random sampling	Louth Wexford Laois Galway	207 227 156 293	293 318 264 408	316 319 216 389	146 116 075 168	Grade 4 and above lesions*	5, Trained and Calibrated
Department of Health, 1964[6] 1962-63	Cross-sectional study	Two stage Stratified random sampling	Kerry Clare West-Meath Offaly	227 162 220 217	396 308 325 343	331 303 272 327	161 176 128 150	Grade 4 and above lesions*	6, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
Department of Health, 1964[5] 1962	Cross-sectional study	Two stage Stratified random sampling	Tipperary (North Riding) Tipperary (South Riding) Kilkenny Carlow	296 211 277 224	330 317 343 293	275 361 299 280	152 168 119 106	Grade 4 and above lesions*	7, Trained and Calibrated
Department of Health, 1965[7] 1963	Cross-sectional study	Two stage Stratified random sampling	Meath Donegal Sligo Mayo	196 248 259 262	370 394 316 350	297 355 333 395	133 158 109 161	Grade 4 and above lesions*	9, Trained and Calibrated
Department of Health, 1965[8] 1963	Cross-sectional study	Two stage Stratified random sampling	Roscommon Longford Leitrim Cavan Monaghan	250 219 216 239 274	313 253 268 360 321	274 215 251 292 256	182 169 162 91 126	Grade 4 and above lesions*	6, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
O'Mullane et al., 1986[14] 1984	Cross-sectional survey.	Two stage Stratified random sampling	Health Boards: Eastern Midland Mid-western North Eastern North Western South Eastern Southern Western	N F PF 157 139 9 149 112 23 124 121 13 183 89 42 143 69 57 123 117 57 157 137 27 92 85 62	N F PF 141 151 27 152 145 31 146 115 30 164 90 54 133 52 75 131 118 67 156 141 12 109 86 61	N F PF 136 128 20 132 78 60 137 95 42 172 89 57 132 52 90 132 91 126 131 137 19 128 79 81	N F PF 124 133 54 193 44 104 183 22 112 215 49 74 142 12 135 99 60 152 210 62 37 179 21 39	Grade 4 and above lesions*	10, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
Whelton et al., 2006 [28] 2002	Cross-sectional survey North South Survey of Children's Oral Health in Ireland 2002	Two stage Stratified random sampling	Health Boards: Eastern *(Now called Eastern Regional Health Authority, ERHA)* East Coast Area (Sub-region of ERHA) Northern Area (sub-region of ERHA) South Western Area (sub-region of ERHA) Midland Mid-western North Eastern North Western South Eastern Southern Western Republic of Ireland	804 227 272 305 306 382 3308 270 551 658 378 N F PF 2159 3614 668	933 248 356 329 276 402 374 242 547 652 350 N F PF 816 2211 363	855 217 325 313 337 413 363 268 592 698 357 N F PF 746 2089 367	894 230 335 329 260 350 346 263 495 622 305 N F PF 632 2062 343	WHO 3C and BASCD 3VC criteri	36, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
Regional									
Western Health Board, 1994[15] 1991-1992	Cross-sectional study.	Two stage Stratified random sampling	Western Health Board (Total)	N F PF 85 301 69	N F PF 88 291 141	N F PF 102 278 141		WHO 3C (cavity into the dentine)	Information not available
Eastern Health Board, 1994[16] 1993	Cross-sectional survey.	Two stage Stratified random sampling	Dublin Kildare Wicklow	1,711 275 354	1,908 322 406	1,860 323 369	793 110 82	WHO 3C (cavity into the dentine)	8, Trained and Calibrated
Southern Health Board, 1995[17] 1995	Cross-sectional survey.	Two stage Stratified random sampling	Kerry North Cork North Lee South Lee West Cork	228 171 211 279 181	275 221 266 288 202	270 225 248 296 205	218 203 174 208 156	WHO 3C (cavity into the dentine)	10, Trained and Calibrated
Mid-Western Health Board, 1998[20] 1997	Cross-sectional survey.	Two stage Stratified random sampling	Clare Limerick North Tipperary	157 222 217	204 239 231	230 241 210	196 217 221	WHO 3C (cavity into the dentine)	6, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
North Western Health Board, 1998[21] 1998	Cross-sectional survey	Two stage Stratified random sampling	NWHB Region	N F PF 339 291 62	N F PF 403 322 86	N F PF 432 353 91	N F PF 285 203 122	WHO 3C (cavity into the dentine)	4, Trained and Calibrated
Eastern Health Board, 1997[19] 1997	Cross-sectional survey.	Two stage Stratified random sampling	Dublin Kildare Wicklow	285 164 196		283 186 207		WHO 3C (cavity into the dentine)	7, Trained and Calibrated
South Eastern Health Board, 1998'99[22] 1998/'99	Cross-sectional Survey.	Two stage Stratified random sampling	Carlow/Kilkenny South Tipperary Waterford Wexford			212 224 280 234		WHO 3C and BASCD 3VC criteria	4, Trained and Calibrated
North Eastern Health Board, 1996[18] 1995	Cross-sectional survey.	Two stage Stratified random sampling	Cavan/Monaghan Louth Meath	201 169 204	226 152 242	250 204 251	233 173 226	WHO 3C (cavity into the dentine)	6, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	***Study Design***	***Sampling Technique***	***Area or County***	***5-years-old***	***8-years-old***	***12-years-old***	***15-years-old***	***Diagnostic Threshold (Using the dmft/DMFT Index)***	***Examiners and Reliability***
County									
Dublin									
O'Hickey and Pigott, 1981[11] 1970	Cross-sectional survey	Two stage Stratified random sampling	Dublin	453	377	577	243	Grade 4 and above lesions	3, Trained and Calibrated
O'Hickey and Pigott, 1983[12] 1975	Cross-sectional survey	Two stage Stratified random sampling	Dublin	540	717	833	271	Grade 4 and above lesions	3, Trained and Calibrated
Downer et al., 1994[25] 1992*	Cross-sectional study	Two stage random sampling	Dublin			551		Visual dentinal caries[33]	2, Trained and Calibrated
Sagheri et al., 2007[29] 2002	Cross-sectional study	Two stage Stratified random sampling	Dublin			332		WHO 3C (cavity into the dentine)	1, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
Oral Health Services and Research Center. University College Cork[30] 2014	Cross-sectional	Two stage Stratified random sampling	Dublin, Kerry, and Cork	892		597		WHO 3C (cavity into the dentine)	Trained and Calibrated
James et al., 2021[31] 2017	Nested Longitudinal Study	Two stage Stratified random sampling	Dublin, Kerry, and Cork	704				WHO 3C and BASCD 3VC criteria	Trained and Calibrated
Limerick									
Lemasney et al., 1984[13] 1982*	Cross-sectional Study	Stratified random sampling	Limerick city	267		308 (11 year old children)		Visual criteria by Whittle and Downer[34]	2, Trained and Calibrated
Offaly									
Thomas, 1972[9] 1972	Cross-sectional survey	National schools in the urban area of Tullamore	Tullamore (Co. Offally)	193	196	113		Grade 4 and above lesions	2, Trained and Calibrated

Table S8 Continued…

Study, Year of Survey	*Study Design*	*Sampling Technique*	*Area or County*	*5-years-old*	*8-years-old*	*12-years-old*	*15-years-old*	*Diagnostic Threshold (Using the dmft/DMFT Index)*	*Examiners and Reliability*
Kerry									
Creedon and O'Mullane, 2001[26] 1997	Cross-sectional survey	Two stage Stratified random sampling.	Kerry	611				WHO 3C and BASCD 3VC criteria	1, Trained and Calibrated
Clare									
Whelton et al., 1991[23] 1990	Cross-sectional study	Proportionate random cluster sampling	County Clare	N F PF 133 112 14	N F PF 136 137 16	N F PF 135 107 20		WHO 3C (cavity into the dentine)	2, Trained and Calibrated
Cork									
Collins and O'Mullane, 1970[10] 1969	Cross-sectional study	Two stage Stratified random sampling	Cork (Cork city)	320				Grade 4 and above lesions	1, Trained and Calibrated
Bolin, 1997[35] 1994	Cross-sectional survey	Two stage Stratified random sampling	Cork (Cork city)	200		200		WHO 3C (cavity into the dentine)	1, Trained and Calibrated
Kilkenny									
Daly et al., 1991[24] 1987	Cross-sectional survey	Two stage Stratified random sampling	Kilkenny	157		181	185	WHO 3C (cavity into the dentine)	Information not available

*The system of grading the degrees of caries which was adopted followed by the British Ministry of Health in the 1950s surveys in Britain. Six grades were recognised: Grade 1: Discoloration without destruction of enamel believed to be caused by caries; Grade 2: Pitting of enamel; Grade 3: Deep pitting reaching into dentine; Grade 4: Cavity into dentine; Grade 5: Large cavity penetrating deeply into dentine, generally of a few years' standing and with the pulp involvement; Grade 6: Cavity with definite and unmistakable evidence of periapical infection fistula on buccal gingiva or possibly on palatal mucosa in case of upper molar involvement.

Abbreviations: N- Non fluoridated areas , F-Full Fluoridated areas, PF- Partially fluoridated areas, WHO – World Health Organisation, BASCD- British Association for the Study of Community Dentistry, 3C – Dentinal cavity, and 3VC – Visual dentinal caries.

Reference:

1. Medical Research Council of Ireland. Dental caries in Ireland. Dublin, Ireland; 1953.

2. Department of Health (DoH). Health (Fluoridation of water supplies) Act, 1960: Report on the incidence of dental caries in school children, and on the analysis of public piped water supplies in the health authority areas of Cork, Limerick and Waterford. Dublin, Ireland; 1962.

3. Department of Health (DoH). Health (Fluoridation of water supplies) Act, 1960: Report on the Incidence of Dental Caries in School Children, and on the Analysis of Public Piped Water Supplies, in Dublin, Kildare and Wicklow Health Authority Areas. Dublin, Ireland; 1962.

4. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Louth, Wexford, Laois and Galway. . Dublin; 1962.

5. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Tipperary (North Riding), Tipperary (South Riding), Kilkenny and Carlow. Dublin, Ireland; 1964.

6. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Kerry, Clare, West-Meath and Offaly. . Dublin, Ireland; 1964.

7. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Meath, Donegal, Sligo and Mayo. Dublin, Ireland; 1965.

8. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Roscommon, Longford, Leitrim, Cavan and Monaghan. . Dublin, Ireland; 1965.

9. Thomas WM. Report on a survey of the incidence of dental caries in national school children in the Tullamore urban area Co. Offaly. Portlaoise: Midland Health Board (MHB); 1972.

10. Collins CK, O'Mullane DM. Dental caries experience in Cork City schoolchildren aged 4-11 years after 4 1/2 years of fluoridation. Journal of Irish Dental Association. 1970;16(5):130-34.

11. O'Hickey S, Pigott B. Dental Caries Experience of Dublin School-children after 5 1/2 years of fluoridation. Journal of Irish Dental Association. 1981;27:78-83.

12. O'Hickey S, Pigott B. Dental Caries Experience of Dublin School-children after 10 1/2 years of fluoridation. Journal of Irish Dental Association. 1983;29(1):5-8.

13. Lemasney J, O'Mullane D, Coleman M. Effect of fluoridation on dental health in 5- and 11-year-old Irish schoolchildren. Community Dentistry and Oral Epidemiology. 1984;12(4):218-22.

14. O'Mullane D, Clarkson J, Holland T, O'Hickey S, Whelton H, Health Mf, et al. Children's Dental Health in Ireland, 1984: A Survey Conducted on behalf of the Minister for Health by University College Cork. Dublin: Department of Health Ireland; 1986.

15. Western Health Board, Oral Health Services Research Center. University College Cork. Children's dental health in the Western Health Board region. Ireland; 1994.

16. Eastern Health Board, Oral Health Services Research Center. University College Cork. Children's dental health in the Eastern Health Board region, 1993. Dublin: Eastern Health Board (EHB); 1994.

17. Southern Health Board, Oral Health Services Research Center. University College Cork. Oral Health of Children and Adolescents,1995. Ireland; 1995
.

18. North Eastern Health Board, Oral Health Services Research Center. University College Cork. Children's Dental Health in the North Eastern Health Board Region, 1995. Ireland; 1996.

19. Eastern Health Board, Oral Health Services Research Center. University College Cork. Oral health of Children in the Eastern Health Board, 1997. Ireland; 1997.

20. Mid-Western Health Board, Oral Health Services Research Center. University College Cork. Survey of Oral Health of Children and Adolescents, 1997. Ireland; 1998.

21. North Western Health Board, Oral Health Services Research Center. University College Cork. Survey of Oral Health of Children and Adolescents, 1997/'98. Ireland; 1998.

22. South Eastern Health Board, Oral Health Services Research Center. University College Cork. Oral Health of Children and Adolescents in the South Eastern Region, 1998/'99. Ireland; 1998/'99.

23. Whelton H, O'Keefe J, O'Mullane DM. Children's dental health in County Clare, 1991. Cork: Mid-Western Health Board; 1991.

24. Daly B, Hobdell MH, Sadlier D, Jennings N. The Kilkenny Integrated Oral Health Project. Irish Journal of Medical Science 1991;160 (Suppl 9):50-4.

25. Downer M, Blinkhorn A, Holt R, Wight C, Attwood D. Dental caries experience and defects of dental enamel among 12-year-old children in north London, Edinburgh, Glasgow and Dublin. Community Dent Oral Epidemiol. 1994;22(5 Pt 1):283-5.

26. Creedon MI, O'Mullane DM. Factors affecting caries levels amongst 5-year-old children in County Kerry, Ireland. Community Dental Health. 2001;18(2):72-8.

27. Bolin AK. Children's dental health in Europe. An epidemiological investigation of 5- and 12-year-old children from eight EU countries. Swedish Dental Journal Supplement. 1997;122:1-88.

28. Whelton H, Crowley E, Harding M, Guiney H, Cronin M, Flannery E, et al. North South Survey of Children's Oral Health in Ireland 2002. Ireland: The Department of Health and Children Health Services Executive, Ireland; The Department of Health Social Services and Public Safety, Northern Ireland; WHO Collaborating Centre for Oral Health Services Research University College Cork; 2006.

29. Sagheri D, McLoughlin J, Clarkson JJ. A comparison of dental caries levels in two communities with different oral health prevention strategies stratified in different social classes. J Public Health Dent. 2007;67(1):1-7.

30. Oral Health Services Research Centre. University College Cork. OHSRC Briefing Document on HRB funded Fluoride and Caring for Children's Teeth study (FACCT). Ireland; 2018.

31. James P, Harding M, Beecher T, Browne D, Cronin M, Guiney H, et al. Impact of Reducing Water Fluoride on Dental Caries and Fluorosis. Journal of Dental Research. 2021;100(5):507-14.

32. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: Report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Louth, Wexford, Laois and Galway. . Dublin, Ireland; 1963.

33. Dirks OB, Houwink B, Kwant GW. The results of 612 years of artificial fluoridation of drinking water in The Netherlands: The tiel—Culemborg experiment. Archives of Oral Biology. 1961;5(3):284-300.

34. Whittle JG, Downer MC. Dental health and treatment needs of Birmingham and Salford school children. A comparison in a fluoridated and a non-fluoridated area. British Dental Journal. 1979;147(3):67-71.

35. Bolin AK, Bolin A, Jansson L, Calltorp J. Children's dental health in Europe. Swedish Dental Journal. 1997;21(1):25-40.

Supplementary file S3

List of excluded studies with reasons

Table S9. List of excluded studies with reasons

	Author(s) and Year	Reasons for Exclusion
1	Alyahya et al., 2001[1]	Sample not representative of the County.
2	Bolin, 1997[2]	Primary survey already included
3	Bradley, 2003[3]	Sample not representative of the County.
4	Buckley, 1980 [4]	Full text not available
5	Burden et al., 2001 [5]	Sample not representative
6	Clerkin et al., 2006 [6]	Full text not available
7	Cochran et al., 2004[7]	Dental fluorosis study.
8	Convery and Lee, 1987 [8]	Sample not representative of County and included age groups
9	East Coast Area Health Board, 2001,[9]	Sample representative of the specific group (disadvantaged children)
10	North Eastern Health Board et al., 2002[10]	Primary survey already included
11	Norton and O'Connell, 2012[11]	Dental injury
12	O' Dowling and McNamara, 1990[12]	Study on congenital missing teeth
13	O' Keefe, 1991[13]	Sample not representative of Meath County
14	O'Mullane and Whelton, 1994[14]	Primary survey (1984 National Oral health Survey) already included
15	O'Mullane and Whelton, 1997[15]	Primary survey data already included
16	O' Mullane, 1988[16]	Primary survey data already included
17	O'Mullane, 1982[17]	Sample not representative of included age groups
18	O'Mullane et al., 1986[18]	Primary survey data already included
19	Whelton et al., 2002[19]	Primary survey data already included
20	Kinirons and Mageean, 1980[20]	Sample representative of a small area of County Cork
21	Mageean et al., 1979[21]	Sample representative of a small area of County Cork
22	Holland and Crowley, 1982[22]	Sample not representative
23	Nunn J, 2009[23]	Dental erosion study
24	Whelton et al., 1991[24]	Primary survey data already included
25	Whelton et al., 2004[25]	Primary survey data already included
26	Whelton et al., 2006[26]	Primary survey data already included
27	Whelton et al., 2003[27]	Primary survey data already included
28	Tuohy et al., 2001[28]	Sample not representative

Table S9 Continued…

	Author(s) and Year	**Reasons for Exclusion**
29	Ormsby et al., 2001[29]	Full text not available
30	Harding et al., 2010[30]	Full text not available
31	Ellwood and O'Mullane, 1995[31]	Sample not representative (Dental fluorosis)
32	McSwiney and Millett, 2013[32]	Hospital records
33	Rutledge et al., 2002[33]	Hospital records
34	Mullen et al., 2012[34]	Sample not representative
35	Clarkson and O'Mullane, 1989[35]	Dental fluorosis
36	Harding et al., 2005[36]	Dental fluorosis
37	Sagheri et al., 2007[37]	Dental fluorosis
38	O' Mullane, 1972[38]	Dental injury

Reference:

1. Alyahya RH, School DD, Public HDo, Health CD, College T. The prevalence of enamel defects and dental fluorosis in 12-year-old children in fluoridated areas in Dublin. Dublin: Trinity College Dublin; Ireland; 2001.

2. Bolin AK. Children's dental health in Europe. An epidemiological investigation of 5- and 12-year-old children from eight EU countries. Swed Dental Journal Suppl. 1997;122:1-88.

3. Bradley C. The dental health of 5-year-old children from disadvantaged schools in the Eastern Regional Health Authority area 2000. Journal of Irish Dental Association. 2003;49(4):133-8.

4. Buckley LA. A study of the distribution of plaque and gingival inflammation in a population of young Irish adults. Quintessence Int Dent Dig. 1980;11(3):51-7.

5. Burden DJ, Pine CM, Burnside G. Modified IOTN: an orthodontic treatment need index for use in oral health surveys. Community Dent Oral Epidemiology. 2001;29(3):220-5.

6. Clerkin P, Walsh K, Nic Gabhainn S. Oral hygiene among Irish schoolchildren. 2006.

7. Cochran JA, Ketley CE, Arnadóttir IB, Fernandes B, Koletsi-Kounari H, Oila AM, et al. A comparison of the prevalence of fluorosis in 8-year-old children from seven European study sites using a standardized methodology. Community Dent Oral Epidemiol. 2004;32:28-33.

8. Convery L, Lee P. Dental decay and dietary habits of 100 preschool-children (mean age, 45 months) living in dis-advantaged areas of greater Dublin. . Journal of Dental Research 1987;66(4):907-.

9. East Coast Area Health Board. Oral health in disadvantaged schools in the Eastern region / report prepared by the National Nutrition Surveillance Centre, Department of Health Promotion, National University of Ireland, Galway. 2001.

10. North Eastarn Health Board, Health Service Executive HSE, Centre OHSR, Parnell C, Connolly E, O'Farrell M, et al. Oral health of 5 year old children in the North East, 2002: Health Service Executive (HSE); 2002.

11. Norton E, O'Connell AC. Traumatic dental injuries and their association with malocclusion in the primary dentition of Irish children. Dent Traumatol. 2012;28(1):81-6.

12. O'Dowling IB, McNamara TG. Congenital absence of permanent teeth among Irish school-children. Journal of Irish Dental Association. 1990;36(4):136-8.

13. O'Keeffe JP. Childrens dental health in 8 primary schools in South County Meath (1988). J Ir Dent Assoc. 1991;37(2):48-50.

14. O'Mullane D, Whelton H. Caries prevalence in the Republic of Ireland. Int Dent J. 1994;44(4):387-91.

15. O'Mullane D, Whelton H. Efficacy of fluoride against dental caries; fluoride in water. Fogorvosi szemle. 1997;90:7-12.

16. O'Mullane DM, Clarkson J, Holland T, O'Hickey S, Whelton H. Effectiveness of water fluoridation in the prevention of dental caries in Irish children. Community Dent Health. 1988;5(4):331-44.

17. O' Mullane D. The changing patterns of dental caries in Irish school children between 1961 and 1981. Journal of Dental Research. 1982;61:1317-20.

18. O' Mullane D, O'Hickey S, Whelton H. Prevalence of Dental Caries in Children Resident in Fluoridated and Non-fluoridated Communities in Ireland. CARIES RESEARCH. 1986;20(2):188-9.

19. Whelton H, Cronin M, O'Mullane D. Dental caries amongst Irish children in the 1990s. Journal of Dental Reserach. 2002;81:B301-B.

20. Kinirons MJ, Mageean JF. Dental caries prevalence and treatment status of 12-year-old children in a non-fluoridated area. Community Dental Oral Epidemiology. 1980;8(4):208-10.

21. Mageean JF, Holland TJ, Gleeson P. Dental caries prevalence in 5 year old children in Mallow (a non fluoridated area), Cork, Ireland. Community Dental Oral Epidemiology. 1979;7(2):115-6.

22. Holland TJ, Crowley MJ. Detailed examination of caries progression in 4-year-old children in a non-fluoridated area in Ireland. Community Dental Oral Epidemiology. 1982;10(3):144-7.

23. Nunn J. A longitudinal study of tooth erosion in adolescents indicates that this may be a progressive phenomenon, at least on some tooth sites. United States2009 2009-12. 221-2 p.

24. Whelton H, Mageean J, O'Mullane DM, Health NIDo, Services S, University College COHSRC. Children's dental health in Northern Ireland (a comparison with the Repubic of Ireland). Cork; Belfast: ["University College, Cork. Oral Health Services Research Centre", "Northern Ireland. Department of Health and Social Services"]; 1991. -43p.: fig, tab; 28cm. p.

25. Whelton H, Crowley E, O'Mullane D, Donaldson M, Kelleher V, Cronin M. Dental caries and enamel fluorosis among the fluoridated and non-fluoridated

populations in the Republic of Ireland in 2002. Community Dent Health. 2004;21(1):37-44.

26. Whelton H, Crowley E, O'Mullane D, Donaldson M, Cronin M, Kelleher V. Dental caries and enamel fluorosis among the fluoridated population in the Republic of Ireland and non fluoridated population in Northern Ireland in 2002. Community Dent Health. 2006;23(1):37-43.

27. Whelton H, Crowley E, O'Mullane D, Cronin M, Kelleher V. Children's oral health in Ireland 2002: preliminary results 2003.

28. Tuohy M, Whelton H, O'Mullane D. Medical card ownership and dental caries levels in 3-year-old Tipperary children. Journal of Dental Reserach. 2001;80(4):1178-.

29. Ormsby M, Whelton H, O'Mullane D. The relationship between toothbrushing habits and dental fluorosis in 8 year-old children in the North West of Ireland. Journal of Dental Reserach. 2001;80(4):1145-.

30. Harding M, Whelton H, Shirodaria S, O'Mullane D, Cronin M. Is tooth wear in the primary dentition predictive of tooth wear in the permanent dentition? Report from a longitudinal study. Community dental health. 2010;27(1):41-5.

31. Ellwood RP, O'Mullane DM. Dental enamel opacities in three groups with varying levels of fluoride in their drinking water. Caries Res. 1995;29(2):137-42.

32. McSwiney TP, Millett DT. North Cork HSE orthodontic treatment waiting list 2009-2010: retrospective audit of patient records. J Ir Dent Assoc. 2013;59(2):87-90.

33. Rutledge D, Public DDUHDo, Health CD, College T. Prevalence of tooth agenesis in a referred health board population. Dublin: Trinity College Dublin, Ireland; 2002.

34. Mullen J, McGaffin J, Farvardin N, Brightman S, Haire C, Freeman R. Caries status in 16 year-olds with varying exposure to water fluoridation in Ireland. Community Dent Health. 2012;29(4):293-6.

35. Clarkson J, O'Mullane D. A modified DDE Index for use in epidemiological studies of enamel defects. Journal of Dental Research. 1989;68(3):445-50.

36. Harding MA, Whelton H, O'Mullane DM, Cronin M, Warren JJ. Primary tooth fluorosis in 5-year-old schoolchildren in Ireland. European Journal of Paediatric Dentistry. 2005;6(3):155-61.

37. Sagheri D, McLoughlin J, Clarkson JJ. The prevalence of dental fluorosis in relation to water or salt fluoridation and reported use of fluoride toothpaste in school-age children. European Archives of Paediatric Dentistry. 2007;8(1):62-8.

38. O'Mullane DM. Injured permanent incisor teeth: an epidemiological study. Journal of Irish Dental Association. 1972;18(4):160-73.

Supplementary file S4

Result tables for mean d_{3c}mft/D_{3C}MFT (sd/SD) scores and percentage of caries-free children at National level.

Table S10. The mean d_{3c}mft (sd) scores and percentage of caries-free children among the 5-year-olds at National level by fluoridation status. For reporting the mean d_{3c}mft scores, the dental caries diagnostic threshold used during 1952, the 1960s and 1984 surveys was Grade 4 (cavity into dentine) and above lesions and *3C (cavity into dentine)* in 2002 survey. For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1952 survey was *Grade 3 (deep pitting reaching down to dentine) and above lesions*, *Grade 4 (cavity into dentine) and above lesions* in the 1960s and 1984 survey, and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey. CWF (Community Water Fluoridation).

Age group	**1952 survey**	**1960s surveys**	**1984 survey**		**2002 survey**	
	(Pre-fluoridation) (n = 704)	(Pre-fluoridation) (n = 9,823)	(CWF) (n = 869)	(No CWF) (n = 836)	(CWF) (n = 3,614)	(No CWF) (n = 2,159)
Mean d_{3c}mft scores (sd)	5.9	5.66 (5.59)	1.8 (2.8)	3.0 (3.7)	1.0	1.7
Percentage of caries-free	0.4	16.98	52.1	38.5	63.1	45.5

Table S11. The mean D_{3C}MFT scores (SD) among the 8, 12 and 15-year-olds at National level by fluoridation status. For reporting the mean d_{3c}mft scores, the dental caries diagnostic threshold used during 1952, the 1960s and 1984 surveys was Grade 4 (cavity into dentine) and above lesions and *3C (cavity into dentine)* in 2002 survey. CWF (Community Water Fluoridation).

Age group	**1952 survey**	**1960s surveys**	**1984 survey**		**2002 survey**	
	(Pre-fluoridation)	(Pre-fluoridation)	(CWF)	(No CWF)	(CWF)	(No CWF)
8-year-olds	1.0 (n = 803)	1.72 (n = 19,173)	0.6 (1.1) (n = 898)	1.0 (1.3) (n = 792)	0.3 (n = 2,211)	0.3 (n = 816)
12-year-olds	4.1 (n = 758)	4.77 (4.14) (n = 17,645)	2.6 (2.3) (n = 749)	3.3 (2.5) (n = 755)	1.2 (n = 2,089)	1.4 (n = 746)
15-year-olds		8.28 (n = 9,157)	4.1 (3.1) (n = 403)	5.4 (3.7) (n = 668)	2.1 (n = 2,062)	3.2 (n = 632)

Table S12. The percentage of caries-free children among the 8, 12, and 15-year-olds at National level by fluoridation status. For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1952 survey was *Grade 3 (deep pitting reaching down to dentine) and above lesions*, *Grade 4 (cavity into dentine) and above lesions* in the 1960s and 1984 survey, and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey. CWF (Community Water Fluoridation).

Age group	**1952 survey**	**1960s surveys**	**1984 survey**		**2002 survey**	
	(Pre-fluoridation)	(Pre-fluoridation)	(CWF)	(No CWF)	(CWF)	(No CWF)
8-year-olds	14.9	33.49	69.5	55.7	79.5	75.4
12-year-olds	1.2	6.46	22.8	14.7	46.5	37.9
15-year-olds		2.07	11.9	7.8	27	20.7

Result tables for mean $d_{3c}mft/D_{3C}MFT$ scores and percentage of caries-free children at Health Board level.

Table S13. The mean $d_{3C}mft$ [sd] scores among the 5-year-olds at Health Board level by fluoridation status. For reporting the mean $d_{3c}mft$ scores, the dental caries diagnostic threshold used in the 1960s, and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and *3C (cavity into dentine)* in the 1990s and 2002 surveys. CWF (Community Water Fluoridation).

Health Board	**1960s (n)**	**1984 (n)**		**1990s (n)**		**2002 (n)**	
	(Pre-fluoridation)	CWF	No CWF	CWF	No CWF	CWF	No CWF
Eastern	5.43 [6.1] (1,210)	1.3 [2.2] (139)	2.9 [3.8] (123)	0.9*, 1.0**	1.7**	0.8	
Mid-land	5.05 [5.1] (1,110)	1.9 [3.2] (112)	3 [3] (89)			1.2	1.6
Mid-Western	6.53 [5.9] (981)	2.3 [3.4] (121)	4 [4.7] (110)	1.7	2.9	1.4	1.7
North-Eastern	5.05 [5.3] (1,293)	1 [2] (89)	2.1 [2.9] (139)	1.2	1.8	1.1	1.6
North-Western	5.25 [5.5] (1,024)	1.7 [2.5] (69)	3 [4] (62)	1.1	1.8	1.5	1.9
South-Eastern	6.22 [5.6] (1,750)	1.9 [2.8] (117)	2.8 [3] (93)	1	1.8	1.6	1.9
Southern	6.3 [6.2] (1,266)	2.5 [2.9] (137)	4 [4.2] (143)	1.1	2.3	0.9	1.8
Western	5.07 [5.4] (1,190)	1.5 [2.5] (85)	2.2 [3.4] (77)	1	2.1	0.8	1.8

Table S14. The percentage of caries-free children among the 5-year-olds at Health Board level by fluoridation status. For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1960s and 1984 survey was *Grade 4 (cavity into dentine) and above lesions*, *3C (cavity into dentine)* in the 1990s, and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey. *1993 survey, **1997 survey. CWF (Community Water Fluoridation). Blank cells represents the missing data.

Health Board	**1960s**	**1984**		**1990s**		**2002**	
	(Pre-fluoridation)	CWF	No CWF	CWF	No CWF	CWF	No CWF
Eastern	14.8	57	37	*70, 67**		68.4	
Mid-land	19.9	54	34			57.1	53.4
Mid-Western	12.68	45	36	62	45	54.5	45.3
North-Eastern	21.30	66	46			59.1	49.2
North-Western	21.23	52	40	66	51	46.9	31.2
South-Eastern	13.58	50	38	70	53	54.5	51.7
Southern	14.6	39	30			68.3	48.2
Western	19.37	59	47	68	42	64.4	45

Table S15. The mean $D_{3C}MFT$ [SD] scores among the 8, 12, and 15-year-olds at Health Board level by fluoridation status. For reporting the mean $D_{3C}MFT$ scores, the dental caries diagnostic threshold used in the 1960s, and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and *3C (cavity into dentine)* in the 1990s and 2002 surveys. *1993 survey, **1997 survey. CWF (Community Water Fluoridation).

	Health Board	**1960s (n)**	**1984 (n)**		**1990s (n)**		**2002 (n)**	
		(Pre-fluoridation	CWF	No CWF	CWF	No CWF	CWF	No CWF
8-year-olds	Eastern	2.03 (2,944)	0.5 (151)	1 (83)	0.3* *		0.3	
	Mid-land	1.61 (2,390)	0.5 (145)	0.9 (93)			0.3	0.3
	Mid-Western	1.86 (1,856)	1 (115)	1.1 (126)	0.6	0.8	0.3	0.4
	North-Eastern	1.48 (2,604)	0.5 (90)	0.6 (125)	0.3	0.3	0.5	0.3
	North-Western	1.5 (1,923)	0.8 (52)	1.1 (29)	0.3	0.4	0.2	0.3
	South-Eastern	1.83 (3,235)	0.4 (118)	1.2 (105)	0.4	0.3	0.4	0.2
	Southern	1.9 (2,044)	0.9 (141)	1 (134)	0.3	0.5	0.3	0.4
	Western	1.42 (2,177)	0.4 (86)	0.9 (97)	0.4	0.5	0.2	0.2
12-year-olds	Eastern	5.3 [5.1] (2,469)	2.2 [2.2] (128)	3.4 [2.2] (101)	1.4*,1.1**	1.8	1	
	Mid-land	4.6 [4] (1,645)	2.5 [2.2] (78)	2.5 [2.1] (64)			1.1	1.3
	Mid-Western	5 [4.3] (1,804)	3.1 [2.7] (95)	3.7 [2.8] (114)	1.4	2.1	1.5	1.7
	North-Eastern	4.3 [3.8] (2,401)	2.3 [1.9] (89)	2.8 [2.3] (132)	1.2	1.6	1.4	1.4
	North-Western	4.3 [3.8] (1,904)	2.4 [2] (52)	3.9 [2.6] (25)	1.2	1.5	1.4	1.1
	South-Eastern	5.1 [4.2] (2,483)	2.2 [2.3] (91)	3.5 [2.6] (114)	1.2	1.8	1.3	1.9
	Southern	5.3 [4.5] (1,660)	3.3 [2.2] (137)	4.1 [2.9] (95)	1.3	1.8	1.1	1.7
	Western	4.2 [4.3] (1,924)	2.3 [2.2] (79)	3 [2.7] (110)	1.6	2.1	1.2	
15-year-olds	Eastern	9 (1,020)	3.7 (133)	4.8 (97)	2.5*		2	
	Mid-land	7.8 (981)	3.5 (44)	3.9 (56)			2.2	2.5
	Mid-Western	8.2 (1,083)	4.3 (22)	5.9 (98)	3	3.8	1.9	3.7
	North-Eastern	7.6 (1,204)	4.1 (49)	5.2 (119)	2.2	2.7	2.4	2.8
	North-Western	7.8 (1,026)	2.3 (12)	5.8 (18)	2.2	3.3	2	2.9
	South-Eastern	8.9 (1,291)	4 (60)	5.6 (41)	3	3.3	2.2	2.7
	Southern	9.5 (971)	5.4 (62)	6.8 (129)	2.8	4.3	2.4	3.2
	Western	7.3 (1,126)	4.5 (21)	4.8 (110)			2.1	

Table S16. The percentage of caries-free children among the 8, 12, and 15-year-olds at Health Board level by fluoridation status: For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1960s and 1984 survey was *Grade 4 (cavity into dentine) and above lesions*, *3C (cavity into the dentine)* in the 1990s, and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey. *1993 survey, **1997 survey. CWF (Community Water Fluoridation).

	Health Board	**1960s**	**1984**		**1990s**		**2002**	
		(Pre-fluoridation)	CWF	No CWF	CWF	No CWF	CWF	No CWF
8-year-olds	Eastern	26.6	72	55	81*		80.2	
	Mid-land	35.4	75	57			77.6	77.1
	Mid-Western	30.5	60	47	75	62	77.1	70.6
	North-Eastern	40.2	73	66			75.3	78.8
	North-Western	39.9	60	59	79	77	71.8	71.2
	South-Eastern	30.4	79	50	74	80	73.8	77.4
	Southern	27.6	58	54			86.1	75.5
	Western	40.0	76	60	82.1	78.4	82.4	79.1
12-year-olds								
	Eastern	4.5	27	15	42**		51	
	Mid-land	6.8	27	25			48.8	41.9
	Mid-Western	5.6	18	10	45	36	38	36.4
	North-Eastern	8.5	21	16			47.1	41.2
	North-Western	8.6	21	16	56	49	34.7	24.0
	South-Eastern	5.2	31	11	47	37	36.2	35.2
	Southern	3.8	14	10			52.3	45.8
	Western	9.0	27	18	48.2	44.1	40.7	
15-year-olds								
	Eastern	0.6	16	13	29*		28.5	
	Mid-land	2.2	9	9			26.7	32.4
	Mid-Western	2.1	4	5	21	18	29.7	20.1
	North-Eastern	3.0	10	9			26.1	21.4
	North-Western	2.0	17	6	32	27	18.2	16.0
	South-Eastern	2.0	17	5	21	24	22.5	15.8
	Southern	1.2	3	5			31.4	26.2
	Western	3.2	14	8			22.9	

Result tables for mean d_{3c}mft/D_{3C}MFT (sd/SD) scores and percentage of caries-free children at County level (County Dublin).

Table S17. Mean d_{3c}mft/D_{3C}MFT (sd/SD) scores at the County level (County Dublin). For reporting the mean d_{3c}mft/D_{3C}MFT scores, the dental caries diagnostic threshold used in 1952, 1961, 1970, 1975, and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and in the 1990s, 2002, and 2014 surveys was *3C (cavity into dentine)*. For reporting the percentage of caries-free children, dental caries diagnostic threshold used in 1961 was *Grade 4 (cavity into dentine) and above lesions*, in the 1990s, 2002, and 2014 surveys was *3C (cavity into dentine)*. The 1992 survey used the visual criteria by Backer-Dirks et al[1].

Year/Study	Fluoridation status	Sample size 5-year	12-year	Mean d_{3c}mft (sd) 5-year-olds	Mean D_{3C}MFT (SD) 12-year-olds	% caries-free (5-year-olds) d_{3c}mft = 0	% caries-free (12-year-olds) D_{3C}MFT = 0
1952[2]	No CWF	177	172	6.14	4.59		
1961[3]	No CWF	575	616	5.72 (5.87)	6.11 (5.07)	11.3	3.25
1970[4]	CWF	453	577	2.03 (4.5)	4.03 (4.2)		
1975[5]	CWF	540	833	1.81 (4.62)	3.05 (4.67)		
1984[6]	CWF			1.3	2.2		
1992[7]	CWF		551		1.48 (1.7)		42.8
1993[8]	CWF	1,711	1,860	0.7	1.2	74	46
1997[9]	CWF	285	283	1.05	1.05		
2002[10]	CWF		332		0.8 (1.24)		59.9
2014[11]	CWF	892	597	0.7 (1.9)	0.6 (1.2)	76	73

Reference:

1. Dirks OB, Houwink B, Kwant GW. The results of 612 years of artificial fluoridation of drinking water in The Netherlands: The tiel—Culemborg experiment. Archives of Oral Biology. 1961;5(3):284-300.

2. Medical Research Council of Ireland. Dental caries in Ireland. Dublin, Ireland; 1953.

3. Department of Health (DoH). Health (Fluoridation of water supplies) Act, 1960: Report on the Incidence of Dental Caries in School Children, and on the Analysis of Public Piped Water Supplies, in Dublin, Kildare and Wicklow Health Authority Areas. Dublin, Ireland; 1962.

4. O'Hickey S, Pigott B. Dental Caries Experience of Dublin School-children after 5 1/2 years of fluoridation. Journal of Irish Dental Association. 1981;27:78-83.

5. O'Hickey S, Pigott B. Dental Caries Experience of Dublin School-children after 10 1/2 years of fluoridation. Journal of Irish Dental Association. 1983;29(1):5-8.

6. O'Mullane D, University College Cork. National survey of childrens' dental health 1984: conducted on behalf of the Minister for Health by University College Cork: Preliminary report. Ireland: Department of Health (DoH); 1984.

7. Downer M, Blinkhorn A, Holt R, Wight C, Attwood D. Dental caries experience and defects of dental enamel among 12-year-old children in north London, Edinburgh, Glasgow and Dublin. Community Dent Oral Epidemiol. 1994;22(5 Pt 1):283-5.

8. Eastern Health Board. Children's dental health in the Eastern Health Board region, 1993: Report of a study conducted by the Dental Department of the Eastern Health Board in collaboration with the Oral Services Research Centre University College Cork. Dublin, Ireland: Oral Health Services Research Center. University College Cork; 1994.

9. Eastern Health Board. Oral health of Children in the Eastern Health Board, 1997. Dublin, Ireland: Oral Health Services Research Center. University College Cork; 1997.

10. Sagheri D, McLoughlin J, Clarkson JJ. A comparison of dental caries levels in two communities with different oral health prevention strategies stratified in different social classes. J Public Health Dent. 2007;67(1):1-7.

11. Oral Health Services Research Centre. University College Cork. OHSRC Briefing Document on HRB funded Fluoride and Caring for Children's Teeth study (FACCT). Ireland; 2018.

Appendix B

Supplementary file S1

Study characteristics:

Growing Up in Ireland

Growing Up in Ireland (GUI) is a multi-domain longitudinal study carried out jointly by the Department of Children, Equality, Diversity, Integration and Youth (DCEDIY) and the Central Statistics Office (CSO) (DCEDIY and CSO, 2023). On behalf of DCEDIY, before January 2023, the study was carried out jointly by a team of researchers from the Economic and Social Research Institute (ESRI) and Trinity College Dublin (TCD) (DCEDIY and CSO, 2023). The study began in 2006 and has since then been following two study cohorts: Cohort '98 (comprised of 8,500 nine-year old children born in the year 1998, also called the Child Cohort) and Cohort '08 (consisted of 11,000 nine-months old children born in the year 2008, also called the Infant Cohort). Currently, the members of the Infant Cohort are aged about 15 years while those of Child Cohort are 25 years old. The conceptual framework for Growing Up in Ireland is based on the bioecological model proposed by Urie Bronfenbrenner, which placed the child at the centre, surrounded and influenced by multiple layers such as the child's characteristics, immediate family, neighbours and community services (Bronfenbrenner and Morris, 2007).

The timeline, year of survey, data collection method, age of study child and the sample size at each wave of the two surveys is presented below (Table S1.1).

Cohort	Wave	Year of data collection	Age of study child	Sample size	Data collection
Cohort'08					
	1	2008-09	9 months	11,134	Face-to-face interview
	2	2010-11	3 years	9,793	Face-to-face interview
	3	2013	5 years	8,712	Face-to-face interview
	4	2016	7 years	5,344	Postal questionnaire
	5	2017-18	9 years	7,770	Face-to-face interview
Cohort'98					
	1	2007-08	9	8,568	Face-to-face interview
	2	2011-12	13	7,525	Face-to-face interview
	3	2015-16	17/18	6,216	Face-to-face interview
	4	2018-19	20	5,190	Face-to-face interview

Table S1.1. Timeline of the GUI cohort surveys (DCEDIY and CSO, 2023).

Thematic objectives:

1) to describe the lives and chart the development of Irish children at critical life stages, from birth to adulthood
2) To identify the key factors influencing the child's growth and development and study the effects of early life experiences on later life
3) To study the variations in children's life and identify the factors leading to social inequalities, ill health and deprivation
4) To create a data bank of Irish children's life over the years and help in the development of evidence informed policies and services for children and their families

Growing Up in Scotland

Growing up in Scotland (GUS) is a longitudinal study studying the lives of Scottish children and their families, starting from birth through to the teenage years and adulthood. The GUS was aimed to provide evidence to help the Scottish Government and other agencies in framing policies and developing services for children and their families (Bradshaw, Knudsen and Mabelis, 2015). The GUS is funded by the Government of Scotland, carried out by Scottish Centre for Social Research (ScotCen), and is a part of Cohort and Longitudinal Studies Enhancement Resources (CLOSER)

(ScotCen and Scottish Government, 2023). CLOSER is an interdisciplinary partnership of leading social and biomedical longitudinal population studies in the UK, bringing together world-leading longitudinal studies to increase their visibility, usefulness and impact (Bradshaw *et al.*, 2007). The GUS was originally launched in 2005, and till date, have collected data from three nationally representative cohorts, Table S1.2.

Table S1.2. Cohorts in the Growing Up in Scotland Study

Cohort	**No. of participants**	**Birth year of cohorts**
Birth Cohort 1	5,217	2004/05
Child Cohort	2,858	2002/03
Birth Cohort 2	6,127	2010/11

A further group of 1500 children (born between June 2004 and May 2005) were added in the year 2017 to the birth cohort 1, the only cohort that is being followed at present. The GUS study team stopped data collection for two cohorts, the birth cohort 2 and the child cohort, in the year 2015/16 and 2008/09, respectively (ScotCen and Scottish Government, 2023). The calendar year, age and number of respondents at each wave (sweep) of the GUS birth cohort 1 survey have been presented in Table S1.3.

Table S1.3 Timeline of the GUS birth cohort 1 survey (ScotCen and Scottish Government, 2023)

GUS Birth Cohort 1	**Wave (sweep)**	**Calendar year**	**Age of participants**	**Sample size**	**Data collection**
	1	2005-06	10 months	5217	Face-to-face interview
	2	2006-07	2 years	4512	Face-to-face interview
	3	2007-08	3 years	4193	Face-to-face interview
	4	2008-09	4 years	3994	Face-to-face interview
	5	2009-10	5 years	3833	Face-to-face interview
	6	2010-11	6 years	3657	Face-to-face interview
	7	2012-13	8 years	3456	Face-to-face interview
	8	2014-15	10 years	3150	Face-to-face interview
	9	2017-18	12 years	2917 (Main sample)	Face-to-face interview
	10	2019-20	14 years	2669 (Main sample)	Face-to-face interview

Thematic objectives:

1) To study the cognitive, emotional, social, and behavioural development of Scottish children
2) To study the effects of home, parenting, family, community, child care, education, employment and social networks on the physical, mental health and well-being of Scottish children
3) Involvement in risky behaviours by Scottish children in their adolescence and later life

Longitudinal Study of Australian Children

The Longitudinal Study of Australian Children (LSAC) is a major study documenting the development of 10,000 young children and their families from urban and rural areas in all states and territories in Australia. This study is a collaboration among the Department of Social Services, the Australian Institute of Families and the Australian Bureau of Statistics. The multidisciplinary study started in 2003 examining the study cohorts and their families across a broad range of topics such as parenting, child care and health, education, family and peers. The study consists of two cohorts. Both the study cohorts comprised of 5000 children in the age range of 0-1 years (B cohort) and 4-5 years (K cohort) in 2003-04 (Sanson *et al.*, 2002).

The data are collected every two years from the two study cohorts and the study will continue to follow the participants into adulthood. The information is collected from the study participants, their parents (both resident and non-resident), teachers and carers. The study follows a holistic approach focussed around outcomes across multiple domains of child development. It adopts the bioecological model of development proposed by Bronfenbrenner like the Growing Up in Ireland survey wherein family, school, community, society along with the child's own biological makeup and other attributes interact in complex ways over time and contribute towards the development of the child (Zubrick *et al.*, 2015). The data for child's oral health was collected via face-to-face interviews and self-completed questionnaires. Dental examinations were not included in the surveys.

Table S1.4 Timeline of the LSAC B and K surveys (Mohal *et al.*, 2023).

Wave	**Year of data collection**	**Age of study child**		**Sample size**		**Data collection**
		B-cohort	***K-cohort***	***B-cohort***	***K-cohort***	
1	2003-04	0-1 year	4-5 years	5,107	4,983	Face-to-face interview
2	2005-06	2-3 years	6-7 years	4,606	4,464	Face-to-face interview
3	2007-08	4-5 years	8-9 years	4,386	4,332	Face-to-face interview
4	2009-10	6-7 years	10-11 years	4,242	4,169	Face-to-face interview
5	2011-12	8-9 years	12-13 years	4,085	3,956	Face-to-face interview
6	2013-14	10-11 years	14-15 years	3,764	3,537	Face-to-face interview
7	2015-16	12-13 years	16-17 years	3,381	3,089	Face-to-face interview
8	2017-18	14-15 years	18-19 years	3,127	3,037	Face-to-face interview (B-cohort) Computer assisted web-interview (K-cohort)
9C1	2020	16-17 years	20-21 years	2,017	1,789	Computer assisted web-interview
9C2	2021	17-18 years	21-22 years	2,688	2,463	Computer assisted web-interview

Thematic objectives:

1) To study the effect of economic, social and cultural environment on the health and well-being of Australian children over the life course
2) To provide evidence for the development of policies, services and interventions for improving the Australian children's lives.

Growing Up in New Zealand

Growing Up in New Zealand (GUN), is a longitudinal and multidisciplinary study of the development and well-being of children growing up in New Zealand in the 21st century. The study recruited the child cohort via pregnant women whose delivery dates lay between 25th April 2009 and 25th March 2010, residing in the three District Health Board regions of Auckland, Manukau and Waikato during their term period. The study began in 2009 and 2010 with a total of 6853 cohort children, recruited at baseline and

later joined by additional 200 children born in late 2008. This study is a University of Auckland Study managed by Auckland UniServices and is funded by Government of New Zealand's Ministry of Social Development (Morton *et al.*, 2013; Morton *et al.*, 2020). The conceptual framework of this study is based on a life course approach, in which the complex and dynamic interplay between behavioural, psychological and biological processes that occur throughout the life of individuals is studied as mechanisms linking health/development events and exposures occurring in early stages of life (Morton *et al.*, 2013; Crall and Forrest, 2018). There are six main domains (societal context, family and whanau, education, health and well-being, culture and identity) on which the GUN study is focussed, weaving together into four themes, to accommodate the ethnic diversity of the population (Asian, European, Maori and Pacific) (Morton *et al.*, 2013; Morton *et al.*, 2020). The timeline, age and number of participants at each wave of GUN study launched till date are summarised in Table S1.5.

Table S1.5 Timeline of the GUN cohort survey (Morton *et al.*, 2020).

Wave (sweep)	**Calendar year**	**Age of participants**	**Sample size**	**Data collection**
DCW 0		Antenatal		Face-to-face interview
DCW 1	2009-10	6 weeks	6843	Phone call
DCW 1	2010-11	9 months	6476	Face-to-face interview
DCW 1		16 months		Phone call
DCW 1		23 months		Phone call
DCW 2	2011-12	2 years	6327	Face-to-face interview
DCW 3		31 months		Phone call
DCW 4		45 months		Phone call
DCW 5	2014-15	54 months	6156	Face-to-face interview
DCW 6		72 months		Online questionnaire
DCW 8	2017-19	8 years	5241	Face-to-face interview

Thematic objectives:

1) To study the effect of social, cultural, political, familial, intergenerational, and individual influences on the development trajectories through the life course of New Zealand children
2) To study the associations between ethnicity and developmental trajectories across the life course

Millennium Cohort Study (MCS)

The UK Millennium Cohort Study is an ongoing multidisciplinary child cohort survey following the lives of children born in the UK between September 2000 and January 2002. The Centre of Longitudinal Studies at the Institute of Education, University of London manages MCS and Economic and Social Research Council and a collaboration between the Governments of Wales, Scotland and Northern Ireland fund this study. This study is also commonly known as the 'Child of the New Century' study and follows the lives of approximately 19,000 young people and their families born across England, Scotland, Wales and Northern Ireland in the years 2000-02 (Plewis *et al.*, 2007; Connelly and Platt, 2014). This study is guided by the conceptual framework by Bronfenbrenner, like the GUI and the LSAC studies, recognising the family and social factors surrounding an individual during their development (Joshi and Fitzsimons, 2016).

Table S1.6 Timeline of the MCS survey (Joshi and Fitzsimons, 2016; Centre For Longitudinal Studies, 2023).

Wave (sweep)	Calendar year	Age of participants	Sample size	Data collection
1	2001-02	9 months	18,818	Face-to-face interview
2	2003-04	3 years	15,808	Face-to-face interview
3	2006	5 years	15,460	Face-to-face and postal interview
4	2008	7 years	14,043	Face-to-face and postal interview
5	2012	11 years	13,469	Face-to-face and postal interview
6	2015	14 years	11,938	Face-to-face interview
7	2018-19	17 years	10,345	Face-to-face and web

Thematic objectives:

1) To study the influence of social, economic and health advantages and disadvantages on the lives of children of the new century in the UK
2) To provide an evidence base for comparison with the earlier British cohort studies and study intergenerational links
3) To study the role of ethnicity and other non-parental care; and focus on the parent's experience and aspiration of child's early years
4) To study the role of family, community services and facilities, social networks, and civic engagement on the growth and development of new century children in the UK.

List of excluded studies

Table S1.7 List of excluded studies and the reasons for exclusion

Study	**Reason for exclusion**
GUS, birth cohort 2	Survey discontinued
GUS, child cohort	Survey discontinued
ALSPAC (UK)	Start date before the year 2000.
ECLS B	Survey completed or discontinued
ECLS K 2001	Survey completed or discontinued
ECLS K 2011	Survey completed or discontinued
National Longitudinal Survey of Children and Youth (NLSCY), Canada	Start date before the year 2000.
1958 National Child Development Study	Start date before the year 2000
1970 British Cohort Study	Start date before the year 2000

GUS: Growing Up in Scotland, ALSPAC; Avon Longitudinal Study of Parents and Children; NLSCY: National Longitudinal Survey of Children and Youth; ECLS: Early Childhood Longitudinal Study.

Supplementary file S2

1) Toothbrushing behaviours

Table S2.1 Questionnaires used in the cohort survey waves for measuring toothbrushing constructs.

Child age	**Cohort/year of data collection**						
	GUI infant	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year			Can child brush his/her teeth without help at least some of the time? • Yes • No				
2- 3 years	How often is a toothbrush used to clean child's teeth? • More than twice a day • Twice a day • Once a day • Less often than once a day • Rarely • Not at all		***Sweep 2*** How often is a toothbrush used to clean child's teeth? • More than twice a day • Twice a day • Once a day • Less often than once a day • Not at all If child's teeth are brushed, is toothpaste used • Yes • No	How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? • Months_____ • Year_____ • Don't clean child's teeth		How often are child's teeth brushed? • Twice a day or more • Once a day • Less than once a day • Never Does someone help child to brush his/her? • Yes, most of the times • Yes, sometimes • No	

	Table S2.1 Continued…		If toothpaste is used, how old was the child when you started using toothpaste? Age _____months Which of these statements best describes how you organise cleaning child's teeth? • I supervise him/her in cleaning his/her teeth but I do most • I supervise him/her in cleaning his/her teeth but he/she does most • I supervise him/her in cleaning his/her teeth but he/she does it all • He/she cleans his/her teeth • I clean his/her teeth	In the past month, how often did you...help the child brush his/her teeth? • Daily • A few times a week • A few times a month • Rarely • Not at all		Does child use toothpaste that has fluoride in it? • Yes • No • Does not use toothpaste Does he/she usually use a regular or adult toothpaste, or one just for kids? • Adults • Kids Are his/her teeth usually brushed after the snack, before he/she goes to sleep? • Yes, most of the times • Yes, sometimes • No	

	Table S2.1 Continued….		***Sweep 3*** Can child brush his/her teeth without help at least some of the time? • Yes • No				
4- 5 years			***Sweep 5*** How often is a toothbrush with fluoride toothpaste used to clean child's teeth? • More than once • Once a day • Less than once a day Does study child have to do any of the following at bedtime? Brush his teeth? • Always • Usually • Sometimes • Never	How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? • Months_____ • Year_____ • Don't clean child's teeth In the past month, how often did you supervise the child brush his/her teeth? • Once a day or more • Few times a week • Few time a month		How often are child's teeth brushed? • Twice a day or more • Once a day • Less than once a day • Less than weekly • Never Does someone help child to brush his/her? • Yes, most of the times • Yes, sometimes • No	

	Table S2.1 Continued….			• Rarely • Not at all In the past month, how often did you...help the child brush his/her teeth? • Daily • A few times a week • A few times a month • Rarely • Not at all			
6-7 years				How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? Age_____ In the past month, how often did	How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? Age_____ In the past month, how often did		

	Table S2.1 Continued…			you...help the child brush his/her teeth? • Daily • A few times a week • A few times a month • Rarely • Not at all	you...help the child brush his/her teeth? • Daily • A few times a week • A few times a month • Rarely • Not at all		
8-9 years	How often does child brush his/her teeth? • More than twice a day • Twice a day • Once a day • Less often than once a day • Rarely • Not at all	Does the study child brush his/her teeth at least once per day? • Yes • No		How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? Age_____ In the past month, how often did you...help the child brush his/her teeth? • Daily • A few times a week • A few times a month	How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? • Months_____ • Year_____ • Don't clean child's teeth In the past month, how often did you supervise the child brush his/her teeth? • Once a day or more	How often are child's teeth brushed? • More than twice a day • Twice a day • Once a day • Less than once a day How often do you supervise child when he/she brushes his/her teeth? • Always • Sometimes • Rarely • Never	

	Table S2.1 Continued…			• Rarely • Not at all In the past month, how often did you supervise the child brush his/her teeth? • Once a day or more • Few times a week • Few time a month • Rarely • Not at all	• Few times a week • Few time a month • Rarely • Not at all		
10-11 years				Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all	How often are the child's teeth currently cleaned? • More than twice a day • Twice a day • Once a day • Less than once a day • Don't clean teeth How old was the child when you started to clean his/her teeth? Age_____ Yesterday, how often did you brush your teeth? • More than twice • Twice		How often does the child brush his/her teeth? • Twice a day or more • Once a day • At least once a week but not daily • Less than once a week

	Table S2.1 Continued…						
					• Once • Not at all		• Never
12-13 years		How often do you brush your teeth? • More than twice a day • Twice a day • Once a day • Less often than once a day • Rarely • Not at all		Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all	Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all		
14-15 years				Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all	Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all		How often do you brush your teeth? • Twice a day or more • Once a day • At least once a week but not daily • Less than once week

	Table S2.1 Continued…						• Never
16-17 years		How often do you brush your teeth? • More than twice a day • Twice a day • Once a day • Less often than once a day • Rarely • Not at all			Yesterday, how often did you brush your teeth? • More than twice • Twice • Once • Not at all		
18-20 years							

2) Dentist visit behaviour

Table S2.2 Questionnaires used in the cohort survey waves for measuring dentist visit behaviour constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year							
2- 3 years	Has child been to visit the dentist because of a problem with his/her teeth? • Yes • No		Thinking about the last six months, did you or any member of your household contact or visit any of the following people or services because of child's health? Dentist • Yes • No if yes, how many times? Sweep 3 Thinking about the last six months, did you or any member of your household contact or visit any of the following people or			Has your child ever been to see the school dental therapist or a dentist? • Yes • No	Question for the older sibling aged 10 years or less England only) Has child ever been to see a dentist? • Yes • No Older sibling aged between 10 and 15 years England only Have you ever been to see a dentist? • Yes • No

	Table S2.2 Continued		services because of study child's health, including any routine check-ups? Dentist • Yes • No if yes, how many times in the last six months?				
4- 5 years	Has child been to visit the dentist because of a problem with his/her teeth? • Yes • No		**Sweep 4** Thinking about the last six months, did you or any member of your household contact or visit any of the following people or services because of child's health, including any routine check-ups? Dentist • Yes • No If yes, how many times in the last six months? ***Sweep 5***			Has child ever been to see a school dental therapist, mobile unit or a dentist? • Yes • No	Older sibling aged between 10 and 15 years England only Have you ever been to see a dentist? • Yes • No

	Table S2.2 Continued….		Has child ever been to the dentist's surgery, either for treatment or for a check-up? • Yes • No On average, how often does child attend a dentist for a routine check-up? • More frequently than once every 6 months • Every six months • Every 12 months • Every 24 months • At longer intervals • Never How your child feels about attending the dentist?. Would you say a visit to the dentist is				

	Table S2.2 Continued…		• Not scary at all • Scary to some extent • Very scary				
6-7 years							
8-9 years	Which of the following best describes how regularly child visits the dentist? • At least once a year • Once every two years • Once every three years • Only when there is a problem • Never/Almost never When was the last time child saw a dentist? Year_____, month_____ Was it a HSE or private dentist? • HSE • Private	Which of the following best describes how regularly child visits the dentist? • At least once a year • Once every two years • Once every three years • Only when there is a problem • Never/Almost never	If any of the people have seen the child in the last year, for any reason, not just any problems or concerns you might have mentioned? Local doctor/GP, Health visitor, Practice nurse, Social worker, Psychologist, Other health professional (e.g., physiotherapist, consultant, Dentist), Other education or support service? • Yes • No			How often does child attend a dental service such as the school dental therapist, mobile unit or dentist? Choose one only • Less than once per year • About once per year • About once per six months • Several times per year • Other, please specify_____	

	Table S2.2 Continued…. Did the child have any treatments? • Yes • No						
10-11 years							Has the child been to dentist in the last 12 months? • Yes • No
12-13 years		Which of the following best describes how regularly child visits the dentist? • At least once a year • Once every two years • Once every three years • Only when there is a problem • Never/Almost never	Sweep 9 (12-year-olds) How often do you take child to places he needs to go? Dentist, GP, Sport, Music, or other activities? • Every day or most days • At least once a week • At least once a month • A few times a year • Less often or never				

	Table S2.2 Continued….						
14-15 years							Have you been to a dentist in the last 12 months? • Yes • No
16-17 years		Which of the following best describes how regularly you visit the dentist? • At least once a year • Once every two years • Once every three years • Only when there is a problem • Never/Almost never			When did you last see a dentist? • Less than 1 year ago • 1-2 year ago • More than 2 years ago • Never • Unsure		
18-20 years		Which of the following best describes how regularly you visit the dentist?			When did you last see a dentist? • Less than 1 year ago • 1-2 year ago		

	Table S2.2 Continued….	• Twice a year or more often • Once a year • Once every two years • Once every three years • Only when there is a problem • Never/Almost never			• More than 2 years ago • Never • Unsure		

3) Dental services

Table S2.3 Questionnaires used in the cohort survey waves for measuring dental services constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year				Thinking about community services you might have used or needed. In the last 12 months, have you used any of the services for the study child? Other medical or dental services • Yes • No In the last 12 months, have there been any of these services that this child has needed but could not get? Other medical or dental services • Yes • No			

	Table S2.3 Continued……			Why couldn't you get the service(s) that you needed for this child? • Too expensive • Too far away • Transport problems • Had to wait too long for appointment • Hours available or operating • Own poor health • Child care difficulties • Cultural or language reasons • Services not available • Family reasons • Other reasons (specify)			
2- 3 years			**Sweep 2** Which, if any of the people have seen or spoken to about study child in the last year for	In the last 12 months, have you used any of these services for the child? Dental services			

	Table S2.3 Continued…		any reason? Other health professional (e.g. Physiotherapist, consultant, dentist) • Yes • No	• Yes • No			
4- 5 years	Was there any time during the past 12 months when child really needed to consult a dentist but did not? • Yes • No Was this because you could not afford it, or some other reason • Could not afford it • Other reason		***Sweep 4*** Which, if any of the people have seen or spoken to about study child in the last year for any reason? Other health professional (e.g. Physiotherapist, consultant, dentist) • Yes • No	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No Was this service needed by the child in the last 12	Thinking about community services you might have used or needed. In the last 12 months, have you used any of the services for the study child? Other medical or dental services • Yes • No In the last 12 months, have there been any of these services that this child has needed but could not get? Other medical or dental services • Yes • No	Has child been enrolled in the free dental service? • Yes • No	

	Table S2.3 Continued…			months but you could not access it? Dental services • Yes • No	Why couldn't you get the service(s) that you needed for this child? • Too expensive Too far away • Transport problems • Had to wait too long for appointment • Hours available or operating • Own poor health • Child care difficulties • Cultural or language reasons • Services not available • Family reasons • Other reasons (specify)		
6-7 years			***Sweep 6*** Since starting primary school, has study child had any of the	In the last 12 months, have you used any of these services for the child? Dental services	In the last 12 months, have you used any of these services for the child? Dental services	Did you receive any referrals to additional services for your Growing Up in New Zealand	

	Table S2.3 Continued…		following health checks at school? A dental check • Yes • No	• Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No Was this service needed by the child in the last 12 months but you could not access it? Dental services • Yes • No	• Yes • No	study child as a result of their Before school check (B4 school check)? • Yes, for dental or oral health care	
8-9 years	Was there any time during the past 12 months when, in your opinion, child needed a dental examination or treatment but he/she did not receive it because: • You couldn't afford to pay	Was there any time during the past 12 months when, in your opinion, child needed a dental examination or treatment but he/she did not receive it • Yes • No	***Sweep 7*** Which, if any of the people have seen or spoken to about study child in the last year for any reason? Dentist • Yes • No	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed	Has child been enrolled in the free dental service (Community Oral health Service)? • Yes • No	

	Table S2.3 Continued… • The necessary dental care wasn't available or accessible to you • Our dental insurance did not cover the treatment • You could not take time off work to visit the dentist • You wanted to wait and see if the problem got better • Study child refused/fear of dentist • Study child still on the waiting list • Too far to travel/no means of transport • Other (specify)____	Why did the study child not get the dental examination or treatment? Was this because • You couldn't afford to pay • The necessary dental care wasn't available or accessible to you • You could not take time off work to visit the dentist • You wanted to wait and see if the problem got better • Study child refused/fear of dentist • Study child still on the waiting list • Other (specify)____		that the child has needed but could not get? Dental services • Yes • No	that the child has needed but could not get? Dental services • Yes • No Was this service needed by the child in the last 12 months but you could not access it? Dental services • Yes • No		

10-11 years	**Table S2.3 Continued…**			In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No Was this service needed by the child in the last 12 months but you could not access it? Dental services • Yes • No		

12-13 years	**Table S2.3 Continued…**	Was there any time during the past 12 months when child really needed to consult a dentist but did not? • Yes, there was at least one occasion • No, there was no such occasion What was the main reason for not consulting the dentist? • You couldn't afford to pay • The necessary dental care wasn't available or accessible to you • You could not take time off work to visit the dentist with child • You wanted to wait and see if the problem got better		In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No		

	Table S2.3 Continued…	• Study child refused/fear of dentist • Study child still on the waiting list • Too far to travel/no means of transport Other (specify)____					
14-15 years				In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No	In the last 12 months, have you used any of these services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No		
16-17 years					In the last 12 months, have you used any of these		

	Table S2.3 Continued…				services for the child? Dental services • Yes • No In the last 12 months, have there been any of the services listed that the child has needed but could not get? Dental services • Yes • No		
18-20 years		In the last 12 months, how many times have you seen or consulted, or talked on the phone with any of the following about your physical, emotional or mental health? • Dentist ---- N times___					

4) Self-reported dental health and Dental health ratings

Table S2.4 Questionnaires used in the cohort survey waves for measuring oral health status constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year						How many teeth does the baby have now ____ number of teeth How old was he/she when the first tooth appeared?	
2- 3 years							
4- 5 years			***Sweep 5*** How would you describe study child's dental health at present. Would you say his teeth • Are perfectly healthy • Have some decay • Have a lot of decay				

	Table S2.4 Continued…..		Perfectly healthy = no fillings, no obvious decay Some decay = fillings, some open decay Lot of decay = 5 + teeth affected by dental decay				
6-7 years							
8-9 years	How would you rate child's oral health? • Excellent • Very good • Good • Fair • Poor					How would you describe the health of child's teeth and mouth? • Excellent • Very good • Good • Fair • Poor	
10-11 years							
12-13 years							

14-15 years	**Table S2.4 Continued…**						
16-17 years		How would you rate your oral health? • Excellent • Very good • Good • Fair • Poor					
18-20 years		How would you rate your dental health? • Excellent • Very good • Good • Fair • Poor					

5) Dental injuries

Table S2.5 Questionnaires used in the cohort survey waves for measuring dental injuries constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year			Most babies and small children have accidents at some time. Has child had an accident or injury for which he has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____ What type of accident or injury was it? • Injury to mouth or face e.g. nosebleed? How old was the child at the time of accident?	Since birth, how many times has child been hurt, injured or had an accident and needed medical attention from a doctor or hospital? _____times What types of injury did child have that needed medical attention ? • Dental Injury? Has child stayed in hospital for at least one night because of any (of these) injuries or accidents? • Yes • No			

	Table S2.5 Continued…..						
			Was he/she admitted to hospital?				
2- 3 years			***Sweep 2 and 3*** Most toddlers and small children have accidents at some time. Since we last saw you, has child had an accident or injury for which he has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____ What type of accident or injury was it? • Injury to mouth or face e.g. nosebleed? Was he/she admitted to hospital?	In the last 12 months, how many times the child need medical attention from a doctor or hospital because he/she was hurt or injured? _____times What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____ Has child stayed in hospital for at least one night because of any (of these) injuries or accidents?		Most children have accidents or injuries at some time. Has child ever had an accident or injury for which he/she was taken to the doctor, health center, or hospital? • Yes • No How many accidents or injuries? What sort of injury? • Injury to mouth or tooth How old was child when this accident happened? Age in months___	Has child ever had an accident or injury for which he has been taken to a doctor, health center, or hospital? • Yes • No What sort of injury or accident was it? • Injury to mouth or tooth? How many accidents? How old was the child when this accident happened?

	Table S2.5 Continued…..			• Yes • No Thinking about the most serious injury in the last 12 months, where did this occur? • Home • School or child care • Car accident • Pedestrian accident • Other		Was child admitted to hospital as a result of this accident or injury? • Yes • No Where did this accident or injury happen?	Did child go to hospital?
4- 5 years	Thinking about the most recent (or only) accident or injury, what sort of accident or injury was it? • Injury to mouth or tooth___ Age of child when this injury or accident happened? Did child go to hospital? • Yes • No		***Sweep 4 and 5*** Most small children have accidents at some time. Since we last saw you, has the study child had an accident or injury for which he has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____	In the last 12 months, how many times the child need medical attention from a doctor or hospital because he/she was hurt or injured? _____times What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury	During the last 12 months, how many times has child been hurt, injured or had an accident and needed medical attention from a doctor or hospital? _____times What types of injury or accident did child have that needed medical attention (in the last 12 months)? • Dental Injury	Most children have accidents or injuries at some time. Since child was two, has he/she ever had an accident or injury for which he/she was taken to the doctor, dentist, health center, or hospital? • Yes • No How many accidents or injuries?	Has child ever had an accident or injury for which he has been taken to a doctor, health center, or hospital? • Yes • No Thinking about the most severe (or only) accident or injury, what sort of injury or

	Table S2.5 Continued… Was this • Casualty/Accident or Emergency only • Admitted to hospital Where did this happen • In your home • A friend's or relative's house • In childcare • In school • Outside in your local neighbourhood • Outside, somewhere else • Other, specify___		What type of accident or injury was it? • Injury to mouth or face e.g. nosebleed? Was he/she admitted to hospital?	How many times did the study child have dental injury? _____ Has child stayed in hospital for at least one night because of any (of these) injuries or accidents? • Yes • No Thinking about the most serious injury in the last 12 months, where did this occur? • Home • School or child care • Car accident • Pedestrian accident • Other	During the last 12 months, has child stayed in hospital for at least one night because of any (of these) injuries or accidents? • Yes • No	What sort of injury? • Injury to mouth or tooth How old was child when this accident happened? Age in years___ Was child admitted to hospital as a result of this accident or injury? • Yes • No Where did this accident or injury happen?	accident was it? Injury to mouth or tooth? How many accidents? Did child go to hospital?
6-7 years			Sweep 6 Most small children have accidents at some time. Since we last saw you, has child	What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury	In the last 12 months, how many times the child need medical attention from a doctor or hospital because		Has child ever had an accident or injury for which he has been taken to a doctor, health

	Table S2.5 Continued…		had an accident or injury for which he has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____	How many times did the study child have dental injury? _____	he/she was hurt or injured? _____times What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury?_____ Has child stayed in hospital for at least one night because of any (of these) injuries or accidents? • Yes • No Thinking about the most serious injury in the last 12 months, where did this occur? • Home		center, or hospital? • Yes • No Thinking about the most severe (or only) accident or injury, what sort of injury or accident was it? Injury to mouth or tooth? How many accidents? Did child go to hospital? Where did this accident happen?

	Table S2.5 Continued…..				• School or child care • Car accident • Pedestrian accident • Other		
8-9 years	Thinking about the most recent (or only) accident or injury, what sort of accident or injury was it? • Injury to mouth or tooth___ Age of child when this injury or accident happened? Did child go to hospital? • Yes • No Was this • Casualty/Accident or Emergency only • Admitted to hospital		Sweep 7 Most small children have accidents at some time. Since we last saw you, has child had an accident or injury for which he has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____	In the last 12 months, how many times did child need medical attention from a doctor or hospital because he/she was hurt or injured? _____times What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____ Has child stayed in hospital for at least one night because	In the last 12 months, how many times the child need medical attention from a doctor or hospital because he/she was hurt or injured? _____times What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____ Has child stayed in hospital for at least one night because		

	Table S2.5 Continued… Where did this happen • In your home • A friend's or relative's house • In childcare • In school • Outside in your local neighbourhood • Outside, somewhere else • Other, specify___			of any (of these) injuries or accidents? • Yes • No Thinking about the most serious injury in the last 12 months, where did this occur? • Home • School or child care • Someone's else place • Outside public place • Inside public place • Car accident • Pedestrian accident • Other	of any (of these) injuries or accidents? • Yes • No Thinking about the most serious injury in the last 12 months, where did this occur? • Home • School or child care • Car accident • Pedestrian accident • Other		
10-11 years			Sweep 8 Most small children have accidents at some time. Since we last saw you, has child had an accident or injury for which he	What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury	What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury		Has child ever had an accident or injury for which he has been taken to a doctor, health center, or hospital?

	Table S2.5 Continued…		has been taken to the doctor, dentist, health center, or hospital? • Yes • No If Yes, How many accidents?____	How many times did the study child have dental injury? _____	How many times did the study child have dental injury? _____		• Yes • No What sort of injury or accident was it? • Injury to mouth or tooth? How many accidents? Did the child go to the hospital? Where did it happen?
12-13 years				What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____	What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____		

14-15 years	**Table S2.5 Continued…**			What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____	What types of injury did the child have that needed medical attention (in the last 12 months)? • Dental Injury How many times did the study child have dental injury? _____		Has child ever had an accident or injury for which he has been taken to a doctor, health center, or hospital? • Yes • No What sort of injury or accident was it? • Injury to mouth or tooth? How many accidents? Did the child go to the hospital? Where did it happen?
16-17 years					What types of injury did the child have that needed medical attention (in the last 12 months)?		

	Table S2.5 Continued…				• Dental Injury How many times did the study child have dental injury? _____ ***Study child reported*** Thinking about your most serious injury, what caused the injury? Where does this injury occur? Who treated this injury? Physiotherapist or dentist? What type of injury? Dental injury		
18-20 years					What types of injury did you have that needed medical attention (in the last 12 months)? • Dental Injury How many times did YOU have dental injury? _____		

6) Dental problems

Table S2.6 Questionnaires used in the cohort survey waves for measuring dental problems constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year	Health problems or illnesses for which baby has been taken to the GP, Health Center or Public Health Nurse or to Accident and Emergency. What were these problems? • Dental problems (e.g. teething)		You said that you had more than one problem in study child's first three months. Which one of these things would you say caused you (and your partner) the greatest concern. • Teething How much of a problem was... problems with study child teething? • A big problem • A bit of a problem • Not a problem				
2- 3 years			***Sweep 2*** At our interview last year, you told us study child's teething was a big problem for you (and your partner). How much of a problem would you say this has been	Has the child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No			

	Table 2.6 Continued……..		in the last three months? • Still a big problem • A bit of a problem • Not a problem Have/Did you (and your partner) sought/seek or received/receive any help or advice about study child's teething? • Yes • No ***Sweep 2 and 3*** Does child have any longstanding illness or disability? By longstanding I mean anything that has troubled him over a period of time or that is likely to affect him over a period of time? • Yes • No Complains of teeth/mouth/tongue? • Yes	Has the child ever had any of the following problems with his/her teeth? Tooth or teeth filled because of dental decay • Yes • No Has the child ever had any of the following problems with his/her teeth? Teeth pulled because of dental decay • Yes • No Has the child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No			

	Table S2.6 Continued……..		• No **Sweep 3** How much of a problem each of the following things have been for you (and your partner) In the last three months. Problems with study child's teething • A big problem • A bit of a problem • Not a problem				
4- 5 years			***Sweep 4*** Does child have any longstanding illness or disability? By longstanding I mean anything that has troubled him over a period of time or that is likely to affect him over a period of time? Complains of teeth/mouth/tongue? • Yes • No ***Sweep 5***	Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you/since you		Has child ever had any of the following problems with his/her teeth? • Cavities or dental decay • Tooth or teeth filled because of dental decay • Teeth pulled because of dental decay • Accident causing breakage or loss of teeth	Apart from any pain when new teeth were coming through, has child had toothache in the last 12 months? • Yes • No

	Table S2.6 Continued…..		When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness Does child have any longstanding illness or disability? By longstanding I mean anything that has troubled him over a period of time or that is likely to affect him over a period of time? Complains of teeth/mouth/tongue? • Yes • No	joined the household has the study child ever had any of the following problems with his/her teeth? Tooth or teeth filled because of decay • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Teeth pulled because of decay • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth?		• Other (specify)__	

	Table S2.6 Continued…						
				Accident causing breakage or loss of teeth • Yes • No			
6-7 years			***Sweep 6*** When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness Does child have any longstanding illness or disability? By longstanding I mean anything that has troubled him over a period of time or that is likely to affect him over a period of time? Complains of teeth/mouth/tongue?	Since we last interviewed you/In the last two years has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you/In the last two years has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No	Has the child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Has the child ever had any of the following problems with his/her teeth? Tooth or teeth filled because of dental decay • Yes • No Has the child ever had any of the following problems with his/her teeth? Teeth pulled because of dental decay • Yes	To your knowledge, were any of the following raised as a possible area of concern for your child as a result of their Before School Check (B4 school check) • Oral health/dental issues	

	Table S2.6 Continued……..		• Yes • No		• No Has the child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No		
8-9 years			Sweep 7 When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness	Since the last interviewed you has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth? • Yes • No	Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Tooth		

	Tables S2.6 Continued……..			Since we last interviewed you has the study child ever had any of the following problems with his/her teeth? Braces or other dental problems (e.g. oral surgery) • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No	or teeth filled because of decay • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Teeth pulled because of decay • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No		

10-11 years	**Table S2.6 Continued……..**		Sweep 8 When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness	Since the last interviewed you has the study child ever had any of the following problems with his/her teeth? 1. Cavities or dental decay 2. Accident causing breakage or loss of teeth 3. Braces 4. Other dental problems (e.g. oral surgery) 5. None 6. Don't know • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No	Since we last interviewed you/In the last two years has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you/In the last two years has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No		Has the child had any pain or discomfort with his/her teeth in the last 12 months? • Yes • No

	Table S2.6 Continued……..			Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Braces • Yes • No Since we last interviewed you/since you joined the household has the			

	Table S2.6 Continued……..			study child ever had any of the following problems with his/her teeth? Other dental problems (e.g. oral surgery) • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Don't know • Yes • No			

12-13 years	**Table S2.6 Continued…….**		**Sweep 9** When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness	Since the last interviewed you has the study child ever had any of the following problems with his/her teeth? 7. Cavities or dental decay 8. Accident causing breakage or loss of teeth 9. Braces 10. Other dental problems (e.g. oral surgery) 11. None 12. Don't know • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No	Since the last interviewed you has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth? • Yes • No Since we last interviewed you has the study child ever had any of the following problems with his/her teeth? Braces or other dental problems (e.g. oral surgery) • Yes • No		

	Table 2.6 Continued…….			Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Braces • Yes • No Since we last interviewed you/since you joined the household has the	Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No		

	Table 2.6 Continued…..			study child ever had any of the following problems with his/her teeth? Other dental problems (e.g. oral surgery) • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Don't know • Yes • No			

14-15 years	**Table S2.6 Continued……**		Sweep 10 When we spoke to you last time, you said that child had a longstanding illness or disability. Can I just check, does child still have this longstanding illness or disability? • Yes, child still has this illness • No, child no longer has this illness	Since the last interview has study child had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Accident causing breakage or loss of teeth • Yes • No Braces • Yes • No Other dental problems • Yes • No Other (specify) • Yes • No None • Yes • No Don't know • Yes • No Record 'other' teeth problem (specify)___	Since the last interviewed you has the study child ever had any of the following problems with his/her teeth? 13. Cavities or dental decay 14. Accident causing breakage or loss of teeth 15. Braces 16. Other dental problems (e.g. oral surgery) 17. None 18. Don't know • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No		

	Table S2.6 Continued……..			***Study child*** In the past one month, how much of a problem has this been for you. You have tooth pain • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have tooth pain when you eat or drink something hot, cold, or sweet • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have teeth that are dark in colour • Almost always • Often	Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Braces • Yes • No Since we last interviewed you/since you joined the household has the		

	Table S2.6 Continued…….			• Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have gum pain • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have blood on your toothbrush after brushing your teeth • Almost always • Often • Sometimes • Almost never • Never	study child ever had any of the following problems with his/her teeth? Other dental problems (e.g. oral surgery) • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Don't know • Yes • No ***Study child***		

	Table S2.6 Continued……..				In the past one month, how much of a problem has this been for you. You have tooth pain • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have tooth pain when you eat or drink something hot, cold, or sweet • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have teeth that are dark in colour • Almost always • Often • Sometimes		

	Table S2.6 Continued……..				• Almost never • Never In the past one month, how much of a problem has this been for you. You have gum pain • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have blood on your toothbrush after brushing your teeth • Almost always • Often • Sometimes • Almost never • Never		
16-17 years					Since the last interviewed you has the study child ever had any of the following problems with his/her teeth?		

	Table S2.6 Continued…….				19. Cavities or dental decay 20. Accident causing breakage or loss of teeth 21. Braces 22. Other dental problems (e.g. oral surgery) 23. None 24. Don't know • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Cavities or dental decay • Yes • No Since we last interviewed you/since you joined the household has the		

	Table S2.6 Continued……				study child ever had any of the following problems with his/her teeth? Accident causing breakage or loss of teeth • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Braces • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Other dental problems (e.g. oral surgery)		

	Table S2.6 Continued……..				• Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? None • Yes • No Since we last interviewed you/since you joined the household has the study child ever had any of the following problems with his/her teeth? Don't know • Yes • No ***Study child*** In the past one month, how much of a problem has this been for you. You have tooth pain		

	Table S2.6 Continued……				• Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have tooth pain when you eat or drink something hot, cold, or sweet • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have teeth that are dark in colour • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much		

	Table S2.6 Continued……				of a problem has this been for you. You have gum pain • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have blood on your toothbrush after brushing your teeth • Almost always • Often • Sometimes • Almost never • Never		
18-20 years					***Study Child*** In the past one month, how much of a problem has this been for you. a) You have tooth pain • Almost always • Often • Sometimes		

	Table S2.6 Continued……				• Almost never • Never In the past one month, how much of a problem has this been for you. You have tooth pain when you eat or drink something hot, cold, or sweet • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have teeth that are dark in colour • Almost always • Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have gum pain • Almost always		

	Table S2.6 Continued……..				• Often • Sometimes • Almost never • Never In the past one month, how much of a problem has this been for you. You have blood on your toothbrush after brushing your teeth • Almost always • Often • Sometimes • Almost never • Never		

7) Dental treatments

Table S2.7 Questionnaires used in the cohort survey waves for measuring dental treatment constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year							
2- 3 years							Has the older sibling (10 year of less England only) Ever had any dental fillings? • Yes, more than one • Yes, one • No Older sibling aged between 10 and 15 years England only Have you ever had to have fillings put in your teeth by a dentist? • Yes, more than one • Yes, one • No

4- 5 years	**Table S2.7 Continued….**		**Sweep 5** Which, if any, of these kinds of treatment has study child had on his teeth? Any fillings? • Yes • No Any teeth taken out due to decay? • Yes • No Any treatment to stop his/her teeth decaying or going bad, such as painting and or/sealing? • Yes • No Orthodontics, that is straightening of the teeth with a brace? • Yes • No Any other treatment? • Yes • No				Older sibling aged between 10 and 15 years England only Have you ever had to have fillings put in your teeth by a dentist? • Yes, more than one • Yes, one • No

6-7 years	**Table S2.7 Continued…..**			Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No			
8-9 years	Has child ever had any permanent/secondary teeth filled? • Yes • No How many____			Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No			

	Table S2.7 Continued…. Has child ever had any permanent/secondary teeth extracted? • Yes • No How many____ Were the extractions part of orthodontic treatment? • Yes • No			Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No • Yes • No			
10-11 years				Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No	Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No		

	Table S2.7 Continued……			Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No	Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No		
12-13 years		Has child ever had • Any permanent/secondary teeth filled Yes No • Any permanent/secondary teeth pulled Yes No		Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a	Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a		

	Table S2.7 Continued…..			result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No	result of the cavity or dental decay? Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No		
14-15 years				Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay?	Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay?		

	Table S2.7 Continued…..			Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No	Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No		
16-17 years		How many, if any, permanent teeth (i.e. secondary or adult) teeth has young person had filled? • None • One • Two • Three or more How many, if any, permanent teeth (i.e. secondary or adult) teeth has young person had extracted? • None			Did the study child receive any of these dental treatments as a result of the cavity or dental decay? Tooth or teeth filled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay?		

	Table S2.7 Continued…..	• One • Two • Three or more Have you ever had (or you currently undergoing) orthodontic treatment? • Yes • No Have you ever worn (or do you currently wear) braces? • Yes • No			Tooth or teeth pulled? • Yes • No Did the study child receive any of these dental treatments as a result of the cavity or dental decay? No treatment • Yes • No		
18-20 years							

8) Parent/Self-perceived general health status

Table S2.8 Questionnaires used in the cohort survey waves for measuring parent/self-reported general health status constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year	In general, how would you describe baby's current health • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell		How is study child's health in general? Would you say it was.. • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor		In general how would you say baby's current health is? • Excellent • Very good • Good • Fair • Poor	
2- 3 years	In general, how would you describe child's current health • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell		***Sweep 2 and 3*** How is study child's health in general? • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor		In general how would you say child's current health is? • Excellent • Very good • Good • Fair • Poor	

	Table S2.8 Continued….						
4- 5 years	In general, how would you describe child's current health • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell		Sweep 4 How is study child's health in general? Would you day it is • Very good • Good • Fair • Bad • Very bad Sweep 5 How is study child health in general? Would you say it was • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor	In general how would you say child's current health is? • Excellent • Very good • Good • Fair • Poor	In general would you say study child's health is • Excellent • Very good • Good • Fair • Poor
6-7 years	In general, how would you describe child's current health • Very healthy, no problems		Sweep 6 How is study child's health in general? Would you day it is • Very good	In general, how would you say child's current health is • Excellent • Very good • Good	In general, how would you say child's current health is • Excellent • Very good • Good		In general would you say study child's health is • Excellent • Very good • Good • Fair

	Table S2.8 Continued…… • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell		• Good • Fair • Bad • Very bad	• Fair • Poor	• Fair • Poor		• Poor
8-9 years	In general, how would you describe child's current health • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell	In general, how would you describe child's health in the past year? • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell	Sweep 7 (8-year-olds) How is study child's health in general? Would you day it is • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor	In general how would you say child's current health is? • Excellent • Very good • Good • Fair • Poor	
10-11 years			Sweep 8 (10-year-olds) How is study child's health in general? Would you day it is • Very good	In general, how would you say child's current health is • Excellent • Very good • Good • Fair	In general, how would you say child's current health is • Excellent • Very good • Good • Fair		In general would you say study child's health is • Excellent • Very good • Good • Fair • Poor

	Table S2.8 Continued…..		• Good • Fair • Bad • Very bad	• Poor	• Poor		
12-13 years		In general, how would you describe child's health in the past year? • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell	Sweep 9 (12-year-olds) How is study child's health in general? Would you day it is • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor		
14-15 years			Sweep 10 (14-year-olds) How is study child's health in general? Would you day it is • Very good • Good • Fair • Bad • Very bad	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor In general, how is your health? • Excellent • Very good	In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor In general, how is your health? • Excellent • Very good		How would you describe your health generally? • Excellent • Very good • Good • Fair • Poor

	Table S2.8 Continued……			• Good • Fair • Poor	• Good • Fair • Poor		
16-17 years		In general, how would you describe child's health in the past year? • Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite ill • Almost always unwell Self-reported (Study child) In general, how would you say your current health is • Excellent • Very good • Good • Fair • Poor			In general, how would you say child's current health is • Excellent • Very good • Good • Fair • Poor In general, how is your health? • Excellent • Very good • Good • Fair • Poor		How would you describe your health generally? • Excellent • Very good • Good • Fair • Poor

	Table S2.8 Continued……						
18-20 years		Self-reported (Study child) In general, how would you say your current health is • Excellent • Very good • Good • Fair • Poor			In general, how would you say young person's current health is? • Excellent • Very good • Good • Fair • Poor In general, how is your health? • Excellent • Very good • Good • Fair • Poor		

9) Parent/Self-reported weight status

Table S2.9 Questionnaires used in the cohort survey waves for measuring parent/self-reported weight status constructs.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year				Do you think child is • Underweight • Normal weight • Somewhat overweight • Very overweight		Do you think child is • Very underweight • Somewhat underweight • Normal weight • Somewhat overweight • Very overweight	
2- 3 years	Which of these best describes child's weight • Underweight • Normal weight • Somewhat overweight • Very overweight			Which of these best describes the child's • Underweight • Normal weight • Somewhat overweight • Very overweight		Do you think child is • Very underweight • Somewhat underweight • Normal weight • Somewhat overweight • Very overweight	
4- 5 years				Which of these best describes the child's	Do you think child is • Underweight	When thinking about his/her	

	Table S2.9 Continued…. Which of these best describes child's weight • Underweight • Normal weight • Somewhat overweight • Very overweight			• Underweight • Normal weight • Somewhat overweight • Very overweight	• Normal weight • Somewhat overweight • Very overweight	body weight, do you think child is • Very underweight • Somewhat underweight • Normal weight • Somewhat overweight • Very overweight	
6-7 years				Which of these best describes the child's • Underweight • Normal weight • Somewhat overweight • Very overweight	Which of these describes the child's • Underweight • Normal weight • Somewhat overweight • Very overweight		
8-9 years	Which of these best describes child's weight • Underweight • Normal weight • Somewhat overweight • Very overweight	Do you think the study child is • Very underweight • Moderately underweight • Slightly underweight • About the right weight • Slightly overweight		Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight	Which of these best describes the child's • Underweight • Normal weight • Somewhat overweight • Very overweight	When thinking about his/her body weight, do you think child is • Very underweight • Somewhat underweight • Normal weight • Somewhat overweight • Very overweight	

	Table S2.9 Continued…… Self-completed (Study child) How would you describe yourself? • Very skinny • A bit skinny • Just the right size • A bit overweight • Very overweight	• Moderately overweight • Very overweight Self-completed (Study child) How would you describe yourself? • Very skinny • A bit skinny • Just the right size • A bit overweight • Very overweight					
10-11 years				Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight	Which of these best describes the child's • Underweight • Normal weight • Somewhat overweight • Very overweight		
12-13 years		Which of these best describes child's weight? • Very underweight • Moderately underweight • Slightly underweight		Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight	Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight		

	Table S2.9 Continued……	• About the right weight • Slightly overweight • Moderately overweight • Very overweight Self-completed (Study child). How would you describe yourself? • Very skinny • A bit skinny • Just the right size • A bit overweight • Very overweight					
14-15 years				Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight How do you feel about your weight at the moment? • Very underweight • Somewhat underweight	Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight How do you feel about your weight at the moment? • Very underweight • Somewhat underweight		Which of these do you think you are? • Underweight • About the right weight • Slightly overweight • Very overweight

	Table S2.9 Continued…						
				• About the right weight • Somewhat overweight • Very overweight	• About the right weight • Somewhat overweight • Very overweight		
16-17 years		Self-completed (Study child) How would you describe yourself? • Very skinny • A bit skinny • Just the right size • A bit overweight • Very overweight			Which of these best describes the study child • Underweight • Normal weight • Somewhat overweight • Very overweight How do you feel about your weight at the moment? • Very underweight • Somewhat underweight		Which of these do you think you are? • Underweight • About the right weight • Slightly overweight • Very overweight

	Table S2.9 Continued……				• About the right weight • Somewhat overweight • Very overweight		
18-20 years		Self-completed (Study child). How would you describe yourself? • Very skinny • A bit skinny • Just the right size • A bit overweight • Very overweight			How do you feel about your weight at the moment? • Very underweight • Somewhat underweight • About the right weight • Somewhat overweight Very overweight		

10) Diet and dietary assessment methods

Table S2.10 Questionnaires used in the cohort survey waves for measuring dietary intake of study participants.

	Cohort/year of data collection						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0-1 year	What else does baby drink apart from milk or formula? • Water • Baby juice • Fruit juices/Cordial/Squash • Fizzy or soft drinks (e.g. Lemonade, coke) • Herbal teas • Tea • Coffee • Others, specify • None of the above		Does the study child regularly eat solid food, such as cereal or rusk? • Yes • No	Does child regularly have other drinks apart from milk or formula? • Yes • No What else does child drink? • Fruit juices • Blackcurrant drinks • Cordial • Fizzy or soft drinks (e.g. Lemonade, coke) • Tea or coffee • Herbal drinks • Water • Others When in bed for a sleep or nap,		How often does baby have the following foods and drinks currently? • __times per day • __times per week • Less than weekly • No longer fed	

	Table S2.10 Continued……			does child drink anything other than water from a baby bottle or feeder cup? • Yes • No			
2- 3 years	24-hour recall (In the last 24-hours has the child had the following foods and drinks) • Once • More than once • Not at all		***Sweep 2 and 3 (2 and 3-year-olds)*** Some children just have snacks all day while others wait for meals. How would you describe study child? Would you say he/she... • Snacks all day and has no real meals • Snacks during the day but also has meals • Doesn't snack much, just has meals • Something else If child is hungry between meals, what would study child be most likely to eat?	Which of these does the child regularly drink? (Yes/No) • Fruit juices • Cordial • Soft drink • Cow's milk • Soy milk • Formula • Tea/Coffee (not herbal) • Water • Other (specify) When in bed for a sleep or nap, does child drink anything other than water from a baby bottle or feeder cup? • Yes • No		Does child usually have a snack or a drink other than water just before going to bed? • Yes • No How often within a day does your child drink something other than water from a sipper bottle, sipper cup, or similar? • More than three times a day • Three times a day • Twice a day	

	Table S2.10 Continued……		• Savoury snacks (e.g. nuts, crackers, cheese portions) • Crisps • Breakfast cereal • Cakes, biscuits • Fresh, dried or tinned fruit • Bread, toast or similar (e.g. crumpets, muffins) • Sweets or chocolate • Other (please specify) • Never hungry between meals On a typical day, how many different types of fresh, frozen or tinned fruit does study child eat? • None • One • Two or three • Four or five • More than five On a typical day, how many different types of fresh, frozen or tinned vegetables does study child eat?	In the last 24 hours how often did the child eat and drink the following • Once • More than once • Not at all ***Child diary*** 5 days (Monday to Friday) For the day described in this diary, how often did this child eat or drink the following? • Once • Twice • Three times • Four or more • Not at all		• Once a day • Never Food frequency questionnaire • None • 1 per day • 2 per day • 3 per day • 4+ per day • 1-2 per week • 3-4 per week • 5-6 per week • 1 per month • 2-3 per month • Portion size ¼ serving ½ serving 1 serving 2+ serving	

	Table S2.10 Continued……		• None • One • Two or three • Four or five • More than five *Sweep 2* How often does study child eat sweets or chocolate? How often does study child eat sweets or chocolate? • 6 or more times a day • 4 or 5 times a day • 2 or 3 times a day • Once a day • 5 or 6 times a week • 2 or 4 times a week • Once a week • 1 to 3 times per month • Less often or never How often does study child eat crisps or other savoury snacks? • 6 or more times a day • 4 or 5 times a day				

	Table S2.10 Continued……		• 2 or 3 times a day • Once a day • 5 or 6 times a week • 2 or 4 times a week • Once a week • 1 to 3 times per month • Less often or never How often does study child drink soft drinks, not including diet or low-calorie drinks? Please include cans and bottles but do not include fresh fruit juice, squash/diluting juice or water. • 6 or more times a day • 4 or 5 times a day • 2 or 3 times a day • Once a day • 5 or 6 times a week • 2 or 4 times a week • Once a week • 1 to 3 times per month • Less often or never *Sweep 3*				

	Table S2.10 Continued……		How often does study child eat sweets or chocolates? Include only whole packets of sweets or chocolates/chocolate bar, not individual sweets • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never How often does study child eat crisps? • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never				

	Table S2.10 Continued……		How often does study child drink soft drinks, not including diet or low-calorie drinks? Please include cans, bottles, and diluting juice but do not include fresh juice or water. • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never				

	Table S2.10 Continued……						
4- 5 years	Food frequency questionnaire (Looking at the card, please tell me how often, on average, your child eats these foods. • Never • Less than once a month • At least once a month • At least once a week • Most days • Once a day • 2-3 per day • 4-5 per day • 6+ per day		***Sweep 5*** If child is hungry between meals, what would study child be most likely to eat? • Savoury snacks (e.g. nuts, crackers, cheese portions) • Crisps • Breakfast cereal • Cakes, biscuits • Fresh, dried or tinned fruit • Bread, toast or similar (e.g. crumpets, muffins) • Sweets or chocolate • Other (please specify) • Never hungry between meals Not counting potatoes, how many different types of vegetables did child eat yesterday? Range 0 - 10	In the last 24 hours how often did the child had the following foods and drinks • Once • Twice • 3 or more times • Not at all ***Child diary*** 5 days (Monday to Friday) For the day described in this diary, how often did this child eat or drink the following? • Once • Twice • Three times • Four or more • Not at all	In the last 24 hours has child had the following foods and drinks • Once • More than once • Not at all	Food frequency questionnaire • None • 1 per day • 2 per day • 3 per day • 4+ per day • 1-2 per week • 3-4 per week • 5-6 per week • 1 per month • 2-3 per month • Portion size ¼ serving ½ serving 1 serving 2+ serving	If study child eats between meals, what does he/she eat? • Crisps and other similar snacks • Breakfast cereal • Cakes and sweet biscuits • Fruit (fresh, dried or tinned • Vegetables (raw or cooked) • Bread, toast, and similar items e.g. crumpets, muffins • Crispbread, crackers, breadsticks, rice cakes etc • Sweets and chocolate • Yoghurt, fromage frais etc • Other dairy products like cheese or eggs • Other (specify) • Does not eat between meals

	Table S2.10 Continued……		Compared with the variety of vegetables child usually eats, would you say that yesterday he/she ate • Less than usual • More than usual • Or about the same as usual How many different types of fruit did child eat yesterday? Range 0 - 10 Compared with the variety of vegetables child usually eats, would you say that yesterday he/she ate • Less than usual • More than usual • Or about the same as usual How often does study child eat sweets or chocolate? Include only packets of sweets or a chocolates/chocolate bar, not individual sweets				When study child drinks between meals, what does he/she drink • Sweetened drinks (e.g. cola, squash, sunny delight) • Artificially sweetened drinks (diet cola, sugar-free squash) • Unsweetened or pure fruit juice • Water – tap or bottled, still or sparkling • Hot drinks e.g. tea or coffee • Milk • Milkshakes, hot chocolate and other drinks made with milk • Other (specify) On a typical day, how many portions of fresh, frozen, tinned or dried fruit does study child eat? • None • One • Two

	Table S2.10 Continued……		• More than once a day • Once a day • 5 or 6 times a week • 2 or 4 times a week • Once a week • 1 to 3 times per month • Less often • Never How often does study child eat crisps? • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never How often does study child drink soft drinks, not including diet or low-calorie drinks? Please include diluting juice but do not include fresh fruit or water.				• Three or more

	Table S2.10 Continued……		• More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never How often does study child drink diet or low calorie soft drinks? Include cans, bottles, mixers. Include diet or low-calorie flavoured water here. Do not include fresh fruit juice or water • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never				

	Table S2.10 Continued……						
6-7 years	24-hour recall (In the last 24-hours has the study child had the following foods and drinks) • Once • More than once • Not at all			In the last 24 hours how often did the child have the following foods and drinks? • Once • Twice • 3 or more times • Not at all	In the last 24 hours how often did the child eat and drink the following • Once • More than once • Not at all ***Child diary*** 5 days (Monday to Friday) For the day described in this diary, how often did this child eat or drink the following? • Once • Twice • Three times • Four or more • Not at all		If study child eats between meals, what does he/she eat? • Crisps and other similar snacks • Breakfast cereal • Cakes and sweet biscuits • Fruit (fresh, dried or tinned • Vegetables (raw or cooked) • Bread, toast, and similar items e.g. crumpets, muffins • Crispbread, crackers, breadsticks, rice cakes etc • Sweets and chocolate • Yoghurt, fromage frais etc • Other dairy products like cheese or eggs • Other (specify) • Does not eat between meals

	Table S2.10 Continued……						When study child drinks between meals, what does he/she drink • Sweetened drinks (e.g. cola, squash, sunny delight) • Artificially sweetened drinks (diet cola, sugar-free squash) • Unsweetened or pure fruit juice • Water – tap or bottled, still or sparkling • Hot drinks e.g. tea or coffee • Milk • Milkshakes, hot chocolate and other drinks made with milk • Other (specify) On a typical day, how many portions of fresh, frozen, tinned or dried fruit

	Table S2.10 Continued……						does study child eat? • None • One • Two • Three or more
8-9 years	24-hour recall (In the last 24-hours has the child had the following foods and drinks) • Once • Twice • More than twice • Not at all	24-hour recall (In the last 24-hours has the study child had the following foods and drinks) • Once • More than once • Not at all Self-completed (Study child) Think back to what you ate yesterday. Did you eat the following? • No • One serving		In the last 24 hours how often did the child have the following foods and drinks? • Once • Twice • 3 or more times • Not at all	In the last 24 hours how often did the child had the following foods and drinks • Once • Twice • 3 or more times • Not at all ***Child diary*** 5 days (Monday to Friday) For the day described in this diary, how often did this child eat or	On average, how many servings of fruit does the child eat per day? • They don't eat fruit • Less than 1 per day • 1 serving per day • 2 servings per day • 3 servings per day • 4 or more servings per day On average, how many servings of	

	Table S2.10 Continued……	• More than one serving			drink the following? • Once • Twice • Three times • Four or more • Not at all	vegetables does the child eat per day? • They don't eat vegetables • Less than 1 per day • 1 serving per day • 2 servings per day • 3 servings per day • 4 or more servings per day In the past 7 days, how many times did child have a fizzy or soft drink, such as cola or lemonade? (- This includes diet (artificially sweetened) and energy drinks such as 'Powerade' or 'V'	

	Table S2.10 Continued……						
						- Does not include powered drinks made up with water such as cordial or 'Raro', or fruit juice such as 'Just Juice'). _____ times In the past 7 days, how many times did child eat any food purchased from a fast food place or takeaway shop, such as fish and chips, burgers, fried chicken or pizza? This includes snacks as well as mealtimes. _____ times	
10-11 years			Sweep 8 How often does study child eat sweets or chocolate? Include only packets	Thinking about yesterday, how often did you have following foods and drinks • Once	In the last 24 hours how often did the child have the following foods and drinks?		How often, if at all, does the study child drink sweetened drinks e.g. cola, squash, or sunny delight?

	Table S2.10 Continued……		of sweets or a chocolates/chocolate bar, not individual sweets • More than once a day • Once a day • 5 or 6 times a week • 2 or 4 times a week • Once a week • 1 to 3 times per month • Less often than once a month • Never How often does study child eat crisps? • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often than once a month • Never How often does study child drink soft drinks, not including	• Twice • More than twice • Not at all	• Once • Twice • 3 or more times • Not at all		• More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never How often, if at all the study child drink artificially sweetened drinks e.. diet cola, sugar-free squash • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never On a typical day, how many portions of fresh, frozen, tinned or dried fruit

	Table S2.10 Continued……		diet or low-calorie drinks? Please include diluting juice but do not include fresh fruit or water. • More than once a day • Once a day • 5 or 6 times a week • 2 to 4 times a week • Once a week • 1 to 3 times per month • Less often • Never How many portions of different fruit did study child eat yesterday? Not counting potatoes, how many portions of different vegetables did study child eat yesterday?				does study child eat? • None • One • Two • Three or more
12-13 years		Self-completed (Study child) Think back to what you ate yesterday. Did you eat each of these foods?		Thinking about yesterday, how often did you have following foods and drinks • Once • Twice	Thinking about yesterday, how often did you have following foods and drinks • Once		

	Table S2.10 Continued……	• Once • More than once • Not at all		• More than twice • Not at all	• Twice • More than twice • Not at all		
14-15 years				Thinking about yesterday, how often did you have following foods and drinks • Once • Twice • More than twice • Not at all	Thinking about yesterday, how often did you have following foods and drinks • Once • Twice • More than twice • Not at all		How often do you eat at least 2 portions of fruit per day? • Never • Some days, but not all days • Every day How often do you eat at least 2 portions of vegetables including salad, fresh, frozen or tinned vegetables per day? • Never • Some days, but not all days • Every day How often, if at all, do you drink sugary drinks like cola or squash?

	Table S2.10 Continued……						• More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never How often, if at all, do you drink diet drinks or sugar free drinks like diet cola or sugar-free squash? • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never How often, if at all, do you eat fast food such as McDonalds, Burger King, KFC or

	Table S2.10 Continued……						
							other fast food like that? • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never
16-17 years		Self-completed (Study child) In the last 24 hours have you had the following foods and drinks? • Once • More than once • Not at all Food frequency questionnaire Your diet over the past year (Average use last year) For each food there is an amount shown,			Thinking about yesterday, how often did you have following foods and drinks • Once • Twice • More than twice • Not at all		How often do you eat at least 2 portions of fruit per day? • Never • Some days, but not all days • Every day How often do you eat at least 2 portions of vegetables including salad, fresh, frozen or tinned vegetables per day? • Never • Some days, but not all days

	Table S2.10 Continued……	either what we think is a medium serving or a common household unit such as a slice or teaspoon. Average use last year •Never or less than once per month •1-3 per month •Once a week •2-4 per week •5-6 per week •Once a day •2-3 per day •4-5 per day •6+ per day					• Every day How often, if at all, do you drink sugary drinks like cola or squash? • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never How often, if at all, do you drink diet drinks or sugar free drinks like diet cola or sugar-free squash? • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month

	Table S2.10 Continued……						• Never How often, if at all, do you eat fast food such as McDonalds, Burger King, KFC or other fast food like that? • More than once a day • Once a day • 3-6 days a week • 1-2 days a week • Less often but at least once a month • Less than once a month • Never
18-20 years		In the last 24 hours have you had the following foods and drinks • Once • Twice • More than twice • Not at all			Thinking about yesterday, how often did you have following foods and drinks • Once • Twice • More than twice • Not at all		

GUI (Growing Up in Ireland); GUS (Growing Up in Scotland); LSAC B (Longitudinal Study of Australian Children Birth cohort; LSAC K (Longitudinal Study of Australian Children Kindergarten cohort; GUN (Growing Up in New Zealand) and MCS (Millennium Cohort Study

Supplementary file S3

Documentation: List of DataSchema Variables and Harmonisation Potential Evaluation of Study-Specific Variables

Domain: Oral health behaviours
Construct: Toothbrushing constructs

Assessment characteristics of the toothbrushing constructs:

Table S3.1 Assessment characteristics of the toothbrushing constructs.

Respondent	Primary care giver (usually parents), Study child.
Construct	Toothbrushing frequency, toothbrushing assistance, toothbrushing supervision, toothbrushing starting age, type of toothpaste used.
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.2 Cohort survey waves with toothbrushing constructs questions included in the survey questionnaires.

Cohort survey	Survey waves
GUI infant	2, 5
GUI child	1, 2, 3
GUS	1, 2, 3, 5
LSAC B	2, 3, 4, 5, 6, 7, 8
LSAC K	2, 3, 4, 5, 6, 7, 8
GUN	1, 2, 4, 8
MCS	5, 6

Proposed Harmonised/DataSchema/Core variables:

Table S3.3.3 Proposed harmonised/DataSchema/core variables for the toothbrushing constructs.

Name	Label	Description/coding
TOOTH_BRUSH_FREQ_DAILY	Toothbrushing frequency	Number of times in a day the study child's teeth were cleaned/brushed. *Coding*: • Twice a day or more (1) • Once a day (2) • Less than once a day (3) • Never (4) • Missing (999)
TOOTH_BRUSH_FREQ_YESTRDY	Toothbrushing frequency yesterday	Number of times the study child brushed their teeth a day before the interview. *Coding*: • More than twice (1) • Twice (2) • Once (3) • Not at all (4) • Missing (999)
TOOTH_BRUSH_ASSIST	Assistance with toothbrushing	Indicator of whether the parents daily assist their child with toothbrushing. *Coding:* • No (0) • Yes (1) • Missing (999)
TOOTH_BRUSH_SUPRVSE_FREQ	Frequency of supervising the study child's toothbrushing	Indicator of how often the study child's toothbrushing was supervised. *Coding*: • Once a day or more (1) • Few times a week (2) • Few times a month (3) • Never (4) • Missing (999)
TOOTH_BRUISH_STRT_AGE	Study child's toothbrushing starting age	Age of the study child in months when their parents started cleaning their teeth. *Coding:* NA
TOOTH_BRUSH_FLU_PASTE	Type of toothpaste used	Indicator of whether the study child uses a fluoridated toothpaste. *Coding:* • No (0) • Yes (1) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.4 Cohort survey waves with variables having exact match or that could be transformed to proposed harmonised variables.

Variable name	Study (wave)
TOOTH_BRUSH_FREQ_DAILY	GUI infant (2, 5), GUI child (2, 3), LSAC B (2, 3, 4, 5), LSAC K (2, 3, 4), GUS (2), GUN (2, 4, 8), and MCS (5, 6)
TOOTH_BRUSH_FREQ_YESTRDY	LSAC B (6, 7, 8), LSAC K (5, 6, 7)
TOOTH_BRUSH_ASSIST	GUN (2, 4), LSAC B (2, 3, 4, 5), LSAC K (2)
TOOTH_BRUSH_SUPRVSE	GUN (8), LSAC B (3, 5) and LSAC K (3)
TOOTH_BRUISH_STRT_AGE	LSAC B (2, 3, 4 5) and LSAC K (2, 3, 4)
TOOTH_BRUSH_FLU_PASTE	GUN (2)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.5 Survey waves where original survey variables could not be transformed into harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
TOOTH_BRUSH_FREQ_DAILY	**GUI child wave 1**: Respondents were asked to report whether the study child brushes their teeth once a day. **GUS cohort survey wave 5:** Partial construct and response level matching. Respondents were asked how often a toothbrush with a fluoride toothpaste was used to clean child's teeth. In a review of the formulation and fluoride content of dentifrices available in the UK market it was reported that approximately, one third of the dentifrices sold were non fluoridated (Gupta *et al.*, 2021).
TOOTH_BRUSH_ASSIST	**GUS cohort survey wave 1 and 3:** Respondents were asked whether the child could brush their teeth without help some of the time.
TOOTH_BRUSH_SUPRVSE	**GUS cohort survey wave 2:** Partial construct matching and incomplete match of the response levels. Whether the parent daily supervise the child while toothbrushing was not included in the survey questionnaire.
TOOTH_BRUISH_STRT_AGE	**GUN cohort survey wave 1**: Respondents were asked whether they have started cleaning the study child's gums or teeth. The age of start of toothbrushing was not reported. **GUS cohort survey wave 1**: Respondents were asked to report the study child's age when they started using toothpaste for cleaning their teeth.
TOOTH_BRUSH_FLU_PASTE	**GUS cohort survey wave 2**: Respondents were asked whether a toothpaste is used when brushing the study child's teeth. No information was asked whether the paste used was fluoridated or not. **GUN cohort survey wave 2**: Respondents were asked whether the study child uses a regular adult toothpaste or one just for kids. No mention about the fluoride content of the toothpaste.

Study Specific Notes:

1) Harmonised Variable: TOOTH_BRUSH_FREQ_DAILY

a) GUI infant cohort wave 2: Partial construct matching. During wave 2 of the GUI infant survey, the respondents were asked, "How often is a toothbrush used to clean a child's teeth?". The question wording was different from the DataSchema variable. In the Republic of Ireland, parents use toothbrushes to clean their child's teeth. Therefore, this variable was intended to collect the daily toothbrushing frequency of the study child. Response levels differed and could be transformed, as shown in Table S3.6.

Table S3.6 Proposed recoding for the tooth brushing frequency variable in the GUI infant cohort survey (wave 2).

Original response levels	Recoded response levels
More than twice a day (1)	Twice a day or more (1)
Twice a day (2)	
Once day (3)	Once a day (2)
Less often than once a day (4)	Less than once a day (3)
Rarely (5)	Never (4)
Not at all (6)	
Missing	Missing (999)

b) GUI infant cohort wave 5: Complete construct matching. The response levels differed and could be transformed to match the defined harmonised variable (Table S3.7).

Table S3.7 Proposed recoding for the tooth brushing frequency variable in the GUI infant cohort survey (wave 5).

Original response levels	Recoded response levels
More than twice a day (1)	Twice a day or more (1)
Twice a day (2)	
Once day (3)	Once a day (2)
Less often than once a day (4)	Less than once a day (3)
Rarely (5)	Never (4)
Not at all (6)	
Missing	Missing (999)

c) GUS cohort survey wave 2: Partial construct matching. Question wordings were the same as for the GUI infant wave 2 survey. Like the toothbrushing frequency variable used in the GUI infant cohort survey wave 2, this variable was also intended to collect the daily toothbrushing frequency of the study child. The response levels differed and could be transformed to match the harmonised variable (Table S3.8).

Table S3.8 Proposed recoding of tooth brushing frequency variable for the GUS cohort wave 2.

Original response levels	Recoded response levels
More than twice a day (1)	Twice a day or more (1)
Twice a day (2)	
Once day (3)	Once a day (2)
Less often than once a day (4)	Less than once a day (3)
Don't clean teeth	Never (4)
Missing	Missing (999)

d) LSAC B cohort survey wave 2, 3, 4, 5 and LSAC K wave 2, 3, 4: Complete construct matching of the original study variables. The proposed transformation of the response levels used in the survey variables to match the harmonised variable is shown in Table S3.9.

Table S3.9 Proposed recoding for tooth brushing frequency variable in the LSAC B (waves 2, 3, 4, and 5) and LSAC K (waves 2, 3, 4) cohort surveys.

Original response levels	Recoded response levels
More than twice a day (1)	Twice a day or more (1)
Twice a day (2)	
Once day (3)	Once a day (2)
Less often than once a day (4)	Less than once a day (3)
Don't clean teeth (5)	Never (4)
Missing	Missing (999)

e) GUN cohort study wave 2: Complete construct matching and slightly different response levels were used in the study-specific variables. The proposed recoding of the original response levels is shown in Table S3.10.

Table S3.10 Proposed recoding for the tooth brushing frequency variable in the GUN cohort survey (wave 2).

Original response levels	Recoded response levels
Twice a day or more (4)	Twice a day or more (1)
Once day (3)	Once a day (2)
Less than once a day (2)	Less than once a day (3)
Never (1)	Never (4)
Ref (98)	Missing (999)
DK (99)	

f) **GUN cohort study wave 5:** Complete construct matching and slightly different response levels were used in the study-specific variables. The proposed recoding of the original response levels is shown in Table S3.11.

Table S3.11 Proposed recoding for tooth brushing frequency variable in the GUN cohort survey (wave 5).

Original response levels	Recoded response levels
Twice a day or more (5)	Twice a day or more (1)
Once day (4)	Once a day (2)
Less than once a day (3)	Less than once a day (3)
Less than weekly (2)	Never (4)
Never (1)	
Ref (98)	Missing (999)
DK (99)	

g) **GUN cohort study wave 8:** Complete construct matching and slightly different response levels were used in the study-specific variables. The proposed recoding of the original response levels is shown in Table S3.12.

Table S3.12 Proposed recoding for the tooth brushing frequency variable in the GUN cohort survey (wave 8).

Original response levels	Recoded response levels
More than twice a day (4)	Twice a day or more (1)
Twice a day (3)	
Once a day (2)	Once a day (2)
Less than once a day (1)	Less than once a day (3)
Ref (98	Missing (999)
DK (99)	

h) **MCS cohort study waves 5 and 6:** During the MSC survey wave 5, the respondents were the primary caregivers of the study children. And during wave 6, the responses were collected directly from the study children. For waves 5 and 6 of the MCS cohort surveys, complete construct and partial response levels match. The proposed recoding of the variable to match the defined harmonised variable is shown in Table S3.13.

Table S3.13 Proposed recoding for the tooth brushing frequency variable in the MCS cohort surveys (waves 5 and 6).

Original response levels	Recoded response levels
Twice a day or more (1)	Twice a day or more (1)
Once a day (2)	Once a day (2)
At least once a week but not daily (3)	Less than once a day (3)
Less than once a week (4)	Never (4)
Never (5)	
Missing	Missing (999)

a) **Harmonised variable: TOOTH_BRUSH_FREQ_YESTRDY**

b) **LSAC B wave (6, 7, 8) and LSAC K wave (5, 6, 7):** Complete construct and response levels matching of the original study variables with the proposed harmonised variable. Proposed changes in the value labels of the response levels are shown in Table S3.14.

Table S3.14 Proposed recoding for the variable used for recording the study child's toothbrushing frequency one day before the survey in the LSAC B (waves 6, 7, 8) and LSAC K (waves 5, 6, 7) cohort surveys.

Original response levels and values	Recoded levels and values
More than twice (4)	More than twice (1)
Twice (3)	Twice (2)
Once (2)	Once (3)
Not at all (1)	Not at all (1)
Missing	Missing (999)

2) Harmonised variable: TOOTH_BRUSH_ASSIST

a) **GUN cohort survey wave 2 and 4:** Complete construct and partial response levels matching. The proposed transformation of the original study variables to match the defined harmonised variable is shown in Table S3.15.

Table S3.15 Proposed recoding for the tooth brushing assistance variable in the GUN cohort survey (waves 2 and 4).

Original response levels and values	Recoded levels and values
Yes, most of the times (3)	Yes (1)
Yes, sometimes (2)	No (0)
Never (1)	
	Missing (999)

b) **LSAC B (waves 2, 3, 4, 5) and LSAC K (wave 2) surveys:** Complete construct and partial response level matching. The proposed transformation of the original study variable, Table S3.16.

Table S3.16 Proposed recoding for the tooth brushing assistance variables in the LSAC B (waves 2, 3, 4, 5) and LSAC K (wave 2) surveys.

Original response levels and values	Recoded levels and values
Once a day or more (1)	Yes (1)
A few times a week (2)	No (0)
A few times a month (3)	
Rarely (4)	
Not at all (5)	
Missing	Missing (999)

3) **Harmonised variable: TOOTH_BRUSH_SUPRVSE**

a) **LSAC B wave (3, 5) and LSAC K wave (3):** Complete construct and response level matching.

b) **GUN cohort survey wave 8:** Complete construct and partial response levels matching. The proposed transformation of the response levels is shown in Table S3.17.

Table S3.17 Proposed recoding for the tooth brushing supervision variable in the GUN survey (wave 8).

Original response levels and values	Recoded levels and values
Always (1)	Once a day or more (1)
Sometimes (2)	Few times a week (2)
Rarely (3)	Never (4)
Never (4)	
Prefer not to say (98)	Missing (999)
Don't know (99)	

4) **Harmonised variable: TOOTH_BRUISH_STRT_AGE**

a) **LSAC B (2, 3, 4 5) and LSAC K (2, 3, 4) surveys**: Complete matching of the construct and response levels.

5) **Harmonised variable: TOOTH_BRUSH_FLU_PASTE**

a) **GUN wave 2:** Complete construct and partial response levels matching. The proposed recoding of the study variable is shown in Table S3.18.

TableS3.18 Proposed recoding for fluoridated toothpaste use variable in the GUN survey (wave 2).

Original response levels and values	Recoded levels and values
Yes (1)	Yes (1)
No (2)	No (0)
Does not use toothpaste (3)	
Ref (98)	Missing (999)
DK (99)	

Harmonisation status summary of the study-specific variables for the defined DataSchema variables for the toothbrushing constructs.

Table S3.3.19 Harmonisation status summary for the toothbrushing construct variables across the waves of cohort surveys. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete and partial status n (%)
TOOTH_BRUSH_FREQ_DAILY	I C I I C	I C C I	I C I I I I I I I	I C C C C I I I	I C C C I I I I	I C I C I I I C	I I I I C C I	17 (34)
TOOTH_BRUSH_FREQ_YESTRDY	I I I I I	I I I I I	I I I I I I I I I	I I I I I C C C	I I I I C C C I	I I I I I I I I	I I I I I I I	6 (12)
TOOTH_BRUSH_ASSIST	I I I I I	I I I I	I I I I I I I I I	I C C C C I I I	I C I I I I I I	I C I C I I I I	I I I I I I I	7 (14)
TOOTH_BRUSH_SUPRVSE	I I I I I	I I I I	I I I I I I I I I	I I C I C I I I	I I I C I I I I	I I I I I I C	I I I I I I I	4 (8)
TOOTH_BRUISH_STRT_AGE	I I I I I	I I I I	I I I I I I I I I	I C C C C I I I	I C C C I I I I	I I I I I I I I	I I I I I I I	7 (14)
TOOTH_BRUSH_FLU_PASTE	I I I I I	I I I I	I I I I I I I I I	I I I I I I I I	I I I I I I I I	I C I I I I I I	I I I I I I I	1 (2)

Domain: Oral health behaviours
Construct: Dentist visit behaviour

Assessment characteristics of the dentist visit constructs:

Table S3.20 Assessment characteristics of the dentist visit behaviour construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dentist visit behaviour
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.21Cohort survey waves with the dentist visit behaviour construct questions in their survey questionnaires.

Cohort survey	Survey waves
GUI infant	2, 3, 5
GUI child	1, 2, 3, 4
GUS	2, 3, 4, 5, 7, 9
LSAC B	
LSAC K	7, 8
GUN	2, 4, 8
MCS	5, 6

Proposed Harmonised/DataSchema Variables/Core variables for the dentist visit construct:

Table S3.22 Proposed harmonised/DataSchema/core variables for the dentist visit behaviour construct.

Name	Label	Description/coding
DENT_VIST_FREQ	Study child's regular dentist visits	Indicator of how often the study child visits a dentist regularly *Coding*: • At least once a year (1) • Once every two years (2) • Once every three years (3) • Only when there is a problem (4) • Never/Almost never (5) • Missing (999)
DENT_VIST_BINARY	Dental visit	Indicator of whether the study child ever had a dental visit. *Coding:* • No (0) • Yes (1) • Missing (999)

Table S3.22 Continued…

Name	Label	Description/coding
DENT_VIST_PROBLEM	Visit for a dental problem	Indicator of whether the study child had visited a dentist because of a problem with his/her teeth *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_VIST_FEEL	Feelings about going to a dentist	Indicator of how the study child feels about attending a dentist. *Coding:* • Not scary at all (1) • Scary to some extent (2) • Very scary (3) • Missing (999)
DENT_VIST_PRIVATE	Visit to a private or public dentist	Indicator of whether the study child visited a private or HSE dentist *Coding*: • HSE (1) • Private (2) • Missing (999)
DENT_VIST_PAST_YEAR_BINARY	Last year visit to dentist	Indicator of whether the study child visited a dentist in last year *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_VIST_LAST	Last time child visited a dentist	Indicator of when did the child last visited the dentist *Coding:* • Less than one year ago (1) • 1-2 year ago (2) • More than 2 years ago (3) • Never (4) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.23 Cohort survey waves with survey variables having exact match or that could be transformed to the proposed harmonised variables.

Variable name	Study (wave)
DENT_VIST_FREQ	GUI infant (5), GUI child (1, 2, 3, 4), GUS (5), GUN (8)
DENT_VIST_BINARY	GUI infant (5), GUI child (1, 2, 3, 4), GUS (5), LSAC K (7, 8), GUN (2, 4)
DENT_VIST_PROBLEM	GUI infant (1, 2 ,3, 5), GUI child (1, 2, 3, 4)
DENT_VIST_PRIVATE	GUI infant (5)
DENT_VIST_PAST_YEAR_BINARY	MCS (5, 6)
DENT_VIST_FEEL	GUS (5)
DENT_VIST_LAST	GUI infant (5) and LSAC K (7, 8)

Study Specific Notes:

6) Harmonised Variable: DENT_VIST_FREQ

a) GUI infant cohort wave 5:

- Complete matching construct
- Complete matching response levels and coding

b) GUI child cohort survey waves 1, 2, 3:

- Complete matching construct
- Complete matching response levels and coding

c) GUI child cohort wave 4:

- Complete matching construct
- Partial matching response levels and coding

The proposed transformation of the study variable's response levels is shown in Table S3.24

Table S3.24 Proposed recoding of the dentist visit frequency variable in the GUI child cohort survey (wave 4).

Original response levels	Recoded response levels
Twice a year or more often (1)	At least once a year (1)
Once a year (2)	
Once every two years (3)	Once every two years (2)
Once every three years (4)	Once every three years (3)
Only when there is a problem (5)	Only when there is a problem (4)
Never/Almost never (6)	Never/Almost never (5)
	Missing (999)

d) GUS cohort survey wave 5:

- Partial matching construct
- Partial matching response and coding

The survey respondents (primary caregivers) were asked to report, "how often does the child attend a dentist for a routine check-up...". The proposed transformation of the study variable, Table S3.25.

Table S3.25 Proposed recoding of the dentist visit frequency variable in the GUS cohort survey (wave 5).

Original response levels	Recoded response levels
More frequently than once every six months (1)	At least once a year (1)
Every six months (2)	
Every 12 months (3)	
Every 24 months (4)	Once every two years (2)
At longer intervals (5)	Once every three years (3)
Never (6)	Never/Almost never (5)
	Missing (999)

e) GUN cohort survey wave 8:

- Complete matching construct
- Partial matching response and coding

The proposed transformation of the study variable, Table S3.26

Table S3.26 Proposed recoding of the dentist visit frequency variable in the GUN cohort survey (wave 8).

Original response levels	Recoded response levels
Less than once per year (1)	Once every two years (2)
About once per year (2)	At least once a year (1)
About once per sixth months (3)	
Several times per year (4)	
Other, please specify (97)	
Missing ()	Missing (999)

7) Harmonised Variable: DENT_VIST_BINARY

a) GUI infant wave 5 and GUI child cohort waves 1, 2, 3:

- Partial construct matching
- Completely un-matching responses and coding

The proposed transformation of the study variables, Table S3.27.

Table S3.27 The proposed recoding of the dentist visit variable in the GUI infant wave 5 and GUI child cohort survey waves 1, 2, 3.

Original response levels	Recoded response levels
At least once a year (1)	Yes (1)
Once every two years (2)	
Once every three years (3)	
Only when there is a problem (4)	
Never/Almost never (5)	No (0)
	Missing (999)

b) GUI child cohort wave 4:

- Partial construct matching
- Completely un-matching responses and coding

The proposed recoding of the study variable, Table S3.28.

Table S3.28 The proposed recoding of the dentist visit variable in the GUI child cohort survey wave 4.

Original response levels	Recoded response levels
Twice a year or more often (1)	Yes (1)
Once a year (2)	
Once every two years (3)	
Once every three years (4)	
Only when there is a problem (5)	
Never/Almost never (6)	No (0)
	Missing (999)

c) GUS cohort survey wave 5:

- Complete matching construct
- Completely matching responses

d) LSAC K cohort survey waves 7 and 8:

- Partial matching construct
- Un-matching responses

Proposed transformation of the study variable, Table S3.29.

Table S3.29 The proposed recoding of the dentist visit variable in the LSAC K cohort survey waves 7 and 8.

Original response levels	Recoded response levels
Less than 1 year ago (1)	Yes (1)
1-2 year ago (2)	
More than 2 years ago (3)	
Never (4)	No (0)
Unsure (5)	
	Missing (999)

e) GUN cohort survey waves 2 and 4:

- Completely matching construct
- Completely matching responses and coding

The proposed transformation of the study variable, Table S3.30.

Table 3.30 The proposed recoding of the dentist visit variable in the GUN child cohort survey waves 2 and 4.

Original response levels	Recoded response levels
Yes (1)	Yes (1)
No (2)	No (0)
Ref (98)	Missing (999)
DK (99)	Missing (999)
	Missing (999)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

GUS cohort survey waves 2, 3, 4, and 7: The PCG were asked "thinking about the last six months, did you or any member of your family visit any of the following people or services because of child's health? Dentist, if yes, how many times in the last six months?"

8) Harmonised variable: DENT_VIST_PROBLEM:

a) GUI infant cohort wave 1:

- Partial construct matching
- Complete matching responses and coding

b) GUI infant cohort survey waves 2 and 3:

- Complete construct matching
- Complete matching responses and different coding labels

The proposed transformation of the study variables, Table S3.31.

Table S3.31 The proposed transformation of the variable for problem visit to a dentist in the GUI cohort survey waves 2 and 3.

Original response levels	Recoded response levels
Yes (1)	Yes (1)
No (2)	No (0)
	Missing (999)

c) GUI infant cohort survey wave 5 and GUI child cohort survey waves 1, 2, 3, 4

- Partial construct matching
- Un-complete matching responses and coding

The proposed transformation of the study variables, Tables S3.32 and S3.33.

Table S3.32 The proposed transformation of the study variables in the GUI infant cohort survey wave 5 and GUI child cohort survey waves 1, 2 and 3.

Original response levels	Recoded response levels
At least once a year (1)	No (0)
Once every two years (2)	
Once every three years (3)	
Only when there is a problem (4)	Yes (1)
Never/Almost never (5)	No (0)
	Missing (999)

Table S3.33 The proposed variable transformation in the GUI child cohort survey wave 4.

Original response levels	Recoded response levels
Twice a year or more often (1)	No (0)
Once a year (2)	
Once every two years (3)	
Once every three years (4)	
Only when there is a problem (5)	Yes (1)
Never/Almost never (6)	No (0)
	Missing (999)

9) Harmonised variable: DENT_VIST_PRIVATE

a) GUI infant cohort wave 5:

- Complete construct matching
- Complete matching responses and coding

10) Harmonised variable: DENT_VIST_PAST_YEAR_BINARY

a) MCS cohort survey waves 5 and 6:

- Complete construct matching
- Complete matching responses and coding

11) Harmonised variable: DENT_VIST_FEEL

a) GUS cohort wave 5:

- Complete construct matching
- Complete matching responses and coding

12) Harmonised variable: DENT_VIST_LAST

a) GUI infant cohort wave 5:

- Complete construct matching
- Un-matching response

The respondents were asked to report the year and month of the last visit to a dentist. Therefore, we recommend calculating the time between the last visit to a dentist and the month and year of interview. The calculated interval should then be classified and recoded to match the response levels for the defined harmonized variable, Table S3.33.

Table S3.34 The proposed transformation for the last dentist visit variable in the GUI infant cohort survey wave 5.

Original response levels	Core variable response levels
Year _____, Month_____	Less than one year ago (1)
	1-2 year ago (2)
	More than 2 years ago (3)
	Never (4)
	Missing (999)

b) LSAC cohort survey waves 7 and 8:

- Complete construct matching
- Complete matching responses and coding

<u>Harmonisation status summary of the study-specific variables for the defined DataSchema variables for the dentist visit behaviour construct.</u>

Table S3.35 Harmonisation status summary for the dentist visit behaviour variables across the waves of cohort surveys. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DENT_VIST_FREQ	I I I I C	C C C C	I I I I C I I I I	I I I I I I I	I I I I I I I	I I I I I I C	I I I I I I	7 (14)
DENT_VIST_BINARY	I I I I C	C C C C	I I I I C I I I I	I I I I I I I	I I I I I I C C	I C I C I I I	I I I I I I	10 (24)
DENT_VIST_PROBLEM	C C C I C	C C C C	I I I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I	8 (16)
DENT_VIST_PRIVATE	I I I I C	I I I I	I I I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I	1 (2)
DENT_VIST_PAST_YEAR_BINARY	I I I I I	I I I I	I I I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I I I I C C	2 (4)
DENT_VIST_FEEL	I I I I I	I I I I	I I I I C I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I	1 (2)
DENT_VIST_LAST	I I I I C	I I I I	I I I I I I I I I	I I I I I I I	I I I I I I C C	I I I I I I I	I I I I I I	3 (6)

Domain: Oral health behaviours
Construct: Dental services use

Assessment characteristics of the dentist visit constructs:

Table S3.36 Assessment characteristics of the dental services use constructs.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dental services use
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.37 Cohort surveys waves with dental services use questions included in the questionnaires.

Cohort survey	Survey waves
GUI infant	3, 5
GUI child	1, 2, 4
GUS	2, 4, 6, 7
LSAC B	1, 2, 3, 4, 5, 6, 7, 8
LSAC K	1, 2, 3, 4, 5, 6, 7
GUN	5, 6, 8
MCS	

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.38 Proposed harmonised/DataSchema/core variables for the dental service construct.

Name	Label	Description/coding
DENT_SERVCE_USE	Use of dental services	Indicator of whether the study child has used dental services in the last 12 months *Coding*: • No (0) • Yes (1) • Missing (999)
DENT_SERVCE_UNMET	Unable to access dental services when needed	Indicator of whether the study child needed dental service but could not get? *Coding:* • No (0) • Yes (1) • Missing (999)

Table S3.38 Continued….

Name	Label	Description/coding
DENT_SERVCE_UNMET_RESON	Reason of not receiving dental services when needed	Indicator of the possible reason "why the study child could not access the dental services, when needed" *Coding:* • You couldn't afford to pay (1) • The necessary dental care wasn't available or accessible to you (2) • You could not take time off work to visit the dentist (3) • You wanted to wait and see if the problem got better (4) • Study child refused/fear of dentist (5) • Study child still on the waiting list (6) • Too far to travel/no means of transport (7) • Other (specify)____(8) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.39 Cohort survey waves with survey variables having an exact match or that could be transformed match the proposed harmonised variables.

Variable name	Study (wave)
DENT_SERVCE_USE	GUI child (4), GUS (2, 4, 6, 7), LSAC B (1, 2, 3, 4, 5, 6, 7, 8), LSAC K (1, 2, 3, 4, 5, 6, 7)
DENT_SERVCE_UNMET_NEED	GUI infant (3), GUI child (1, 2), LSAC B (1, 3, 4, 5, 6, 7, 8), LSAC K (1, 3, 4, 5, 6, 7)
DENT_SERVCE_UNMET_REASON	GUI infant (5), GUI child (1, 2), LSAC B (1), LSAC K (1)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.40 Survey waves where original survey variables could not be transformed into the defined harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
DENT_SERVCE_USE	**GUN cohort survey waves 5 and 8:** The respondents were asked to report "has the study child been enrolled in the free dental services (Community Oral health services)." **GUN cohort survey wave 6**: The respondents were asked "did you receive any referrals to additional services (dental or oral health care) for your Growing Up in New Zealand study child as a result of their Before school check)."
DENT_SERVCE_UNMET_NEED	

Table S3.40 Continued….

Variable name	Study (wave)
DENT_SERVCE_UNMET_REASON	**GUI infant cohort survey wave 3:** The respondents were asked to report whether the reason for not using dental services was they "could not afford it" or "other reason".

Study Specific Notes:

13) Harmonised Variable: DENT_SERVCE_USE

a) GUI infant cohort wave 4:

- Partial matching construct
- Complete matching response and coding

b) GUS cohort wave 2, 4, 6, 7:

- Partial matching construct
- Complete matching response and coding

c) LSAC B and LSAC K cohort wave 1:

- Partial matching construct
- Completely matching response and coding

d) LSAC B cohort waves 2, 3, 4, 5, 6, 7, 8 and LSAC K cohort waves 2, 3, 4, 5, 6, 7

- Completely matching construct
- Completely matching response and coding

14) Harmonised Variable: DENT_SERVCE_UNMET_NEED

a) GUI infant cohort wave 3:

- Completely matching construct
- Completely matching response levels and coding

b) GUI child cohort wave 1, 2

- Partial matching construct
- Complete matching response levels and coding

c) LSAC B and LSAC K cohort wave 1:

- Partial matching construct
- Completely matching response and coding

d) LSAC B cohort waves 3, 4, 5, 6, 7, 8 and LSAC K cohort waves 3, 4, 5, 6, 7

- Completely matching construct
- Completely matching response and coding

15) <u>Harmonised variable: DENT_SERVCE_UNMET_RESON:</u>

a) GUI infant cohort wave 5:

- Complete construct matching
- Completely matching response levels and coding

b) GUI child cohort wave 1

- Complete construct matching
- Partial matching response levels and coding (response level "Too far to travel/no means of transport (7)" was not included in the original variable)

c) GUI child cohort wave 2

- Complete construct matching
- Completely matching response levels and coding

d) LSAC B and LSAC K cohort survey wave 1

- Partial construct matching
- Partially matching response levels and coding

The proposed recoding of the study variables, Table S3.41.

Table S3.41 The proposed recoding of the dental services use variable in the LSAC B and K cohort surveys (wave 1).

Original response levels	Recoded response levels
Too expensive (1)	You couldn't afford to pay (1)
Too far away (2)	Too far to travel/no means of transport (7)
Transport problems (3)	Too far to travel/no means of transport (7)
Had to wait too long for appointment (4)	Study child still on the waiting list (6)
Hours available or operating (5)	Other (specify)____(8)
Own poor health (6)	Other (specify)____(8)
Child care difficulties (7)	Other (specify)____(8)
Cultural or language reasons (8)	Other (specify)____(8)
Services not available (9)	The necessary dental care wasn't available or accessible to you (2)
Family reasons (10)	Other (specify)____(8)
Other reasons (specify) (11)	Other (specify)____(8)
	Missing (999)

Harmonisation status summary for the dentist services use variables across the waves of the cohort surveys.

Table S3.42 Harmonisation status summary for the dental service use variables across the waves of cohort surveys. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DENT_SERVCE_USE	I I I I I	I I I C	I C I C I C C I I I	C C C C C C C C	C C C C C C C I	I I I I I I I I	I I I I I I I	20 (40)
DENT_SERVCE_UNMET_NEED	I I C I I	C C I I	I I I I I I I I I	C I C C C C C C	C I C C C C C I	I I I I I I I I	I I I I I I I	16 (32)
DENT_SERVCE_UNMET_REASON	I I I I C	C C I I	I I I I I I I I I	C I I I I I I I	C I I I I I I I	I I I I I I I I	I I I I I I I	5 (10)

Domain: Oral health status
Construct: Parent/Self-perceived oral health status

Assessment characteristics of the dentist visit constructs:

Table S3.43 Assessment characteristics of the Parent/Self-perceived oral health status construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Parent/Self-perceived oral health status
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.44 Cohort survey waves with Parent/Self-perceived oral health status construct questions included in the questionnaires.

Cohort survey	Survey waves
GUI infant	5
GUI child	3, 4
GUS	5
LSAC B	
LSAC K	
GUN	8
MCS	

Proposed Harmonised/DataSchema Variables/Core variable:

Table S3.45 Proposed harmonised/DataSchema/core variable for the parent/self-perceived oral health status construct.

Name	Label	Description/coding
ORAL_HEALTH_RATING	Oral health rating	Indicator of how the respondents (PCG or the study child) rate/describe the study child's oral health. *Coding*: • Excellent (1) • Very good (2) • Good (3) • Fair (4) • Poor (5) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.46 Cohort survey waves with survey variables having an exact match or that could be transformed to the proposed harmonised variable.

Variable name	Study (wave)
ORAL_HEALTH_RATING	GUI infant (5), GUI child (3, 4), and GUN (8)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.47 Survey waves where original survey variables could not be transformed to match the defined harmonised variable (with reasons for their exclusion).

Variable name	Study (wave)
ORAL_HEALTH_RATING	**GUS cohort survey waves 5:** Complete construct matching. However, completely un-matching response levels. The respondents were asked to describe "the study child's dental health at present" and the response were: • "Are perfectly healthy • Have some decay • Have a lot of decay"

Study Specific Notes:

16) Harmonised Variable: ORAL_HEALTH_RATING

a) GUI infant cohort wave 5; GUI child cohort wave 3, 4; and GUN cohort survey wave 8:

- Complete matching construct
- Complete matching response and coding

Harmonisation status summary for the Parent/Self-perceived oral health status variables across the survey waves

Table S3.48 Harmonisation status summary for the parent/self-perceived oral health status variables across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
ORAL_HEALTH_RATING	I I I I C	I I C C	I I I I I I I I I I	I I I I I I I I	I I I I I I I I	I I I I I I I C	I I I I I I I	4 (8)

Domain: Oral Health status
Construct: Dental injury

Assessment characteristics of the dentist visit constructs:

Table S3.49 Assessment characteristics of the dental injury construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dental injury
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.50 Cohort survey waves with dental injury construct questions in the survey questionnaires.

Cohort survey	Survey waves
GUI infant	3, 5
GUI child	
GUS	1, 2, 3, 4, 5, 6, 7, 8
LSAC B	1, 2, 3, 4, 5, 6, 7, 8
LSAC K	1, 2, 3, 4, 5, 6, 7, 8
GUN	2, 5
MCS	2, 3, 4, 5, 6

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.51 Proposed harmonised/DataSchema/core variables for the dental injury construct.

Name	Label	Description/coding
DENT_INJ_EVR	Ever had dental injury	Indicator of whether the child ever had dental injury *Coding:* No (0)/ Yes (1)/ Missing (999)
DENT_INJ_12_MNTHS	Dental injury in the last 12 months	Indicator of whether the study child had a dental injury in the last 12 months. *Coding:* No (0)/ Yes (1)/ Missing (999)
DENT_INJ_FREQ	Number of dental injuries	Indicator of the number of times the study child had dental injuries in the last 12 months. _____times

Studies/waves with an assigned complete harmonisation status:

Table S3.52 Cohort survey waves with survey variables having an exact match or that could be transformed to match the proposed harmonised variable.

Variable name	Study (wave)
DENT_INJ_EVR	GUI infant (3, 5), GUN (2, 5), MCS (2, 3, 4, 5, 6)
DENT_INJ_12_MNTHS	LSAC B and K (1, 2, 3, 4, 5, 6, 7, 8)
DENT_INJ_FREQ	LSAC B and K (2, 3, 4, 5, 6, 7, 8)

Study Specific Notes:

17) Harmonised Variable: DENT_INJ_EVR

a) **GUI infant cohort survey waves 3 and 5; GUN cohort survey waves 2 and 5; and MCS cohort survey waves 2, 3, 4, 5 and 6:**
- Complete matching construct
- Complete matching response and coding

18) Harmonised Variable: DENT_INJ_12_MNTHS

a) **LSAC B and K cohort survey waves 1, 2, 3, 4, 5, 6, 7, 8:**
- Complete construct matching
- Completely matching responses and coding

19) Harmonised Variable: DENT_INJ_FREQ

a) **LSAC B and K cohort survey waves 1, 2, 3, 4, 5, 6, 7, 8:**
- Complete construct matching
- Completely matching responses and coding

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.53 Survey waves where original survey variables could not be transformed into harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
DENT_INJ_12_MNTHS	**GUS cohort survey waves 1, 2, 3, 4, 5, 6, 7, 8:** No direct question about dental injuries was asked in the survey waves. However, the respondents were asked to report whether the child had an injury to “mouth or face” which included nosebleeds.
DENT_INJ_FREQ	**GUS cohort survey waves 1, 2, 3, 4, 5, 6, 7, 8:** No direct question about the frequency of dental injuries was asked in the survey waves. However, the respondents were asked to report the number of injuries the study child had which required medical attention.

Harmonisation status summary for the dental injury variables across the survey waves.

Table S3.54 Harmonisation status summary for the dental injury variables across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DENT_INJ_EVR	I I C I C	I I I I	I I I I I I I I I I	I I I I I I I I	I I I I I I I I	I C I I C I I I	I C C C C C I	9 (18)
DENT_INJ_12_MNTHS	I I I I I	I I I I	C C C C C C C C I I	C C C C C C C C	C C C C C C C C	I I I I I I I I	I I I I I I I	24 (48)
DENT_INJ_FREQ	I I I I I	I I I I	C C C C C C C C I I	C C C C C C C C	C C C C C C C C	I C I I C I I I	I C C C C C I	31 (62)

Domain: Oral Health status
Construct: Dental problems

Assessment characteristics of the dentist visit constructs:

Table S3.55 Assessment characteristics of the dental problems construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dental problems
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.56 Cohort survey waves with dental problems construct questions included in the questionnaires.

Cohort survey	Survey waves
GUI infant	1
GUI child	
GUS	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
LSAC B	2, 3, 4, 5, 6, 7, 8
LSAC K	2, 3, 4, 5, 6, 7, 8
GUN	4, 6
MCS	3, 5

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.57 Proposed harmonised/DataSchema/core variables for the dental problems construct.

Name	Label	Description/coding
DENT_PROB_BINARY	Study child having any dental problem	Indicator of whether the study child had any dental problem *Coding*: • No (0) • Yes (1) • Missing (999)
DENT_PROB_CAVITIES	Dental cavities or dental decay	Indicator of whether the study child had dental decay or cavities *Coding:* • No (0) • Yes (1) • Missing (999)

Table S3.57 Continued…….

Name	Label	Description/coding
DENT_PROB_CAVITIES_2YEARS	Dental cavities or dental decay in the last 2 years	Indicator of whether the study child had dental decay or cavities in the last 2 years *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_ACCIDENT	Tooth loss or breakage	Indicator whether the study child had tooth loss or breakage because of accident *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_ACCIDENT_2_YEARS	Tooth loss or breakage in the last 2 years	Indicator whether the study child had tooth loss or breakage because of accident in the last 2 years *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_ToothPain	Tooth pain	Indicator of whether the study child had toothache (tooth pain) *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_SENSITIVITY	Dental sensitivity	Indicator of whether the study child had sensitivity to hot, cold or sweet food *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_BleedingGums	Bleeding gums	Indicator of whether the study child had bleeding gums problem *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_PROB_GumPain	Gum pain	Indicator of whether the study child had pain in their gums *Coding:* • No (0) • Yes (1) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.58 Cohort survey waves with survey variables having an exact match or that could be transformed to match the proposed harmonised variable.

Variable name	Study (wave)
DENT_PROB_BINARY	LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7), GUN (4, 6
DENT_PROB_CAVITIES	LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7), GUN (4), GUS (5)
DENT_PROB_CAVITIES_2YEARS	LSAC B (3, 4, 5, 6, 7, 8), LSAC K (3, 4, 5, 6, 7)
DENT_PROB_ACCIDENT	LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7), GUN (4)
DENT_PROB_ACCIDENT_2_YEARS	LSAC B (3, 4, 5, 6, 7, 8), LSAC K (3, 4, 5, 6, 7)
DENT_PROB_ToothPain	LSAC B (8), LSAC K (6, 7, 8), MCS (3, 5)
DENT_PROB_SENSITIVITY	LSAC B (8), LSAC K (6, 7, 8)
DENT_PROB_BleedingGums	LSAC B (8), LSAC K (6, 7, 8
DENT_PROB_GumPain	LSAC B (8), LSAC K (6, 7, 8)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.59 Survey waves where original survey variables could not be transformed into harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
DENT_PROB_BINARY	**GUI infant wave 1:** Partially matching construct but the variable could not be transformed. The respondents were asked to report “health problems or illnesses for which baby has been taken to the GP, Health Center or Public health nurse or Accident and Emergency? Dental problems (e.g., teething). The question was meant to record only those dental problems for which the study child received medical care. **GUS cohort survey wave 1:** The respondents were asked about the problems which caused them (and their partner) the greatest concern? Teething **GUS cohort wave 2, 3, 4, 5, 6, 7, 8, 9, 10:** Completely unmatching construct. The respondents were asked “does the child have any longstanding illness or disability? By longstanding I mean anything that has troubled him over a period of time or that is likely to affect him over a period of time. Complains of teeth/mouth/tongue?”

Study Specific Notes:

20) Harmonised Variable: DENT_PROB_BINARY

a) LSAC B cohort survey waves 2, 3, 4, 5, 6, 7, 8; and LSAC K survey waves 2, 3, 4, 5, 6, and 7:

- Completely matching construct
- Completely matching response and coding

b) GUN cohort wave 4:

- Partially matching construct
- Partially matching response and coding

The proposed transformation of the variables: Following variables (HY16_1_M45CM, HY16_4_M45CM, HY16_97_M45CM, HY16_5_M45CM and HY16_99_M45CM) could be combined to create the proposed harmonised variable. And the response levels could be recoded as shown in Table S3.60.

Table S3.60 The proposed recoding of the study-specific variables in the GUN cohort survey wave 4.

Original response levels	Recoded response levels
HY16_1_M45CM Yes (1)	Yes (1)
HY16_4_M45CM Yes (1)	
HY16_97_M45CM Yes (1)	
HY16_1_M45CM No (0)	No (0)
HY16_4_M45CM No (0)	
HY16_97_M45CM No (0)	
HY16_5_M45CM Yes (1)	
HY16_99_M45CM Yes (1)	Missing (999)
Missing	

c) GUN cohort wave 6:

- Partially matching construct
- Completely matching response and coding

21) Harmonised variables: DENT_PROB_CAVITIES

a) LSAC B cohort survey waves 2, 3, 4, 5, 6, 7, and 8; and LSAC K survey waves 2, 3, 4, 5, 6, and 7; GUN survey wave 4:

- Completely matching construct
- Completely matching response and coding

b) GUS cohort survey wave 5:

- Partially matching construct
- Completely un-matching response and coding

The proposed transformation of the study-specific variable to match the defined harmonised variable, Table S3.61.

Table S3.61 The proposed recoding of the study-specific variable in the GUS cohort survey 5.

Original response levels	Recoded response levels
Are perfectly healthy (1)	No (0)
Have some decay (2)	Yes (1)
Have a lot of decay (3)	

22) Harmonised variables: DENT_PROB_ACCIDENT

a) LSAC B cohort survey waves 2, 3, 4, 5, 6, 7, and 8; and LSAC K survey waves 2, 3, 4, 5, 6, and 7; GUN survey wave 4:

- Completely matching construct
- Completely matching response and coding

23) Harmonised variables: DENT_PROB_CAVITIES_2YEARS

a) LSAC B cohort survey waves 3, 4, 5, 6, 7, and 8; and LSAC K survey waves 3, 4, 5, 6, and 7:

- Completely matching construct
- Completely matching response and coding

24) Harmonised variables: DENT_PROB_ACCIDENT_2_YEARS

a) LSAC B cohort survey waves 3, 4, 5, 6, 7, and 8; and LSAC K survey waves 3, 4, 5, 6, and 7:

- Completely matching construct
- Completely matching response and coding

25) Harmonised variables: DENT_PROB_ToothPain

a) LSAC B cohort survey waves 8; and LSAC K survey waves 6, 7 and 8:

- Partially matching construct
- Partially matching response and coding

The proposed recoding of the study-specific variable to match the defined harmonised variable, Table S3.62.

Table S3.62 The proposed recoding of the study-specific variable in the LSAC B cohort survey waves 8; and LSAC K survey waves 6, 7 and 8

Original response levels	Recoded response levels
Never (0)	No (0)
Almost never (1)	
Sometimes (2) Often (3)	Yes (1)
Almost always (4)	
Missing	Missing (999)

b) MCS cohort survey waves 3 and 5

- Completely matching construct
- Completely matching response and partially matching value labels

The proposed recoding of the study-specific variable to match the defined the harmonised variable, Table S3.63.

Table S3.63 Proposed recoding of the study-specific variable in the MCS cohort survey waves 3 and 5.

Original response levels	Recoded response levels
Yes (1)	Yes (1)
No (2)	No (0)

26) Harmonised variables: DENT_PROB_SENSITIVITY;

27) DENT_PROB_BleedingGums; AND

28) DENT_PROB_GumPain:

a) LSAC B cohort survey wave 8; and LSAC K survey waves 6, 7 and 8:

- Partially matching construct
- Partially matching response and coding

The proposed recoding of the study-specific variable to match the defined harmonised variable, Table S3. 64.

Table S3.64 Proposed recoding of the study-specific variable in the LSAC B cohort survey wave 8 and LSAC K survey waves 6, 7 and 8.

Original response levels	Recoded response levels
Never (0)	No (0)
Almost never (1)	
Sometimes (2)	Yes (1)
Often (3)	
Almost always (4)	
Missing	Missing (999)

Harmonisation status summary for the dental problems variables across the survey waves.

Table S3.65 Harmonisation status summary for the dental problem variables across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DENT_PROB_BINARY	I I I I I	I I I I	I I I I I I I I I	I C C C C C C C	I C C C C C C I	I I I C I C I I	I I I I I I I	15 (30)
DENT_PROB_CAVITIES	I I I I I	I I I I	I I I I C I I I I I	I C C C C C C C	I C C C C C C I	I I I C I I I I	I I I I I I I	15 (30)
DENT_PROB_CAVITIES_2YEARS	I I I I I	I I I I	I I I I I I I I I	I I C C C C C C	I I C C C C C I	I I I I I I I I	I I I I I I I	11 (22)
DENT_PROB_ACCIDENT	I I I I I	I I I I	I I I I I I I I I	I C C C C C C C	I C C C C C C I	I I I C I C I I	I I I I I I I	15 (30)
DENT_PROB_ACCIDENT_2_YEARS	I I I I I	I I I I	I I I I I I I I I	I I C C C C C C	I I C C C C C I	I I I I I I I I	I I I I I I I	11 (22)
DENT_PROB_ToothPain	I I I I I	I I I I	I I I I I I I I I	I I I I I I C	I I I I I C C C	I I I I I I I I	I I C I C I I	6 (12)
DENT_PROB_SENSITIVITY	I I I I I	I I I I	I I I I I I I I I	I I I I I I C	I I I I I C C C	I I I I I I I I	I I I I I I I	4 (8)
DENT_PROB_BleedingGums	I I I I I	I I I I	I I I I I I I I I	I I I I I I C	I I I I I C C C	I I I I I I I I	I I I I I I I	4 (8)
DENT_PROB_GumPain	I I I I I	I I I I	I I I I I I I I I	I I I I I I C	I I I I I C C C	I I I I I I I I	I I I I I I I	4 (8)

Domain: Oral health status
Construct: Dental treatments

Assessment characteristics of the dental treatments construct:

Table S3.66 Assessment characteristics of the dental treatments construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dental treatments
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.67 Cohort survey waves with dental treatments construct questions included in the questionnaires.

Cohort survey	Survey waves
GUI infant	5
GUI child	2, 3
GUS	5
LSAC B	2, 3, 4, 5, 6, 7, 8
LSAC K	2, 3, 4, 5, 6, 7, 8
GUN	4
MCS	2, 3

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.68 Proposed harmonised/DataSchema/core variables for the dental treatments construct.

Name	Label	Description/coding
DENT_TREAT_FILLINGS	Dental fillings	Indicator of whether the study child had their tooth/teeth filled because of dental decay *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_TREAT_EXTRACTIONS	Dental extractions	Indicator of whether the study child had their tooth/teeth extracted because of dental decay *Coding:* • No (0) • Yes (1) • Missing (999)
DENT_TREAT_BRACES	Orthodontic treatment	Indicator of whether the study child had undergone/undergoing orthodontic treatment *Coding:* • No (0) • Yes (1) • Missing (999

Studies/waves with an assigned complete harmonisation status:

Table S3.69 Cohort survey waves with survey variables having an exact match or that could be transformed to proposed harmonised variables.

Variable name	Study (wave)
DENT_TREAT_FILLINGS	GUI infant (5), GUI child (2,3), GUS (5), LSAC B (2,3,4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7), GUN (4)
DENT_TREAT_EXTRACTIONS	GUI infant (5), GUI child (2,3), GUS (5), LSAC B (2,3,4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7), GUN (4)
DENT_TREAT_BRACES	GUI child (3), GUS (5), LSAC B (6, 7, 8), LSAC K (6, 7)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.70 Survey waves where original survey variables could not be transformed into harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
DENT_TREAT_FILLINGS	**MCS cohort survey waves 2 and 3:** In these surveys the respondents were asked to report whether the older siblings ever had any dental fillings and, the question was asked from the English participants only. **LSAC B and K cohort survey wave 5:** The respondents were asked to report "has the study child had..... braces or other dental problems (e.g., oral surgery)."

Study Specific Notes:

29) Harmonised Variable:DENT_TREAT_FILLINGS; AND

30) Harmonised Variable: DENT_TREAT_EXTRACTIONS

a) GUI infant cohort wave 5; GUI child cohort wave 2; GUS cohort survey wave 5:

- Completely matching construct
- Completely matching response and partially matching coding

The proposed recoding of the study-specific variables to match the defined harmonised variable, Table S3.71.

Table S3.71 Proposed transformation of the study-specific variable in the GUI infant cohort wave5; GUI child cohort wave 2; GUS cohort survey wave 5.

Original response levels	Recoded response levels
Yes (1)	Yes (1)
No (2)	No (0)

b) GUI child cohort wave 3:

- Completely matching construct
- Partially matching response and coding

The proposed recoding of the study-specific variables to match the defined harmonised variable, Table S3.72.

Table S3.72 Proposed transformation of the study-specific variable in the GUI child cohort wave 3.

Original response levels	Recoded response levels
None (0)	No (0)
One (1)	Yes (1)
Two (2)	
Three or more (3)	

c) LSAC B cohort survey waves 2, 3, 4, 5; LSAC K cohort survey waves 2, 3, 4, 5; GUN wave 4:

- Partially matching construct
- Completely matching response and coding

During these surveys the respondents were asked "has the child ever had any of the following problems with his/her teeth? Tooth/teeth filled or pulled".

d) LSAC B cohort survey waves 4, 5, 6, 7, 8 and LSAC K cohort survey waves 4, 5, 6, 7:

- Completely matching construct
- Completely matching response and coding

Note: During the GUS, GUN and LSAC surveys, respondents were asked about dental fillings and extractions in general (NO mention about the dentition type (permanent or primary teeth)). However, in the GUI surveys the respondents were specially informed to report permanent tooth/teeth fillings and extractions.

31) <u>Harmonised Variable: DENT_TREAT_BRACES</u>

a) GUI cohort survey wave 3; GUS cohort survey wave 5:

- Completely matching construct
- Partially matching response and coding

The proposed recoding of the study-specific variables to match the defined harmonised variable, Table S3.73.

Table S3.73 Proposed recoding of the study-specific variable in the GUI cohort survey wave 3; GUS cohort survey wave 5.

Original response levels	Recoded response levels
Yes (1)	Yes (1)
No (2)	No (0)

b) LSAC B cohort survey wave 6, 7, 8; LSAC K cohort survey waves 6, 7:

- Completely matching construct
- Completely matching response and coding

<u>Harmonisation status summary for the dental treatment variables across the survey waves.</u>

Table S3.74 Harmonisation status summary for the dental treatment variables across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DENT_TREAT_FILLINGS	I I I I C	I C C I	I I I I C I I I I I	I C C C C C C C	I C C C C C C I	I I I C I I I I	I I I I I I I	18 (36)
DENT_TREAT_EXTRACTIONS	I I I I C	I C C I	I I I I C I I I I I	I C C C C C C C	I C C C C C C I	I I I C I I I I	I I I I I I I	18 (36)
DENT_TREAT_BRACES	I I I I I	I I C I	I I I I C I I I I	I I I I I C C C	I I I I I C C I	I I I I I I I I	I I I I I I I	7 (14)

Domain: General health, body weight status and diet
Construct: Dietary behaviour

Assessment characteristics of the dietary behaviour constructs:

Table S3.75 Assessment characteristics of the dietary behaviour construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Dietary behaviour
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.76 Cohort surveys waves with dietary behaviour construct questions included in the questionnaires.

Cohort survey	Survey waves
GUI infant	1, 2, 3, 4, 5
GUI child	1, 2, 3, 4
GUS	1, 2, 3, 5, 8
LSAC B	1, 2, 3, 4, 5, 6, 7, 8
LSAC K	1, 2, 3, 4, 5, 6, 7, 8
GUN	1, 2, 5, 8
MCS	3, 4, 5, 6, 7

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.77 Proposed harmonised/DataSchema/core variables for the dietary behaviour construct.

Name	Label	Description/coding
DIET_SWEETS_CHOCOLATE	Frequency of eating sweets, chocolates, biscuits, cakes, or pie	Indicator of how often the study child usually have sweets, chocolates, biscuits, cake, pie, or other foods rich in free sugars. *Coding:* • More than once a day (1) • Once a day (2) • Once a week (3) • Once a month (4) • Not at all (0) • Missing (999)
DIET_DRINKS_NonDiet	Frequency of drinking drinks rich in free sugars (non-diet drinks)	Indicator of how often the study child usually have drinks rich in free sugars (non-diet drinks) *Coding:* • More than once a day (1) • Once a day (2) • Once a week (3) • Once a month (4) • Not at all (0) • Missing (999)
DIET_DRINKS_Diet	Frequency of drinking diet drinks (Artificially sweetened beverages)	Indicator of how often the study child usually have diet drinks *Coding:* • More than once a day (1) • Once a day (2) • Once a week (3) • Once a month (4) • Not at all (0) • Missing (999)
DIET_CRISPS_SAVOURY	Frequency of eating crisps and other savoury snacks	Indicator of how often the study child usually have crisps or other savoury snacks *Coding:* • More than once a day (1) • Once a day (2) • Once a week (3) • Once a month (4) • Not at all (0) • Missing (999)

Table S3.77 Continued……

Name	Label	Description/coding
DIET_FRUIT_JUICE	Frequency of drinking fruit juice	Indicator of how often the study child usually have fruit juices *Coding:* • More than once a day (1) • Once a day (2) • Once a week (3) • Once a month (4) • Not at all (0) • Missing (999)
DIET_FreeSugarsFoods_SNACK_BTW_MEALS	In between meals snacking of sugary foods	Indicator of whether the child eats foods rich in free sugars in between meals *Coding:* • No (0) • Yes (1) • Missing (999)
DIET_FreeSugarsDrinks_SNACK_BTW_MEALS	In between meals snacking of sugary drinks	Indicator of whether the child have drinks free sugars rich drinks in between their regular meals *Coding:* • No (0) • Yes (1) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.78 Cohort survey waves with study-specific variables having an exact match or that could be transformed to match the defined harmonised variables.

Variable name	Study (wave)
DIET_SWEETS_CHOCOLATE	GUI infant (2, 3, 4, 5), GUI child (1, 2, 3, 4), GUS (2, 3, 5, 8), LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (1, 2, 3, 4, 5, 6, 7, 8), GUN (1, 2, 5)
DIET_DRINKS_NonDiet	GUI infant (2, 3, 4, 5), GUI child (1, 2, 3, 4), GUS (2, 3, 5, 8), LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (1, 2, 3, 4, 5, 6, 7, 8), GUN (2, 5), MCS (5, 6, 7)
DIET_DRINKS_Diet	GUI infant (2, 3, 4, 5), GUI child (1, 2, 3, 4), GUS (5), LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7, 8), GUN (2, 5), MCS (5, 6, 7)
DIET_CRISPS_SAVOURY	GUI infant (2, 3, 4, 5), GUI child (1, 2, 3, 4), GUS (2, 3, 5, 8), LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (1, 2, 3, 4, 5, 6, 7, 8), GUN (1, 2, 5)
DIET_FRUIT_JUICE	GUI infant (3, 5), GUI child (1, 3, 4), LSAC B (2, 3, 4, 5, 6, 7, 8), LSAC K (2, 3, 4, 5, 6, 7, 8), GUN (1, 2, 5)
DIET_FreeSugarsFoods_SNACK_BTW_MEALS	GUS (2, 5), MCS (3, 4)
DIET_FreeSugarsDrinks_SNACK_BTW_MEALS	MCS (3, 4)

Reasons for assigning an incomplete harmonisation status to the survey waves in addition to those studies with no information included in the survey questionnaires:

Table S3.79 Survey waves where original survey variables could not be transformed into harmonised variables (with reasons for their exclusion).

Variable name	Study (wave)
DIET_SWEETS_CHOCOLATE	
DIET_DRINKS_NonDiet	**GUN wave 1**: Respondents were asked "How often does baby have soft drinks currently?" There was no mention about whether to include or exclude "sugar-free or diet" drinks. **GUN wave 8**: The question included both the non-diet and diet versions of fizzy drinks. The respondents were asked "how many times did child have a fizzy or soft drink, such as cola or lemonade? (This include diet artificially sweetened) and energy drinks....."
DIET_DRINKS_Diet	
DIET_CRISPS_SAVOURY	
DIET_FRUIT_JUICE	
DIET_FreeSugarsFoods_SNACKING	**GUN wave 2**: The question included both snacks and drinks. The respondents were asked "does child usually have a snack or a drink other than water just before going to bed?"
DIET_FreeSugarsDrinks_SNACKING	

Study Specific Notes:

32) Harmonised Variables: DIET_SWEETS_CHOCOLATE

33) DIET_DRINKS_NonDiet

34) DIET_DRINKS_Diet

35) DIET_CRISPS_SAVOURY

36) DIET_FRUIT_JUICE

a) GUI infant cohort survey wave 2:

- Partially matching construct (the respondents were asked "In the last 24 hours has the child had ....."
- Partially matching response levels and coding

The proposed recoding of the study-specific variables to match the defined harmonised variables, Table S3.80.

Table S3.80 Proposed recoding of the study-specific variables in the GUI infant cohort survey wave 2.

Original response levels	Recoded response levels
Not at all (0)	Not at all (0)
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
	Missing (999)

b) GUI infant cohort survey wave 3:

- Completely matching construct (the respondents were asked "on average, your child eats these foods...."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.81.

Table S3.81 Proposed recoding of the study-specific variables in the GUI infant cohort survey wave 3.

Original response levels	Recoded response levels
Never (1)	Not at all (0)
Less than once a month (2)	
At least once a month (3)	Once a month (4)
At least once a week (4)	Once a week (3)
Most days (5)	Once a day (2)
Once a day (6)	
2-3 per day (7)	More than once a day (1)
4-5 per day (8)	
6+ per day (9)	
	Missing (999)

c) GUI infant cohort wave 4:

- Partially matching construct (the respondents were asked "In the last 24 hours has the child had ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.82.

Table S3.82 Proposed recoding of the study-specific variables in the GUI infant cohort survey wave 4.

Original response levels	Recoded response levels
Not at all (3)	Not at all (0)
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
	Missing (999)

d) GUI infant cohort wave 5:

- Partially matching construct (the respondents were asked "In the last 24 hours has the child had ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.83.

Table S3.83 Proposed recoding of the study-specific variables in the GUI infant cohort survey wave 5.

Original response levels	Recoded response levels
Once (1)	Once a day (2)
Twice (2)	More than once a day (1)
More than twice (3)	
Not at all (4)	Not at all (0)
Don't know (5)	Missing (999)
	Missing (999)

e) GUI child cohort survey wave 1:

- Partially matching construct (the respondents were asked "In the last 24 hours has the child had ......"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.84.

Table S3.84 Proposed recoding of the study-specific variables in the GUI child cohort survey wave 1.

Original response levels	Recoded response levels
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
Not at all (3)	Not at all (0)
Don't know (4)	Missing (999)
	Missing (999)

f) GUI child cohort survey wave 2:

- Partially matching construct (the study children were asked "think back to what you ate yesterday. Did you eat each of these foods ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.85.

Table S3.85 Proposed recoding of the study-specific variables in the GUI child cohort survey wave 2.

Original response levels	Recoded response levels
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
Not at all (3)	Not at all (0)
	Missing (999)

g) GUI child cohort survey wave 3:

In the GUI child cohort survey wave 3, a 24-hour recall and a food frequency questionnaire were used to collect the study child's dietary behaviour information

24-hour recall variables:

- Partially matching construct (the study children were asked "in the last 24 hours have you had the following foods and drinks ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.86.

Table S3.86 Proposed recoding of the study-specific variables in the GUI child cohort survey wave 3.

Original response levels	Recoded response levels
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
Not at all (3)	Not at all (0)
	Missing (999)

Food frequency questionnaire variables:

- Partially matching construct (the study children were asked about their diet "over the past year"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.87.

Table S3.87 Proposed recoding of the study-specific variables in the GUI child cohort survey wave 3.

Original response levels	Recoded response levels
Never or less than once per month (1)	Not at all (0)
1-3 per month (2)	Once a month (4)
Once a week (3)	Once a week (3)
2-4 per week (4)	
5-6 per week (5)	Once a day (2)
Once a day (6)	
2-3 per day (7)	More than once a day (1)
4-5 per day (8)	
6+ per day (9)	
	Missing (999)

h) GUI child cohort survey wave 4:

- Partially matching construct (the study children were asked "In the last 24 hours have you the child had the following....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.88.

Table S3.88 Proposed recoding of the study-specific variables in the GUI child cohort survey wave 4.

Original response levels	Recoded response levels
Once (1)	Once a day (2)
Twice (2)	More than once a day (1)
More than twice (2)	
Not at all (3)	Not at all (0)
	Missing (999)

i) LSAC B cohort survey wave 2 and LSAC K cohort survey waves 1 and 2:

- Partially matching construct (the respondents were asked "In the last 24 hours how often did the child eat ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.89.

Table S3.89 Proposed recoding of the study-specific variables in the LSAC B cohort survey wave 2; LSAC cohort survey waves 1 and 2.

Original response levels	Recoded response levels
Not at all (0)	Not at all (0)
Once (1)	Once a day (2)
More than once (2)	More than once a day (1)
Don't know (-2)	Missing (999)
	Missing (999)

j) LSAC B cohort survey waves 3, 4 and 5; LSAC K cohort survey waves 3, 4 and 5:

- Partially matching construct (the respondents were asked "In the last 24 hours how often did the child eat ....."
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.90.

Table S3.90 Proposed recoding of the study-specific variables in the LSAC B cohort survey waves 3, 4 and 5; LSAC cohort survey waves 3, 4 and 5.

Original response levels	Recoded response levels
Not at all (0)	Not at all (0)
Once (1)	Once a day (2)
Twice (2)	More than once (1)
3 or more times (3)	
Don't know (-2)	Missing (999)

k) LSAC B cohort survey waves 6, 7 and 8; LSAC K cohort survey waves 6, 7 and 8:

- Partially matching construct (the study children were asked "thinking about yesterday, how often did you have.....")
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.91.

Table S3.91 Proposed recoding of the study-specific variables in the LSAC B cohort survey wave 6, 7 and 8; LSAC cohort survey waves 6, 7 and 8.

Original response levels	Recoded response levels
Not at all (0)	Not at all (0)
Once (1)	Once a day (2)
Twice (2)	More than once (1)
More than twice (3)	
	Missing (999)

l) GUS cohort survey wave 2:

- Completely matching construct (the respondents were asked "how often does study child eat/drink .....?"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.92.

Table S3.92 Proposed recoding of the study-specific variables in the GUS cohort survey wave 2.

Original response levels	Recoded response levels
6 or more times a day (1)	More than once a day (1)
4-5 times a day (2)	
2-3 times a day (3)	
Once a day (4)	Once a day (2)
5-6 times a week (5)	
2-4 times a week (6)	Once a week (3)
Once a week (7)	
1-3 times per month (8)	Once a month (4)
Less often or never (9)	Not at all (0)
	Missing (999)

m) GUS cohort survey waves 3, 5 and 8:

- Completely matching construct (the respondents were asked "how often does study child eat/drink .....?"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.93.

Table S3.93 Proposed recoding of the study-specific variables in the GUS cohort survey waves 3, 5 and 8.

Original response levels	Recoded response levels
More than once a day (1)	More than once a day (1)
Once a day (2)	Once a day (2)
5-6 times a week (3)	
2-4 times a week (4)	Once a week (3)
Once a week (5)	
1-3 times per month (6)	Once a month (4)
Less often (7)	Not at all (0)
Never (8)	
	Missing (999)

n) MCS cohort survey wave 5:

- Completely matching construct (the respondents were asked "how often, if at all, does the study cohort drink .....?"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.94.

Table S3.94 Proposed recoding of the study-specific variables in the MCS cohort survey wave 5.

Original response levels	Recoded response levels
More than once a day (1)	More than once a day (1)
Once a day (2)	Once a day (2)
3-6 days a week (3)	
1-2 days a week (4)	Once a week (3)
Less often but at least once a month (5)	Once a month (4)
Less than once a month (6)	Not at all (0)
Never (7)	
	Missing (999)

o) MCS cohort survey waves 6 and 7:

- Completely matching construct (the respondents were asked.....?"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.95.

Table S3.95 Proposed recoding of the study-specific variables in MCS cohort survey waves 6 and 7.

Original response levels	Recoded response levels
More than once a day (1)	More than once a day (1)
Once a day (2)	Once a day (2)
3-6 days a week (3)	
1-2 days a week (4)	Once a week (3)
Less often but at least once a month (5)	Once a month (4)
Less than once a month (6)	Not at all (0)
Hardly ever or never (7)	
	Missing (999)

p) GUN cohort survey wave 1:

- Partially matching construct (the respondents were asked "how often does baby have the following foods and drinks currently .....?"
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.96.

Table S3.96 Proposed recoding of the study-specific variables in the GUN cohort survey wave 1.

Original response levels	Recoded response levels
___>1 times per day (1)	More than once a day (1)
__= 1 times per day (1)	Once a day (2)
___> 5 times per week (2)	
___< 5 times per week (2)	Once a week (3)
Less than weekly (88)	Once a month (4)
No longer fed (89)	Not at all (0)
RF (98)	Missing (999)
DK (99)	

q) GUN cohort survey waves 2 and 5:

- Completely matching construct (a food frequency questionnaire was used)
- Partially matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.97.

Table S3.97 Proposed recoding of the study-specific variables in the GUN cohort survey waves 2 and 5.

Original response levels	Recoded response levels
None (1)	Not at all (0)
1 per day (2)	Once a day (2)
2 per day (3)	More than once a day (1)
3 per day (4)	
4+ per day (5)	
1-2 per week (6)	Once a week (3)
3-4 per week (7)	
5-6 per week (8)	Once a day (1)
1 per month (9)	Once a month (4)
2-3 per month (10)	
Ref	Missing (999)
DK	
	Missing (999)

37) <u>Harmonised variables: DIET_FreeSugarsFoods_SNACK_BTW_MEALS:</u>

a) GUS cohort survey wave 2:

- Partially matching construct (the respondents were asked "if the child is hungry between meals, what would study child be most likely to eat.....?"
- In completely matching response levels and coding

The proposed transformation of the study-specific variable, Table S3.98.

Table S3.98 Proposed recoding of the study-specific variables in the GUS cohort survey wave 2.

Original response levels	Recoded response levels
Never hungry between meals (MbFsnk95)	No (0)
Savoury snack (e.g., nuts, crackers, cheese portions (MbFsnk21)	
Fresh, dried, or tinned fruit (MbFsnk25)	
Other (MbFsnk94)	
Crisps (MbFsnk22)	Yes (1)
Breakfast cereal (MbFsnk23)	
Cakes, biscuits (MbFsnk24)	
Sweets or chocolate (MbFsnk27)	
Bread, toast or similar (e.g., crumpets, muffins (MbFsnk26)	
	Missing (999)

b) MCS cohort survey waves 3 and 4:

- Partially matching construct (the respondents were asked "if the child eats between meals, what does the study child eat.....?"
- In completely matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.99.

Table S3.99 Proposed recoding of the study-specific variables in the MCS cohort survey waves 3 and 4.

Original response levels	Recoded response levels
Crisps and other similar snacks (1)	Yes (1)
Breakfast cereal (2)	
Cakes and sweet biscuits (3)	
Bread, toast or similar (e.g. crumpets, muffins (6)	
Sweets and chocolates (8)	
Fruit (fresh, dried, or tinned) (4)	No (0)
Vegetables (raw or cooked) (5)	
Crispbread, crackers, breadsticks, rice cakes etc. (7)	
Yoghurt, fromage frais etc. (9)	
Other dairy products like cheese or eggs (10)	
Other (95)	
	Missing (999)

38) Harmonised variable: DIET_FreeSugarsDrinks_SNACK_BTW_MEALS

a) MCS cohort survey waves 3 and 4:

- Partially matching construct (the respondents were asked "when the study child drinks between meals, what does he/she drink.....?"
- Incompletely matching response levels and coding

The proposed transformation of the study-specific variables, Table S3.100.

Table S3.100 Proposed recoding of the study-specific variables in the MCS cohort survey waves 3 and 4.

Original response levels	Recoded response levels
Sweetened drinks (e.g., cola, squash, sunny delight) (1)	Yes (1)
Artificially sweetened drinks (diet cola, sugar-free squash (2)	
Unsweetened or pure fruit juice (3)	
Water-tap or bottled, still or sparkling (4)	
Hot drinks e.g., tea or coffee (5)	
Milk (6)	No (0)
Milkshakes, hot chocolate, and other drinks made with milk (7)	
Other (95)	
	Missing (999)

In the GUS sweep 3 the interviewer were instructed to “include only whole packets of sweets or chocolates/chocolate bar, not individual sweets”

Harmonisation status summary for the dietary behaviour variables.

Table S3.101 Harmonisation status summary for the dietary behaviour variables across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
DIET_SWEETS_CHOCOLATE	I C C C C	C C C C	I C C I C I I C I I	I C C C C C C C	I C C C C C C C	C C I I C I I I	I I I I I I I	29 (58)
DIET_DRINKS_NonDiet	I C C C C	C C C C	I C C I C I I C I I	I C C C C C C C	I C C C C C C C	I C I I C I I I	I I I I C C C	31 (62)
DIET_DRINKS_Diet	I C C C C	C C C C	I I I I C I I I I I	I C C C C C C C	I C C C C C C C	I C I I C I I I	I I I I C C C	28 (56)
DIET_CRISPS_SAVOURY	I C C C C	C C C C	I C C I C I I C I I	I C C C C C C C	I C C C C C C C	C C I I C I I I	I I I I I I I	29 (58)
DIET_FRUIT_JUICE	I I C I C	C I C C	I I I I I I I I I I	I C C C C C C C	I C C C C C C C	C C I I C I I I	I I I I I I I	22 (44)
DIET_FreeSugarsFoods_SNACKING	I I I I I	I I I I	I C I I C I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I C C I I I	4 (8)
DIET_FreeSugarsDrinks_SNACKING	I I I I I	I I I I	I I I I I I I I I	I I I I I I I	I I I I I I I	I I I I I I I	I I C C I I I	2 (4)

Domain: General Health, Weight status and Diet
Construct: Parent/Self-perceived general health

Assessment characteristics of the Parent/Self-perceived general health construct

Table S3.102 Assessment characteristics of the self-reported general health use construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Parent/Self-perceived general health
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.103 Cohort survey waves with Parent/Self-perceived general health questions included in the survey questionnaires.

Cohort survey	Survey waves
GUI infant	1, 2, 3, 4, 5
GUI child	1, 2, 3, 4
GUS	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
LSAC B	1, 2, 3, 4, 5, 6, 7, 8
LSAC K	1, 2, 3, 4, 5, 6, 7, 8
GUN	1, 2, 5, 8
MCS	3, 4, 5, 6, 7

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.104 Proposed harmonised/DataSchema/core variable for the Parent/Self-perceived general health construct.

Name	Label	Description/coding
GEN_HEALTH	Study child's current health or health in general	Indicator of how the respondents (PCG or the study child themselves) rate the study child's health in general. *Coding*: • Excellent (1) • Very good (2) • Good (3) • Fair (4) • Poor (5) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.105 Cohort survey waves with survey variables having an exact match or that could be transformed to proposed harmonised variables.

Variable name	Study (wave)
GEN_HEALTH	GUI infant (1, 2, 3, 4, 5); GUI child (1, 2, 3, 4); GUS (1, 2, 3, 4, 5, 6, 7, 8, 9, 10); LSAC B (1, 2, 3, 4, 5, 6, 7, 8); LSAC K (1, 2, 3, 4, 5, 6, 7, 8); GUN (1, 2, 5, 8); and MCS (3, 4, 5, 6, 7)

Study Specific Notes:

39) Harmonised Variable: GEN_HEALTH

a) GUI infant cohort wave 1, 2, 3, 4 and 5:

- Completely matching construct
- Completely un-matching response and coding

The proposed transformation of the study-specific variables, Table S3.106.

Table S3.106 Proposed recoding of the study-specific variables in the GUI infant cohort survey waves 1, 2, 3, 4 and 5.

Original response levels	Recoded response levels
Very healthy, no problems (1)	Excellent (1)
Healthy, but a few minor problems (2)	Good (3)
Sometimes quite ill (3)	Fair (4)
Almost always unwell (4)	Poor (5)
	Missing (999)

b) GUI child cohort wave 1, 2 and 3:

- Partially matching construct
- Completely un-matching response and coding

The proposed transformation of the study-specific variables, Table S3.107.

Table S3.107 Proposed recoding of the study-specific variables in the GUI child cohort survey waves 1, 2 and 3.

Original response levels	Recoded response levels
Very healthy, no problems (1)	Excellent (1)
Healthy, but a few minor problems (2)	Good (3)
Sometimes quite ill (3)	Fair (4)
Almost always unwell (4)	Poor (5)
	Missing (999)

c) GUI child cohort wave 3 and 4 (Self-reported by the study child):

- Completely matching construct
- Completely matching response and coding

d) GUS cohort wave 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10:

- Complete matching construct
- Partial matching response and coding

The proposed transformation of the study-specific variables, Table S3.108.

Table S3.108 Proposed recoding of the study-specific variables in the GUS child cohort survey waves (1 to 10).

Original response levels	Recoded response levels
Very good (1)	Very good (2)
Good (2)	Good (3)
Fair (3)	Fair (4)
Bad (4)	Poor (5)
Very bad (5)	Poor (5)
	Missing (999)

e) LSAC B and K cohort survey waves 1, 2, 3, 4, 5, 6, 7 and 8; GUN cohort survey waves 1, 2, 5 and 8; MCS cohort survey waves 3, 4, 5, 6 and 7:

- Completely matching construct
- Completely matching response and coding

Harmonisation status summary for the Parent/Self-perceived general health variables across the survey waves

Table S3.109 Harmonisation status summary for the parent/self-perceived general health variable. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
GEN_HEALTH	C C C C C	C C C C	C C C C C C C C C	C C C C C C C C	C C C C C C C C	C C I I C I I C	I I C C C C C	44 (88)

Domain: General health, Weight status and Diet
Construct: Parent/Self-perceived weight status

Assessment characteristics of the Parent/Self-perceived weight status construct

Table S3.110 Assessment characteristics of the Parent/Self-perceived weight status construct.

Respondent	Primary care giver (usually parents), Study child.
Construct	Parent/Self-perceived weight status
Timing	Age of the study child, number of waves of assessment

Cohort surveys (waves) with relevant data:

Table S3.111 Cohort surveys waves with parent/self-perceived weight status construct questions included in the survey questionnaires.

Cohort survey	Survey waves
GUI infant	2, 3, 5
GUI child	1, 2, 3, 4
LSAC B	1, 2, 3, 4, 5, 6, 7, 8
LSAC K	1, 2, 3, 4, 5, 6, 7, 8
GUN	1, 2, 5, 8
MCS	6, 7

Proposed Harmonised/DataSchema Variables/Core variables:

Table S3.112 Proposed harmonised/DataSchema/core variables for the self-perceived weight status construct.

Name	Label	Description/coding
SUBJ_WEIGHT_PCG	Subjective assessment of weight by PCG	Indicator of how the PCG describes the study child's weight *Coding*: • Underweight (1) • Normal weight (2) • Somewhat overweight (3) • Very overweight (4) • Missing (999)
SUBJ_WEIGHT_CHILD	Subjective assessment of weight by the study child	Indicator of how the study child describe their weight status. *Coding*: • Underweight (1) • Normal weight (2) • Somewhat overweight (3) • Very overweight (4) • Missing (999)

Studies/waves with an assigned complete harmonisation status:

Table S3.113 Cohort survey waves with survey variables having an exact match or that could be transformed to proposed harmonised variables.

Variable name	Study (wave)
SUBJ_WEIGHT_PCG	GUI infant (2, 3, 5); GUI child (1, 2); LSAC B (1, 2, 3, 4, 5, 6, 7, 8); LSAC K (1, 2, 3, 4, 5, 6, 7); GUN (1, 2, 5, 8)
SUBJ_WEIGHT_CHILD	GUI infant (5); GUI child (1, 2, 3, 4); LSAC B (8); LSAC K (6, 7, 8); and MCS (6, 7)

Study Specific Notes:

40) Harmonised Variable: SUBJ_WEIGHT_PCG

a) GUI infant cohort survey waves 2, 3 and 5:

- Complete matching construct
- Completely matching response and coding

b) GUI child cohort survey waves 1 and 2:

- Completely matching construct
- Partially matching response and coding

The proposed transformation of the study-specific variables, Table S3.114.

Table S3.114 Proposed recoding of the study-specific variables in the GUI child cohort survey waves 1 and 2.

Original response levels	Recoded response levels
Very underweight (1)	Underweight (1)
Moderately underweight (2)	Underweight (1)
Slightly underweight (3)	Underweight (1)
About the right weight (4)	Normal weight (2)
Slightly overweight (5)	Somewhat overweight (3)
Moderately overweight (6)	Somewhat overweight (3)
Very overweight (7)	Very overweight (4)
Don't know	Missing (999)

c) LSAC B cohort survey waves 1, 2, 3, 4, 5, 6, 7 and 8; LSAC K cohort survey waves 1, 2, 3, 4, 5, 6 and 7:

- Complete matching construct
- Completely matching response and coding

d) GUN cohort survey waves 1, 2, 5 and 8:

- Completely matching construct
- Partially matching response and coding

The proposed transformation of the study-specific variables, Table S3.115.

Table S3.115 Proposed recoding of the study-specific variables in the GUN cohort survey waves 1, 2, 5 and 8.

Original response levels	Recoded response levels
Very underweight (1)	Underweight (1)
Somewhat underweight (2)	Underweight (1)
Normal weight (3)	Normal weight (2)
Somewhat overweight (4)	Somewhat overweight (3)
Very overweight (5)	Very overweight (4)
Don't know (99)	Missing (999)
Prefer not to say (98)	Missing (999)

41) <u>Harmonised Variable: SUBJ_WEIGHT_CHILD</u>

a) GUI infant cohort survey wave 5 and GUI child cohort waves 3 and 4 (Self-reported by the study child):

- Complete matching construct
- Completely un-matching response and coding

The proposed transformation of the study-specific variables, Table S3.116.

Table S3.116 Proposed recoding of the study-specific variables in the GUI infant cohort survey wave 5; GUI child cohort survey waves 3 and 4.

Original response levels	Recoded response levels
Very skinny (1)	Underweight (1)
A bit skinny (2)	Underweight (1)
Just the right size (3)	Normal weight (2)
A bit overweight (4)	Somewhat overweight (3)
Very overweight (5)	Very overweight (4)
	Missing (999)

b) LSAC B cohort survey wave 8; LSAC K cohort survey waves 6, 7 and 8:

- Completely matching construct
- Partially matching response and coding

The proposed transformation of the study-specific variables, Table S3.117.

Table S3.117 Proposed recoding of the study-specific variables in the LSAC B cohort survey wave 8; LSAC K cohort survey waves 6, 7 and 8.

Original response levels	Recoded response levels
Very underweight (1)	Underweight (1)
Somewhat underweight (2)	Underweight (1)
About the right weight (3)	Normal weight (2)
Somewhat overweight (4)	Somewhat overweight (3)
Very overweight (5)	Very overweight (4)
	Missing (999)

c) MCS cohort survey waves 6 and 7:

- Completely matching construct
- Slightly different response levels

The proposed transformation of the study-specific variables, Table S3.118.

Table S3.118 Proposed recoding of the study-specific variables in the MCS cohort survey waves 6 and 7.

Original response levels	Recoded response levels
Underweight (1)	Underweight (1)
About the right weight (2)	Normal weight (2)
Slightly overweight (3)	Somewhat overweight (3)
Very overweight (4)	Very overweight (4)
	Missing (999)

Harmonisation status summary for the parent/self-perceived weight status

Table S3.119 Harmonisation status summary for the Self-reported weight status across the survey waves. I: Incomplete; C: Complete.

Core Variable	GUI infant	GUI child	GUS	LSAC B	LSAC K	GUN	MCS	Variable with a complete status n (%)
SUBJ_WEIGHT_PCG	I C C I C	C C I I	I I I I I I I I I I	C C C C C C C C C	C C C C C C C I	C C I I C I I C	I I I I I I I	24 (48)
SUBJ_WEIGHT_CHILD	I I I I C	I I C C	I I I I I I I I I I	I I I I I I I C	I I I I I C C C	I I I I I I I I	I I I I I C C	13 (26)

Appendix C

Behavioural factors and socioeconomic (SES) measures

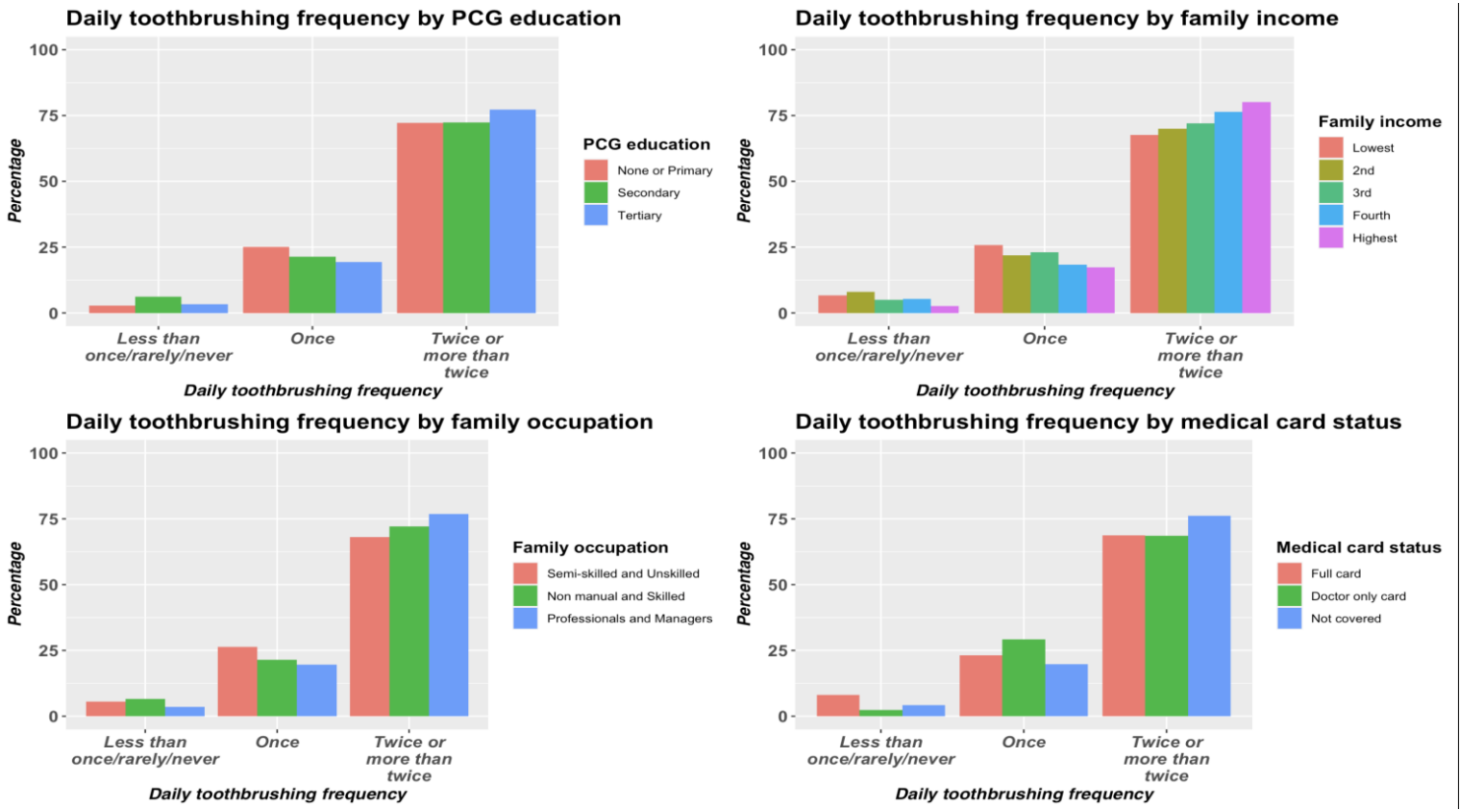


Figure S6.1 Study participants' daily tooth brushing frequency by socioeconomic status (SES) measures at 13 years of age.

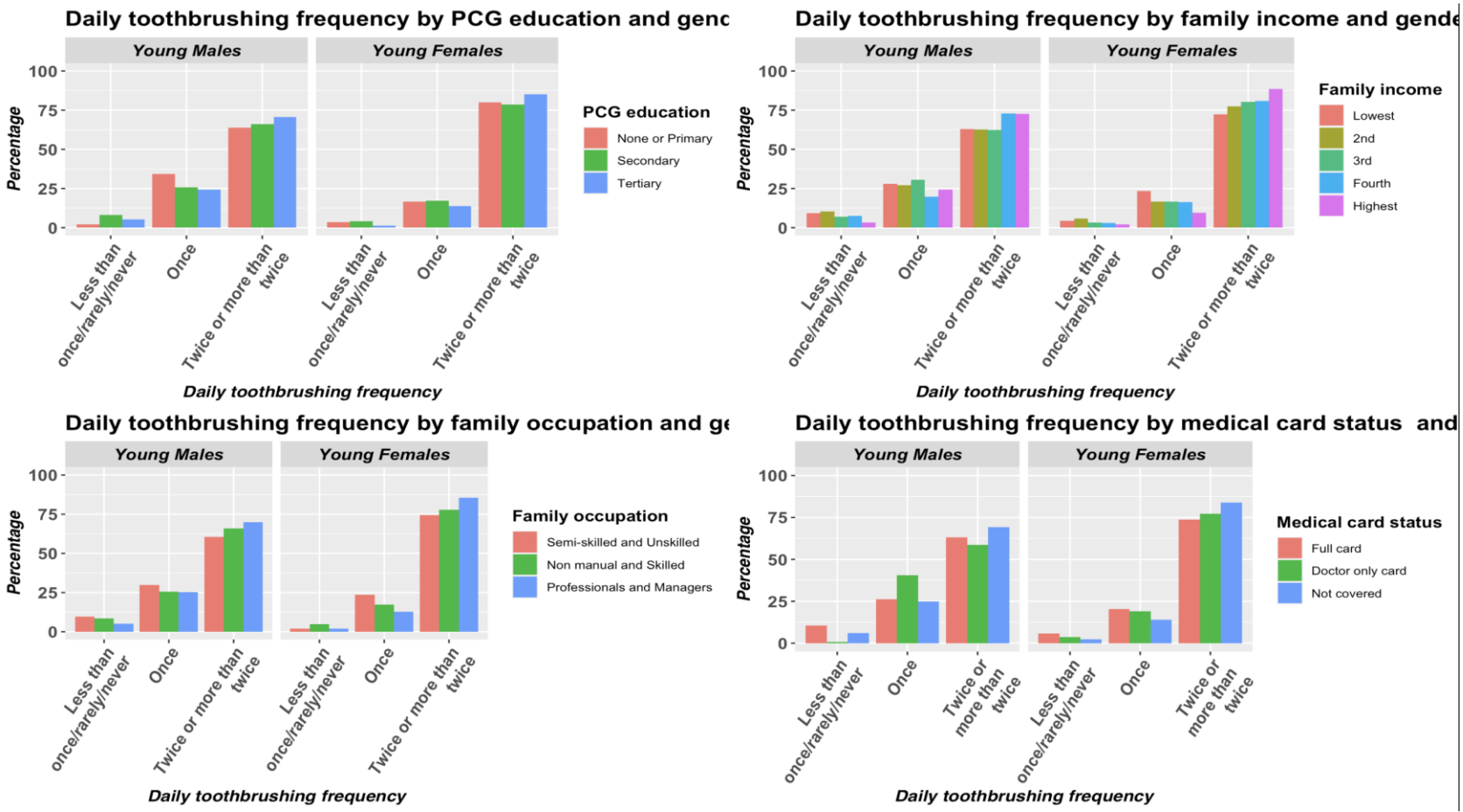


Figure S6.2 Study participants' daily tooth brushing frequency by socioeconomic status (SES) measures and gender at 13 years of age.

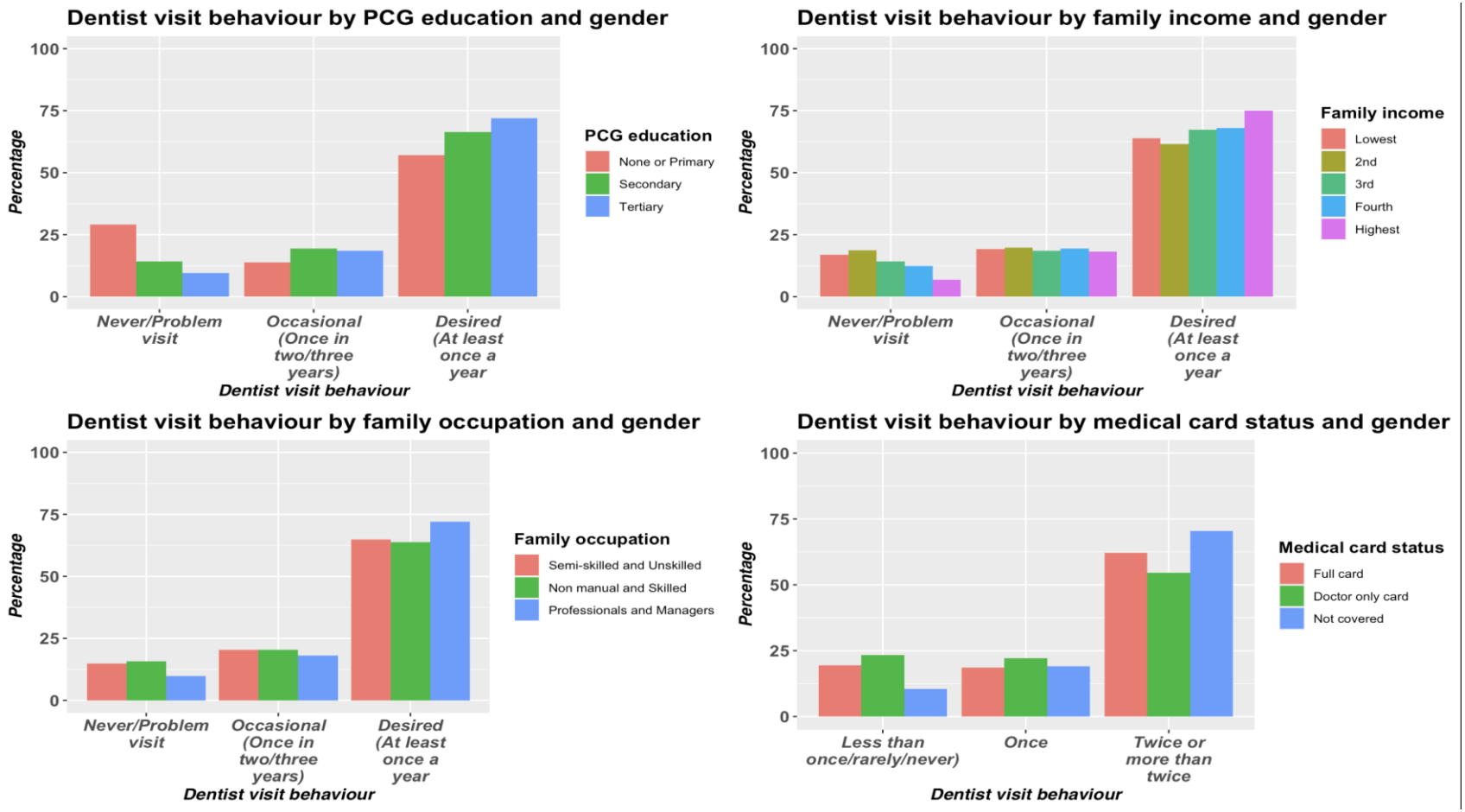


Figure S6.3 Study participants' dentist visit behaviours by socioeconomic status (SES) measures at 13 years of age.

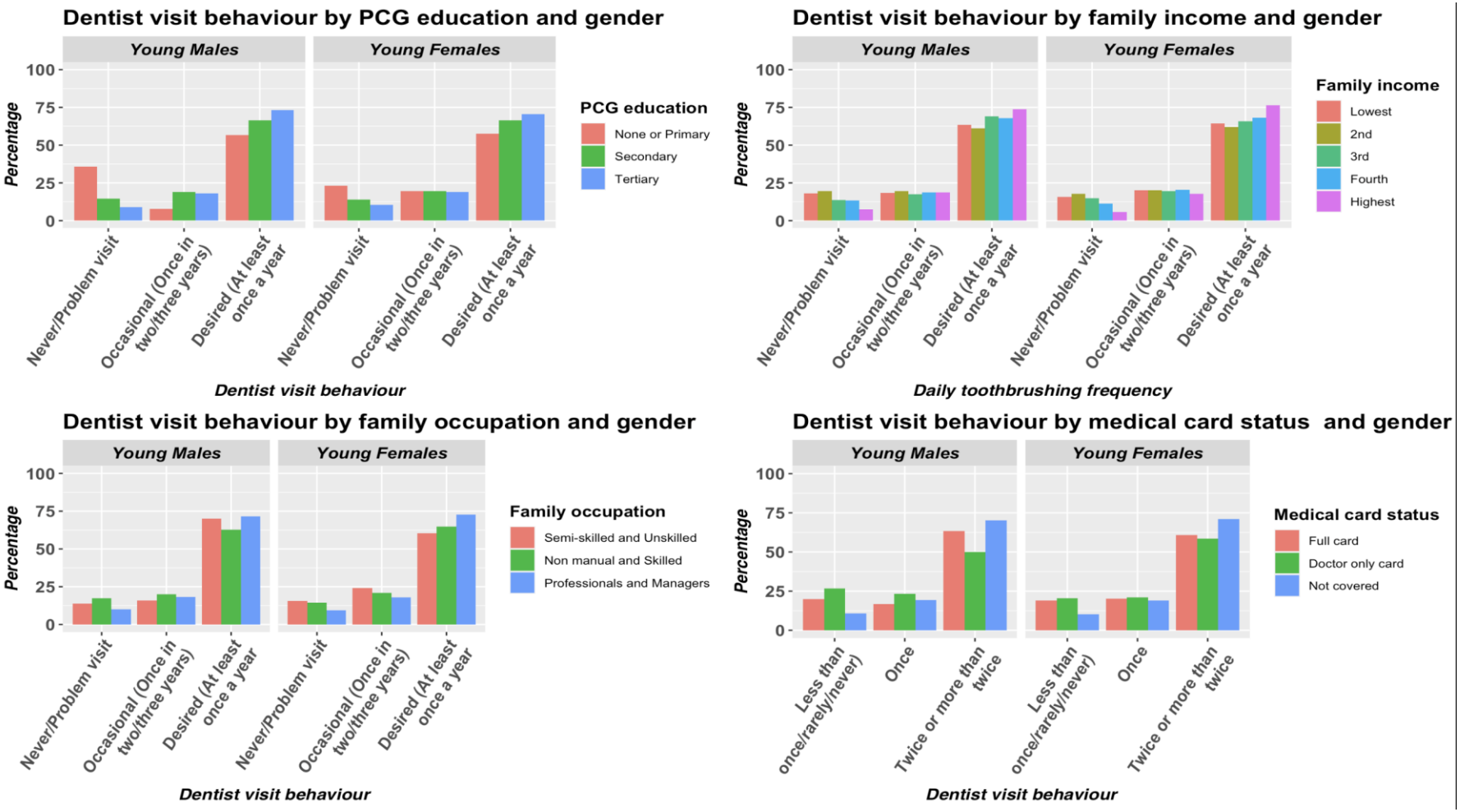


Figure S6.4 Study participants' dentist visit behaviours by socioeconomic status (SES) measures and gender at 13 years of age.

Figure S6.5 Study participants' sugary foods intake by socioeconomic status (SES) measures at 13 years of age.

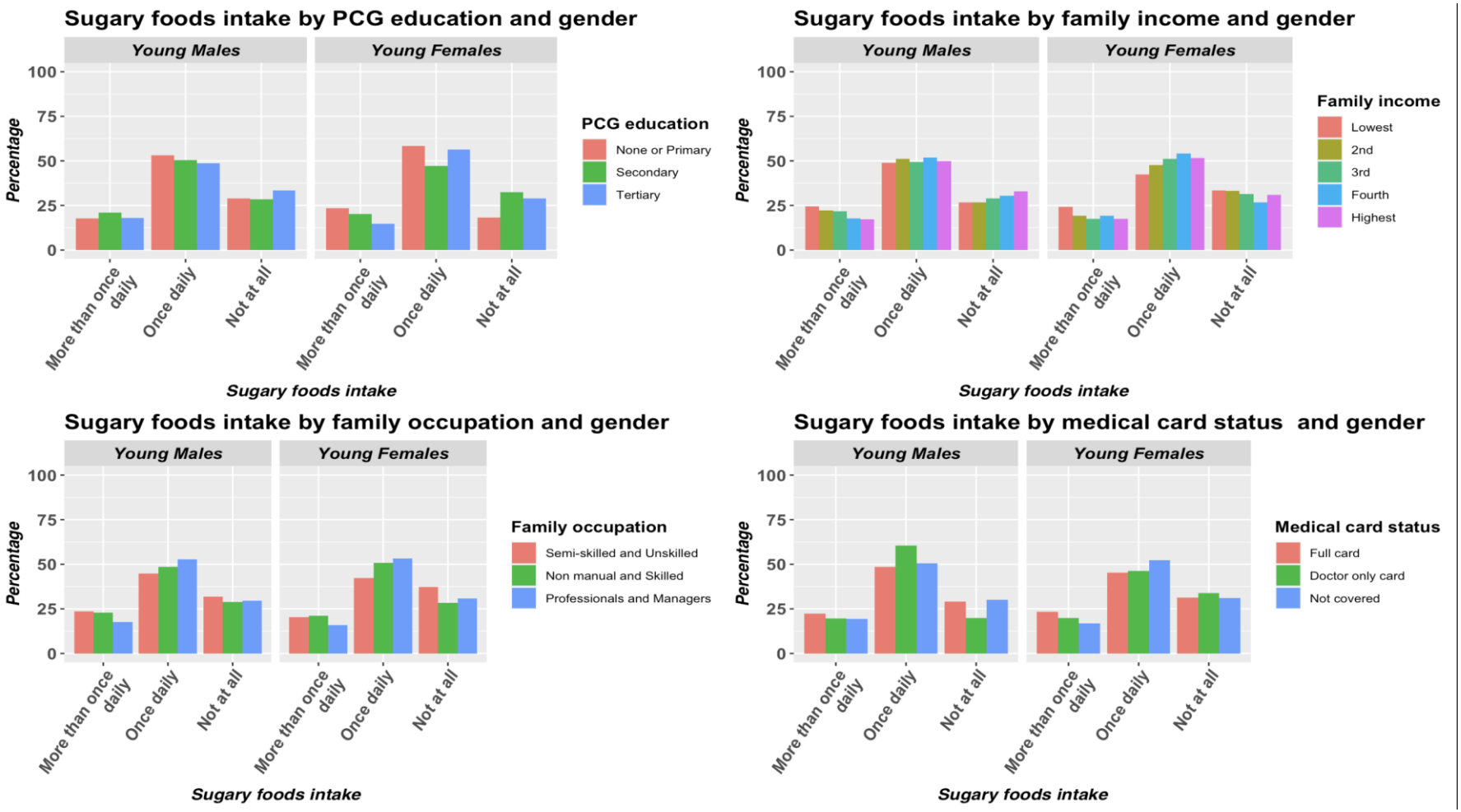


Figure S6.6 Study participants' sugary foods intake by socioeconomic status (SES) measures and gender at 13 years of age.

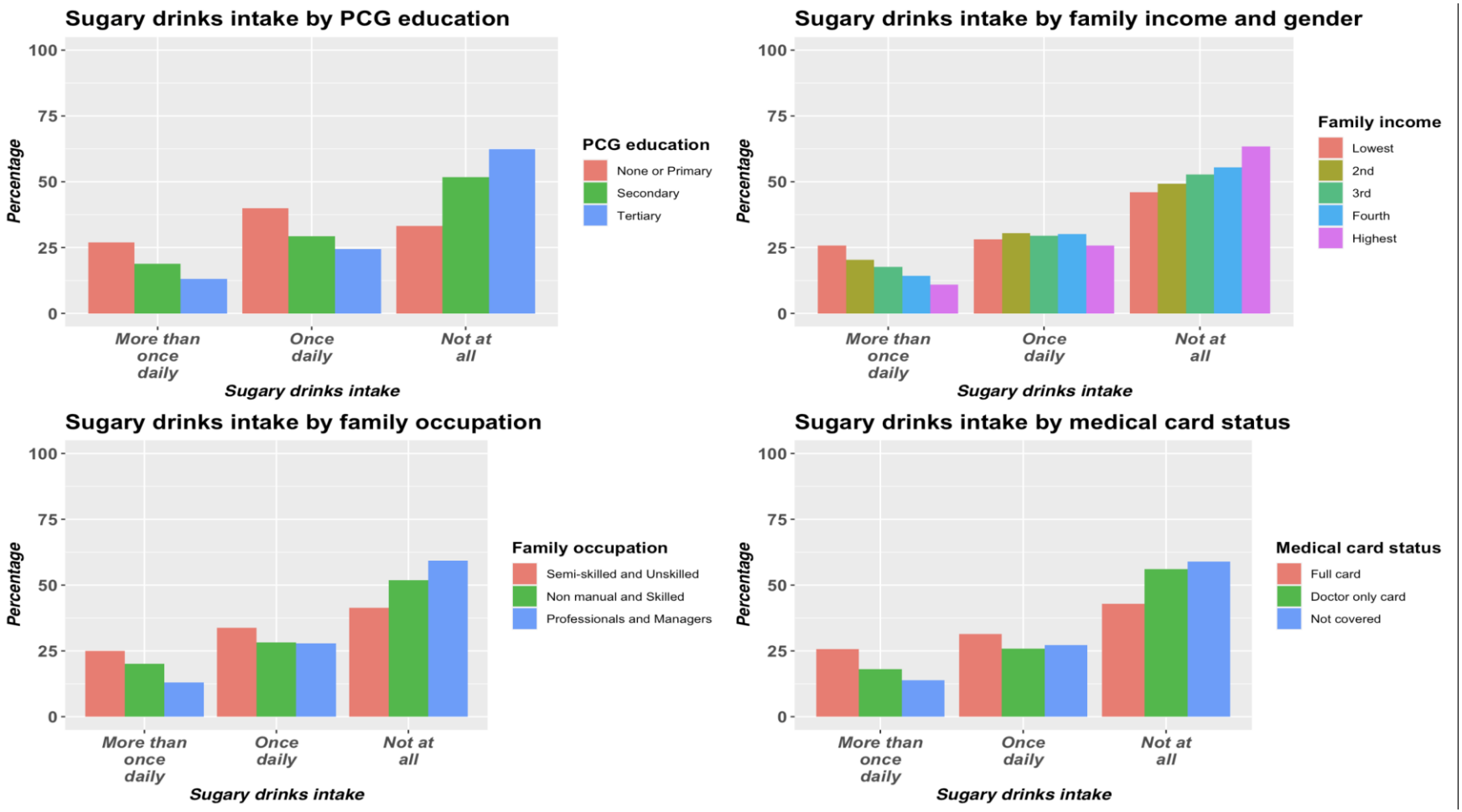


Figure S6.7 Study participants' sugary drinks intake by socioeconomic status (SES) measures at 13 years of age.

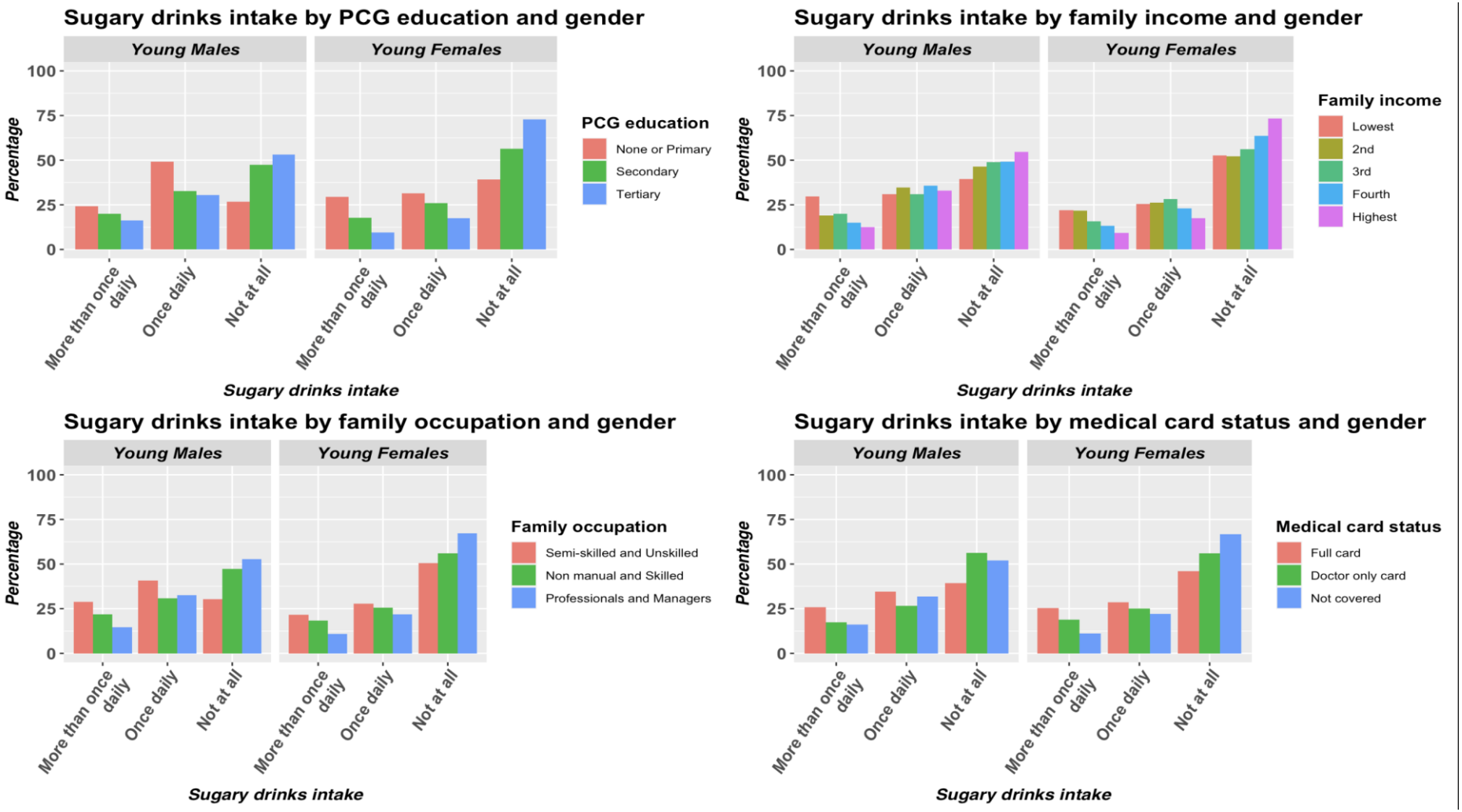


Figure S6.8 Study participants' sugary foods intake by socioeconomic status (SES) measures and gender at 13 years of age

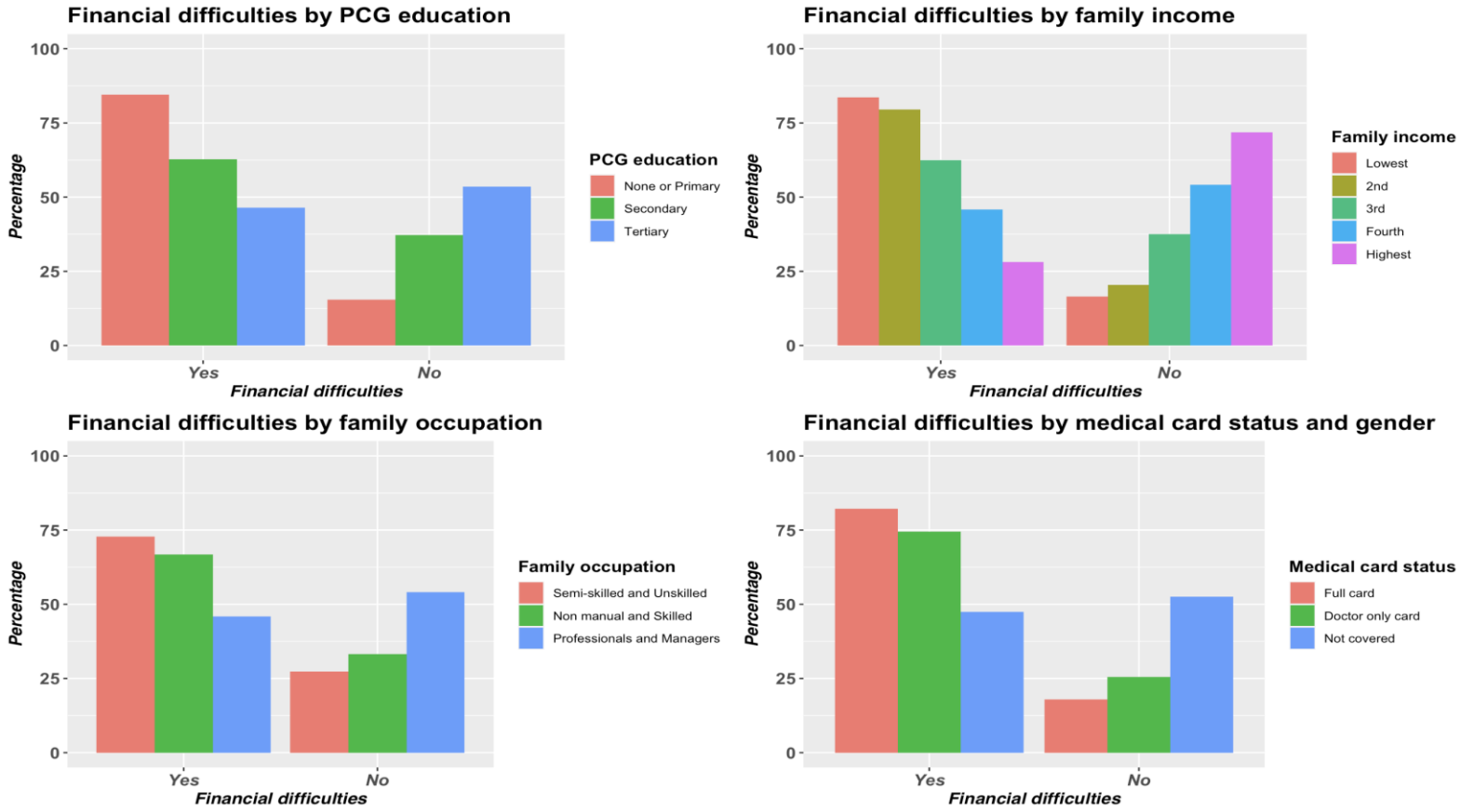


Figure S6.9 Household financial difficulties by socioeconomic status (SES) measures at 13 years of age.

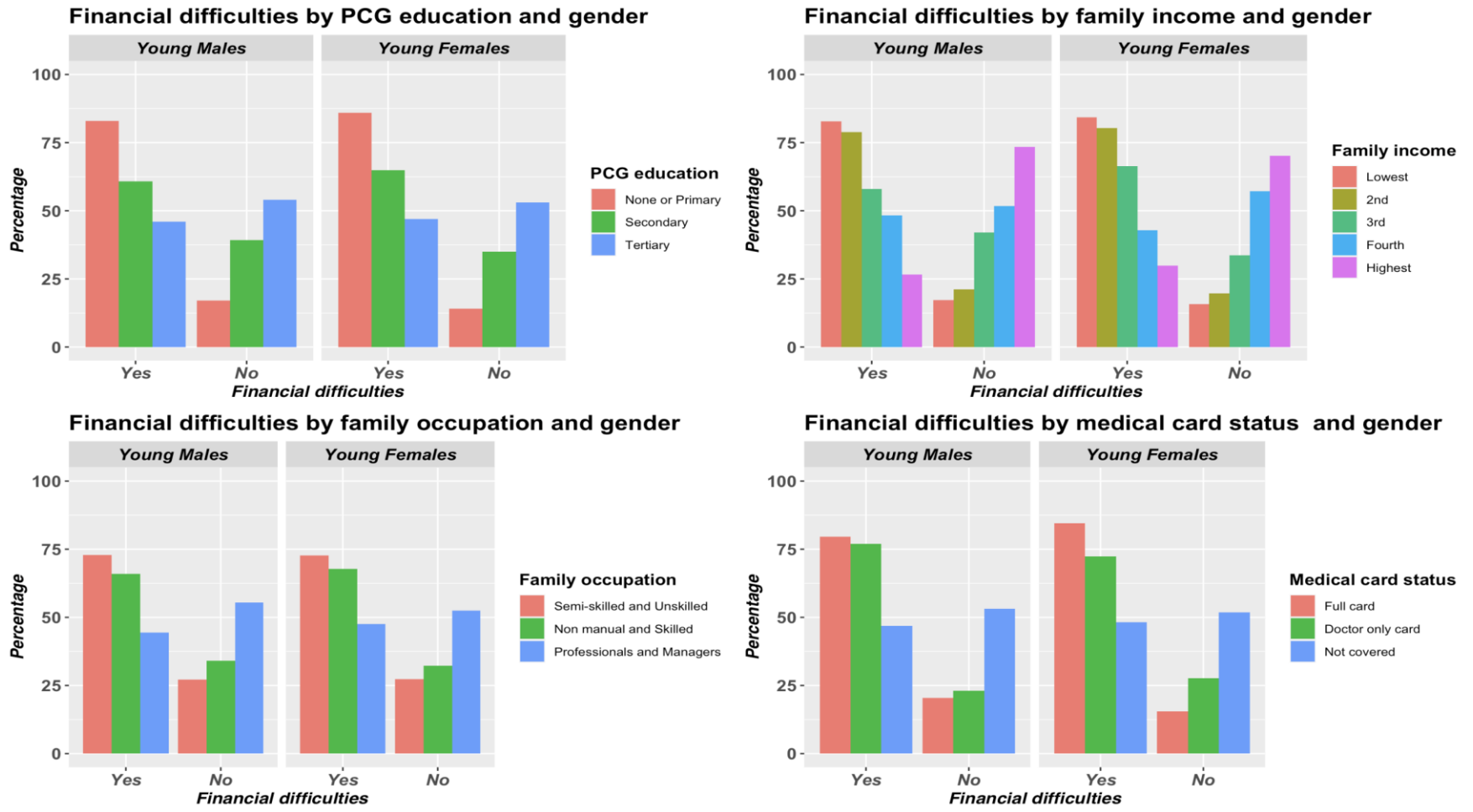


Figure S6.10 Household financial difficulties by socioeconomic status (SES) measures and gender at 13 years of age.

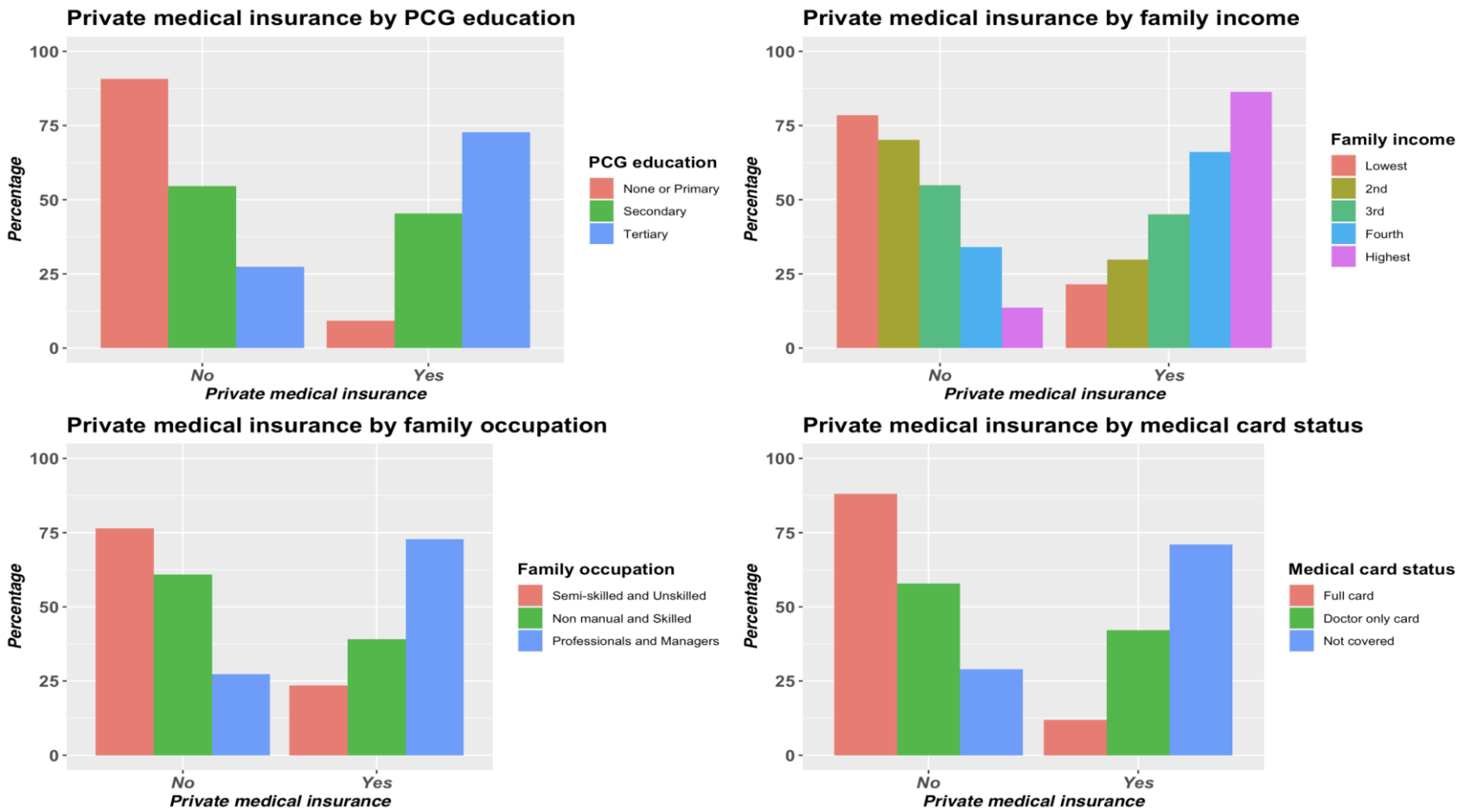


Figure S6.11 Study participants' private medical insurance cover by socioeconomic status (SES) measures at 13 years of age

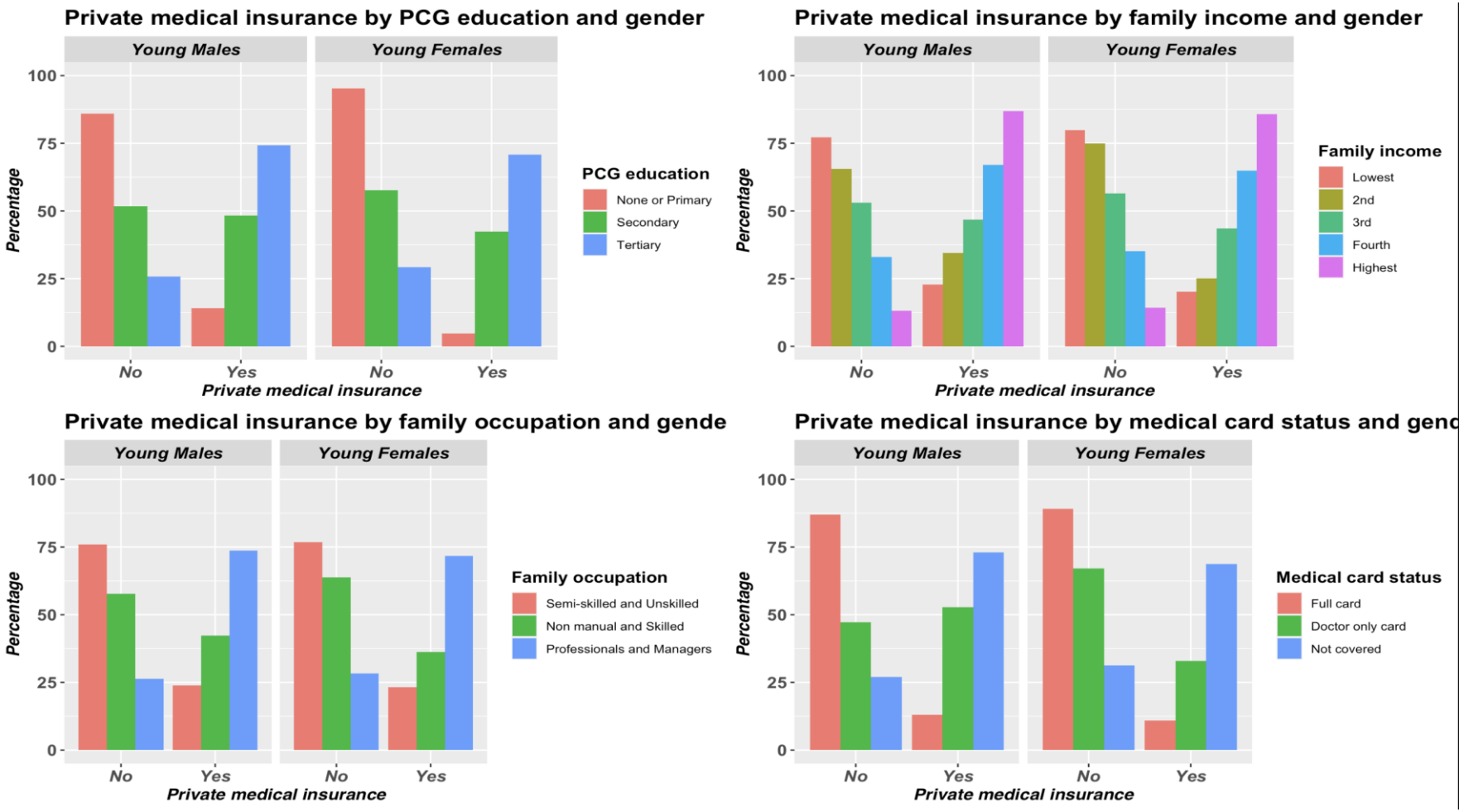


Figure S6.12 Study participants' private medical insurance cover by socioeconomic status (SES) measures and gender at 13 years of age.

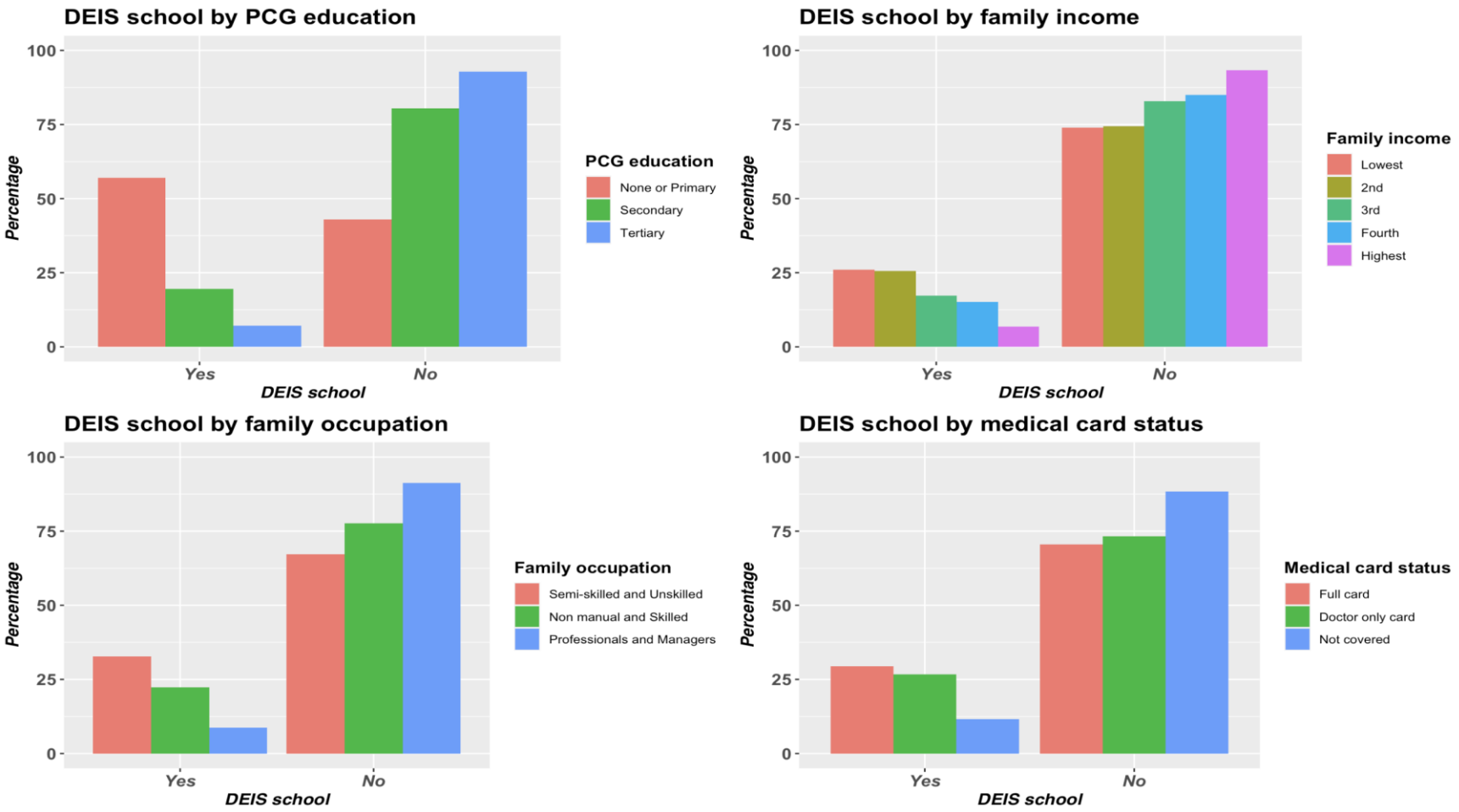


Figure S6.13 Study participants' DEIS school status by socioeconomic status (SES) measures at 13 years of age.

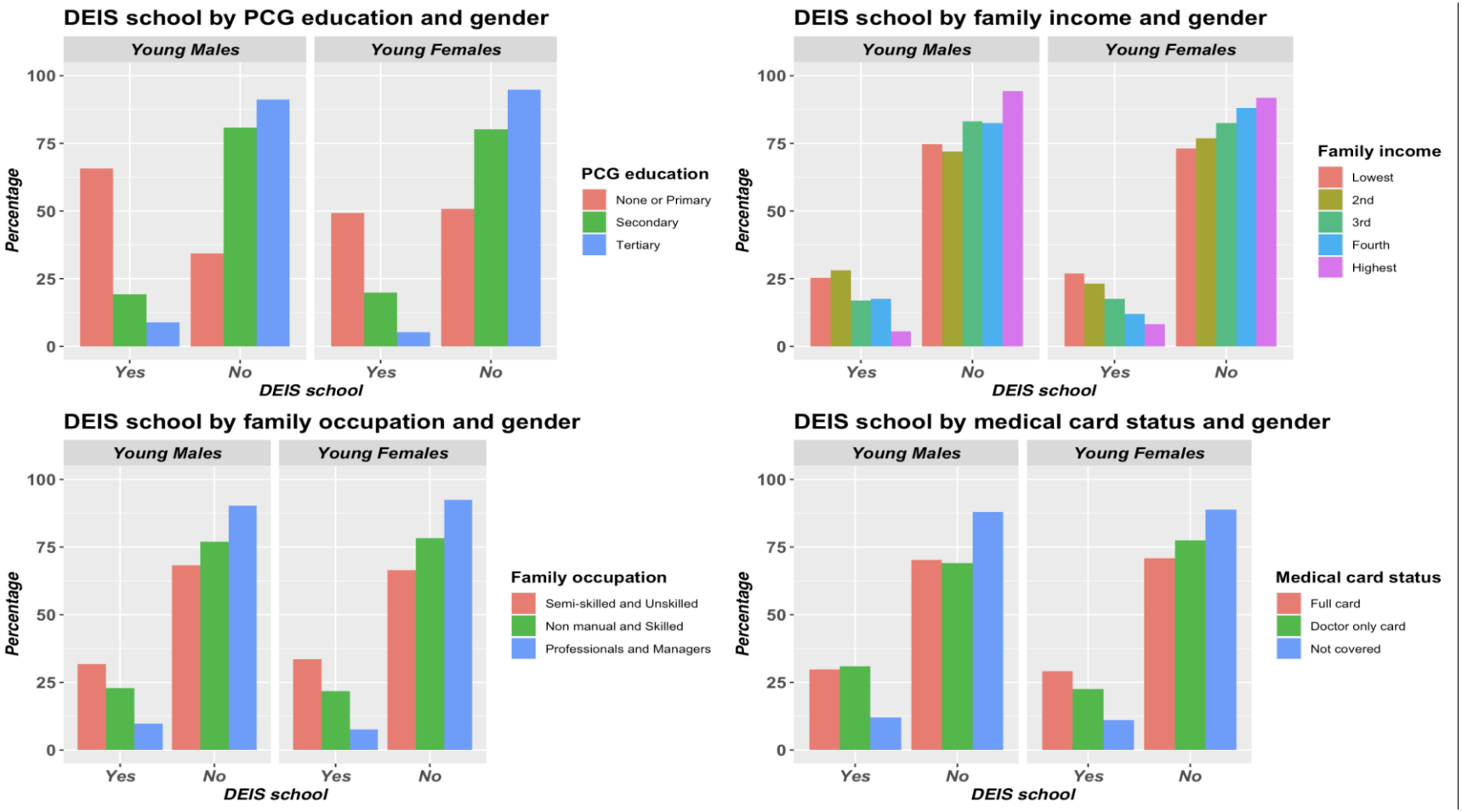


Figure S6.14 Study participants' DEIS school status by socioeconomic status (SES) measures and gender at 13 years of age.

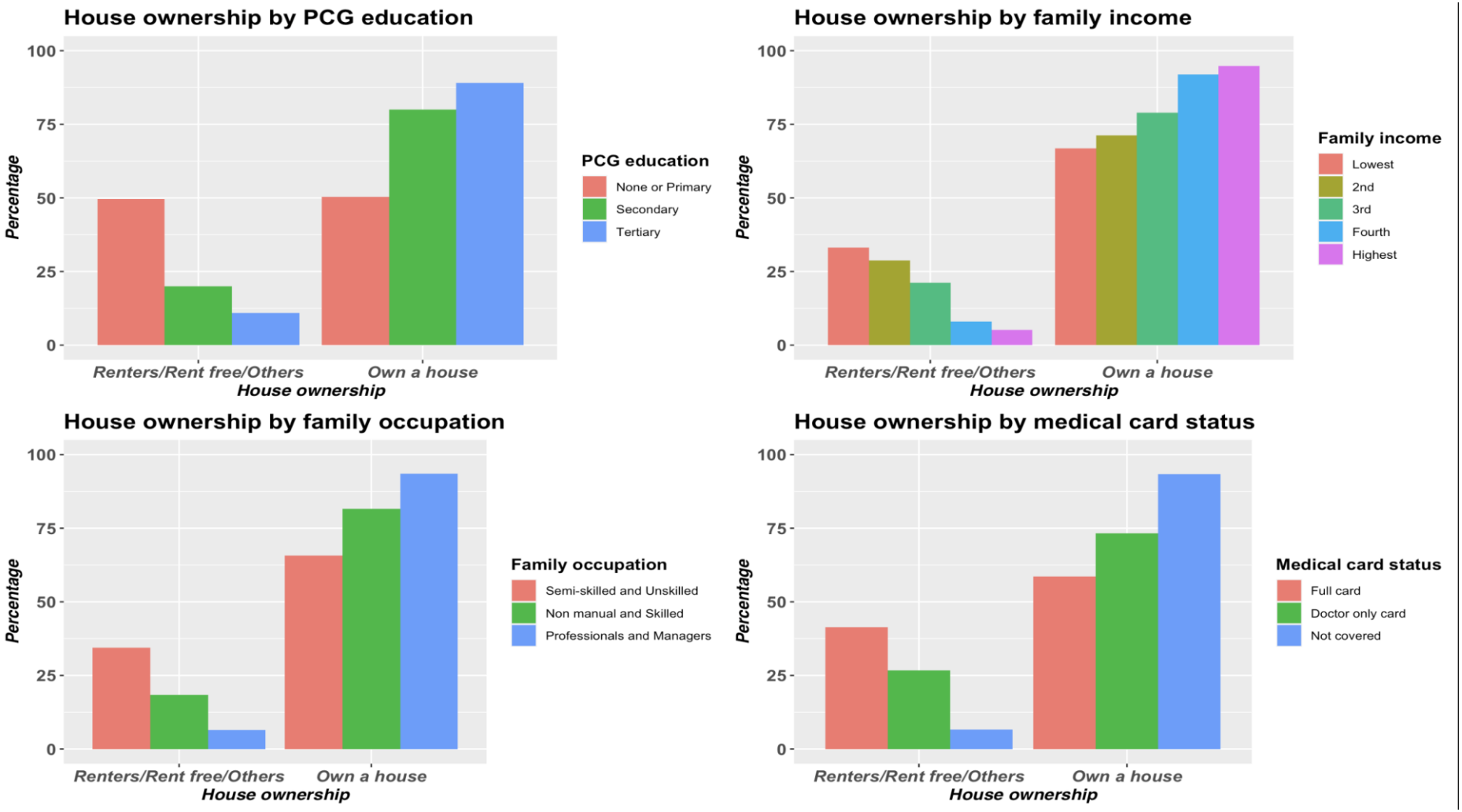


Figure S6.15 Households' house ownership status by socioeconomic status (SES) measures at 13 years of age.

Figure S6.16 Households' house ownership status by socioeconomic status (SES) measures and gender at 13 years of age.

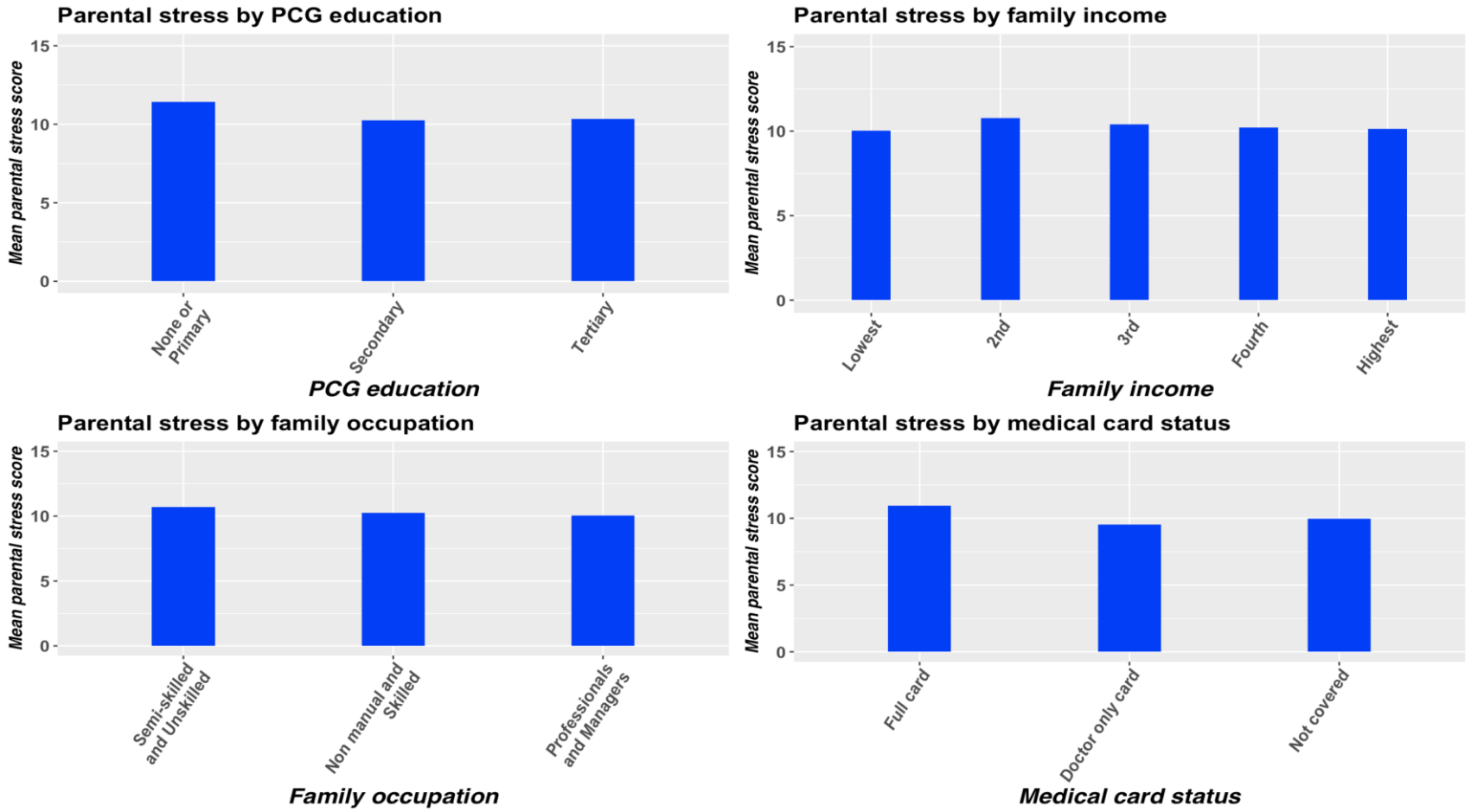


Figure S6.17 PCGs' mean parental stress scores by socioeconomic status (SES) measures at 13 years of age.

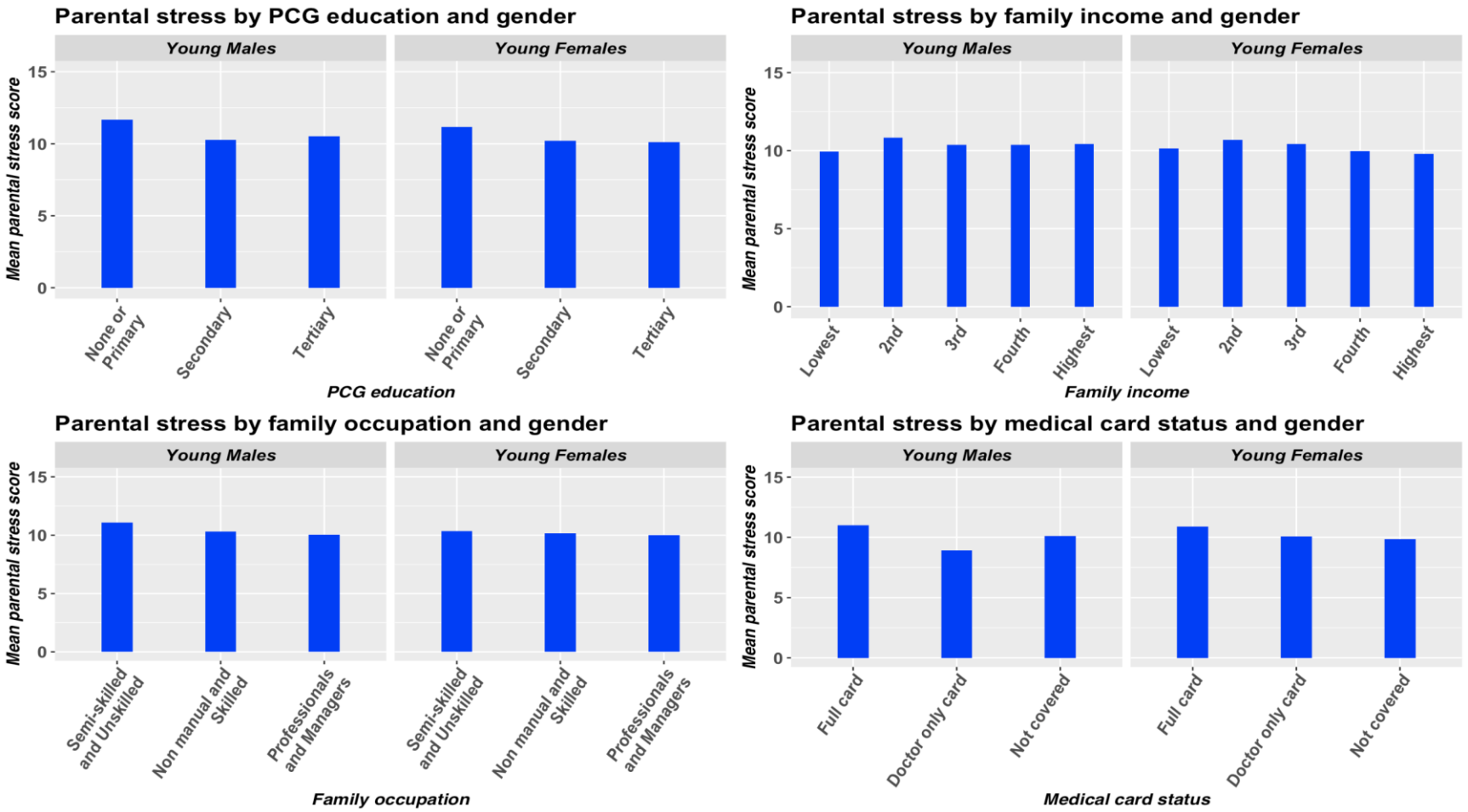


Figure S6.18 PCGs' mean parental stress scores by socioeconomic status (SES) measures and gender at 13 years of age.

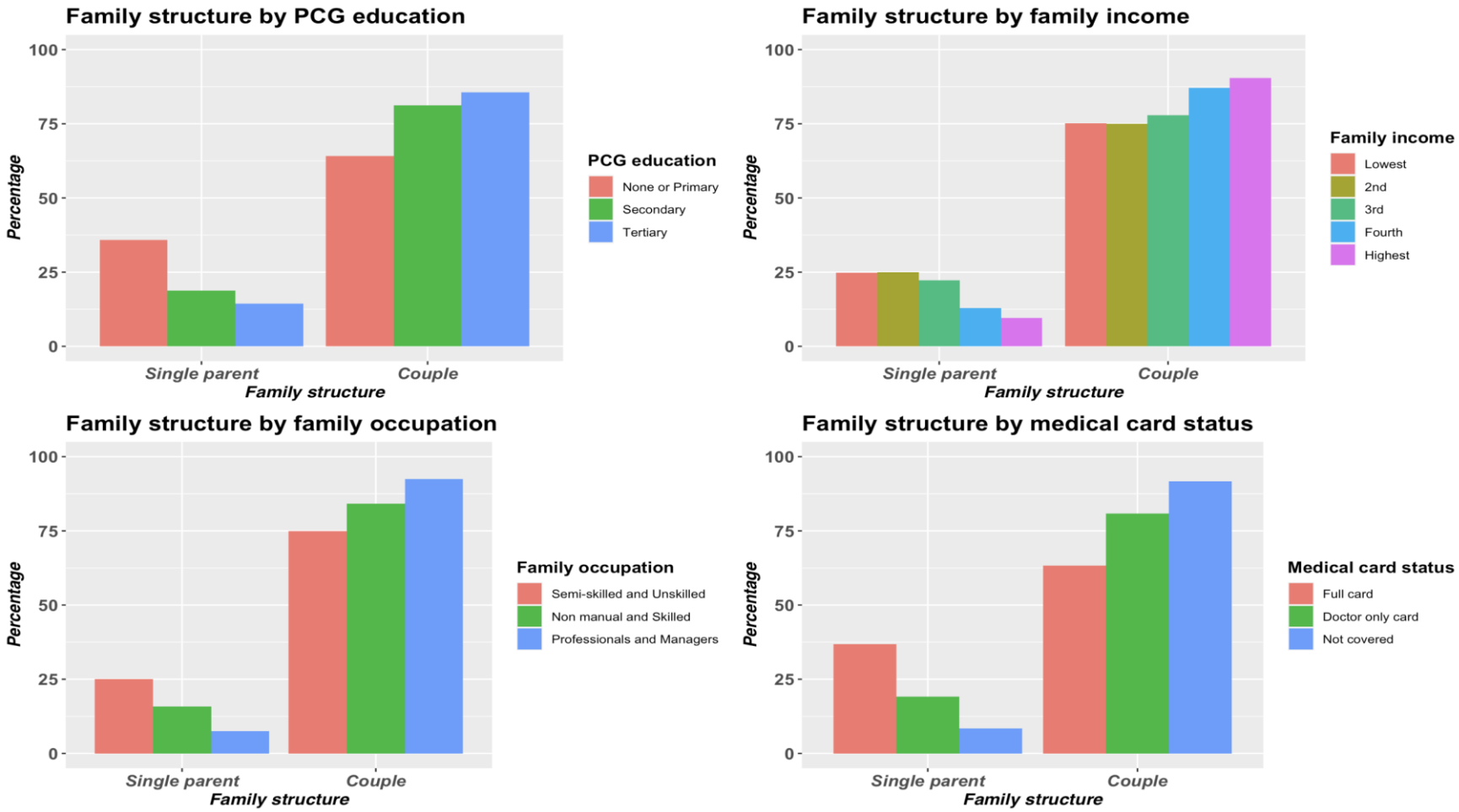


Figure S6.19 Households' family structure status by socioeconomic status (SES) measures at 13 years of age.

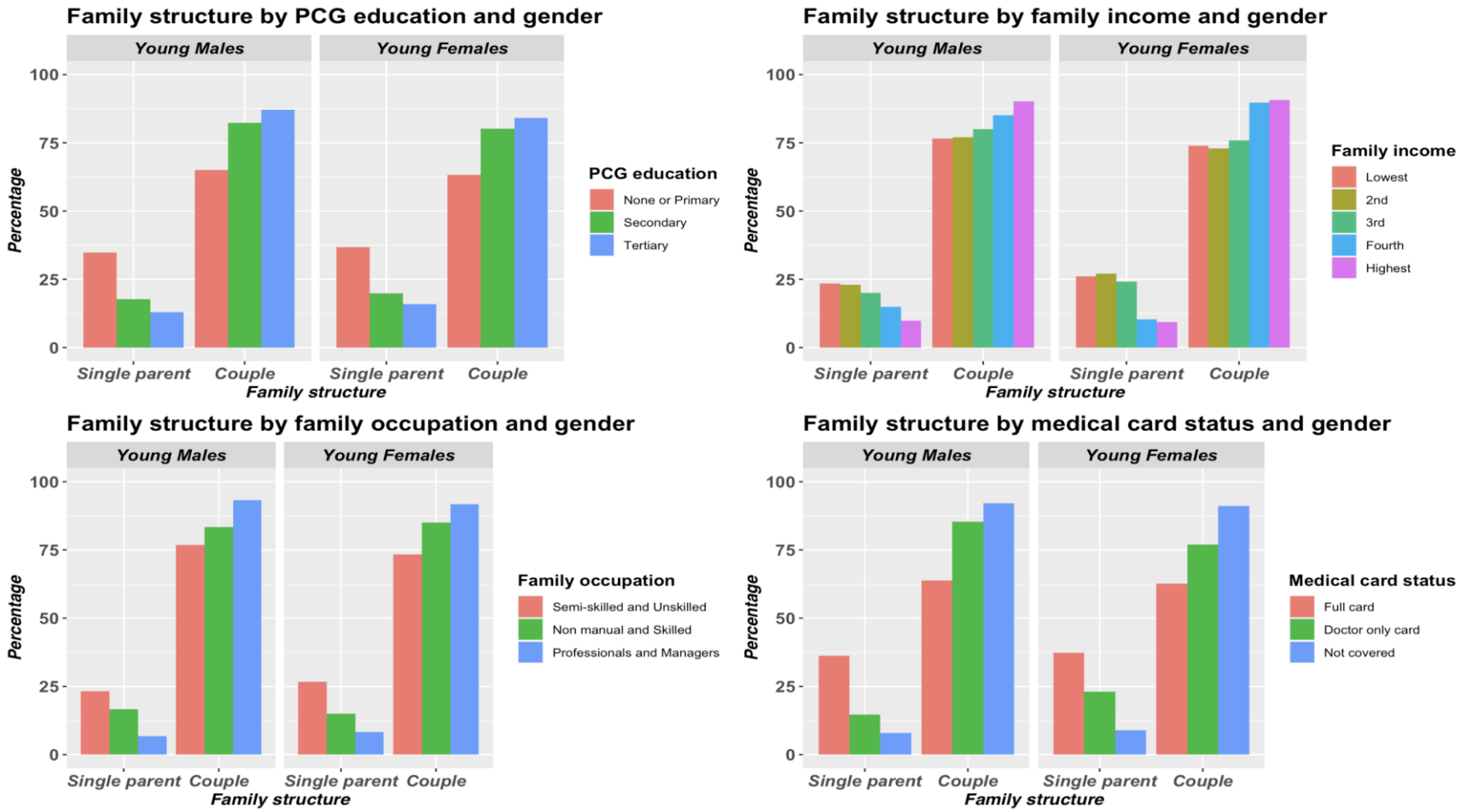


Figure S6.20 Households' family structure status by socioeconomic status (SES) measures and gender at 13 years of age.

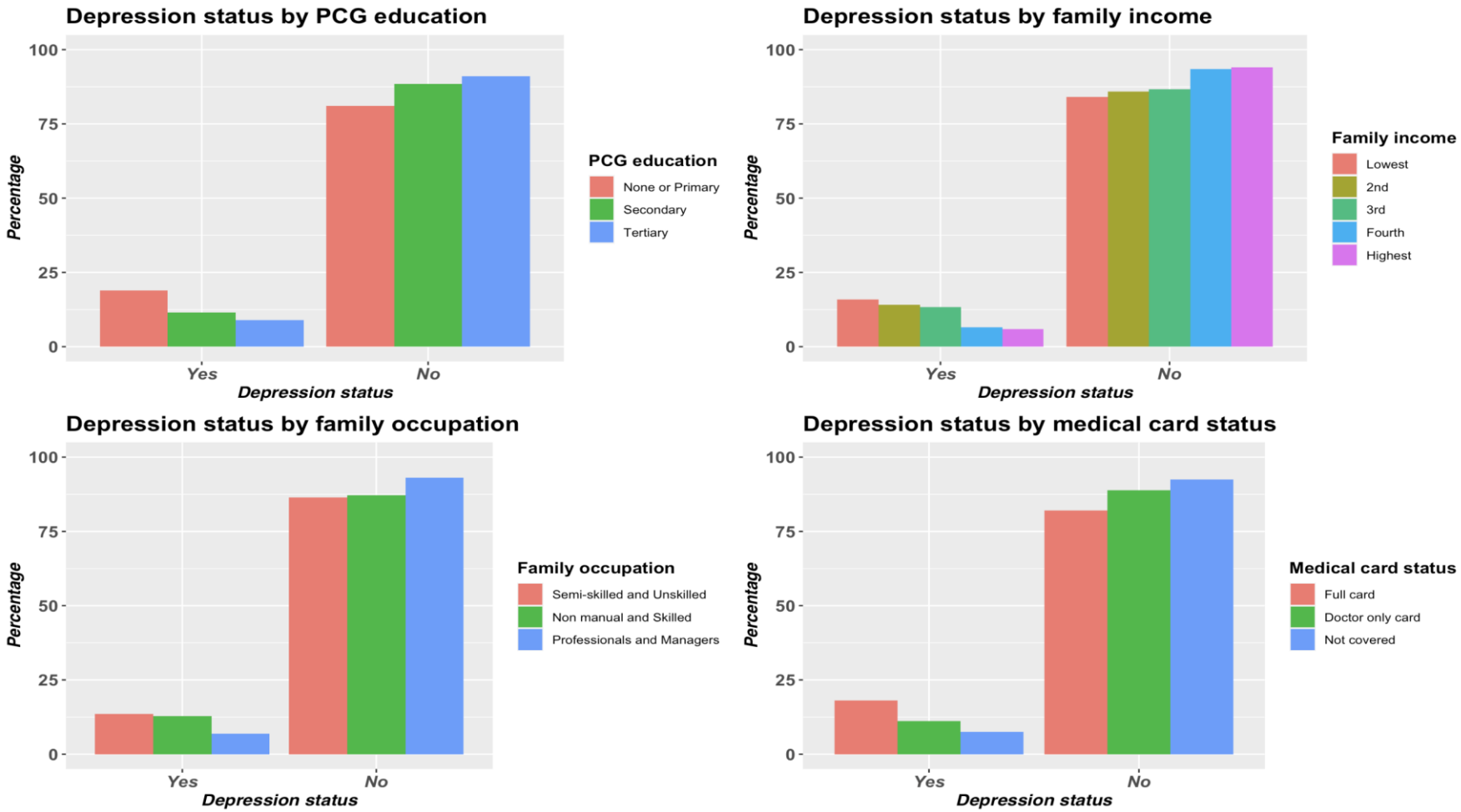


Figure S6.21 PCGs' depression status by socioeconomic status (SES) measures at 13 years of age.

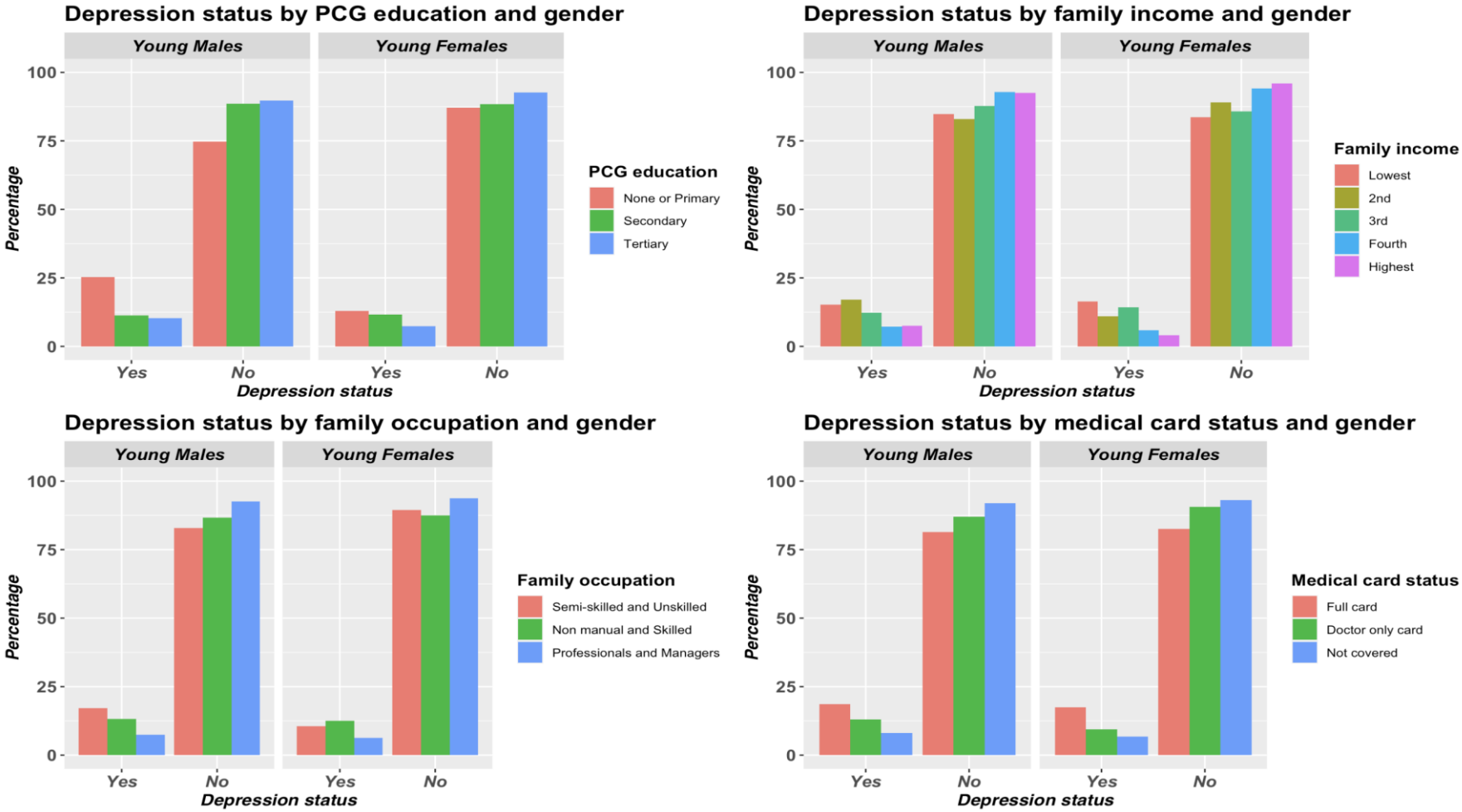


Figure S6.22 PCGs' depression status by socioeconomic status (SES) measures and gender at 13 years of age.

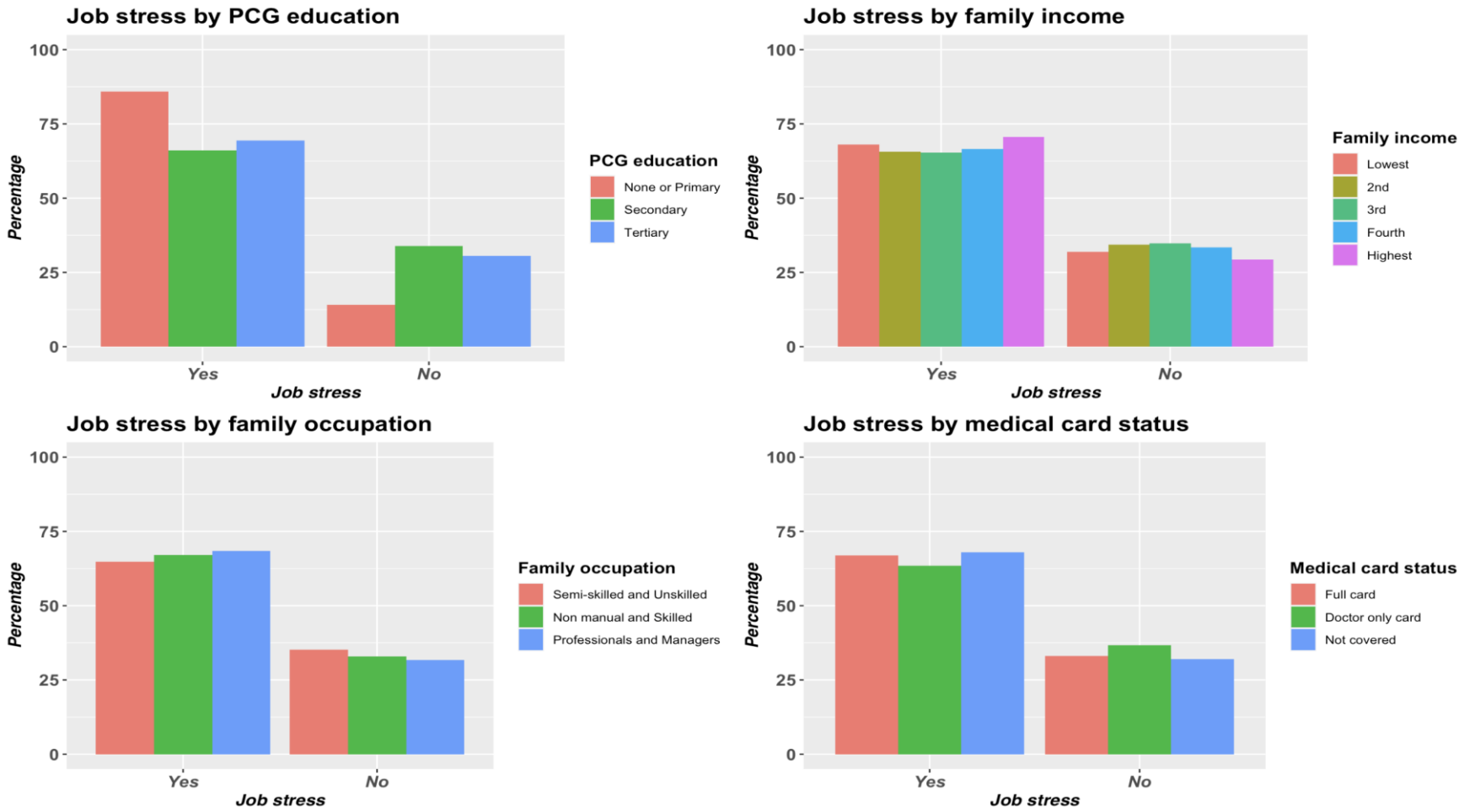


Figure S6.23 PCGs' job stress status by socioeconomic status (SES) measures at 13 years of age.

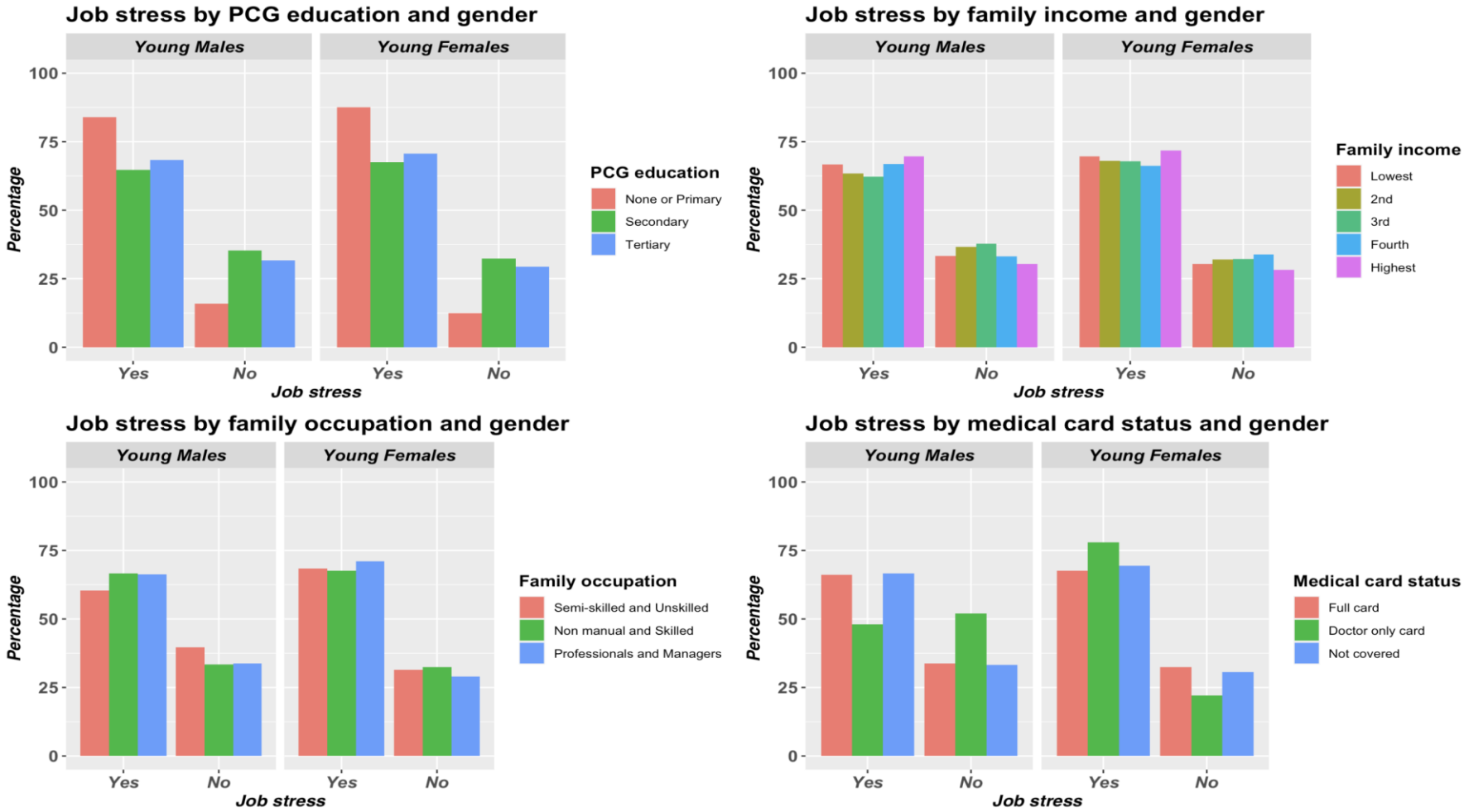


Figure S6.24 PCGs' job stress status by socioeconomic status (SES) measures and gender at 13 years of age.

Table S1 Association between socioeconomic (SES) components and toothbrushing Odds of toothbrushing once a day and less than once a day.

		Total		**Males**		**Females**	
SES components		**Once a day**	**Less than once a day/Rarely/Not at all**	**Once a day**	**Less than once a day/Rarely/Not at all**	**Once a day**	**Less than once a day/Rarely/Not at all**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	1.38 (0.98; 1.94) (p = 0.064)	0.87 (0.36; 2.11) (p = 0.770)	1.57 (1.00; 2.45) (p = 0.049)	0.42 (0.10; 1.77) (p = 0.240)	1.27 (0.73; 2.22) (p = 0.392)	3.06 (0.86; 10.82) (p = 0.083)
	Secondary	**1.18 (1.00; 1.38) (p = 0.039)**	**1.95 (1.40; 2.71) (p < 0.001)**	1.13 (0.92; 1.38) (p = 0.235)	**1.66 (1.14; 2.42) (p = 0.008)**	**1.35 (1.04; 1.75) (p = 0.025)**	**3.72 (1.71; 8.07) (p < 0.001)**
	Tertiary	1	1	1	1	1	1
Family income – quintiles (n = 5586)	Lowest	**1.76 (1.43; 2.17) (p < 0.001)**	**3.00 (1.92; 4.68) (p < 0.001)**	**1.34 (1.02; 1.76) (p = 0.033)**	**3.27 (1.87; 5.71)** (p < 0.001)	**2.99 (2.09; 4.29) (p < 0.001)**	**2.65 (1.25; 5.61) (p = 0.011)**
	2nd	**1.45 (1.17; 1.80) (p < 0.001)**	**3.47 (2.24; 5.38) (p < 0.001)**	1.30 (0.99; 1.71) (p = 0.060)	**3.72 (2.14; 6.45) (p < 0.001)**	**1.99 (1.37; 2.91) (p < 0.001)**	**3.27 (1.58; 6.76) (p = 0.001)**
	3rd	**1.48 (1.19; 1.84) (p < 0.001)**	**2.09 (1.31; 3.33) (p = 0.002)**	**1.48 (1.12; 1.95) (p = 0.005)**	**2.51 (1.39; 4.52) (p = 0.002)**	**1.91 (1.31; 2.77) (p < 0.001)**	1.81 (0.83; 3.93) (p = 0.136)
	4th	1.11 (0.89; 1.38) (p = 0.369)	**2.13 (1.34; 3.37) (p = 0.001)**	0.82 (0.62; 1.08) (p = 0.159)	**2.29 (1.30; 4.03) (p = 0.004)**	**1.86 (1.27; 2.74) (p = 0.002)**	1.54 (0.67; 3.51) (p = 0.309)
	Highest	1	1	1	1	1	1

Table S1 Continued…

		Total		**Males**		**Females**	
		Once a day	**Less than once a day/Rarely/Not at all**	**Once a day**	**Less than once a day/Rarely/Not at all**	**Once a day**	**Less than once a day/Rarely/Not at all**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**1.52 (1.25; 1.84) (p < 0.001)**	**1.73 (1.18; 2.53) (p = 0.005)**	**1.36 (1.04; 1.77) (p = 0.026)**	**2.24 (1.44; 3.48) (p < 0.001)**	**2.14 (1.60; 2.85) (p < 0.001)**	1.23 (0.55; 2.75) (p = 0.617)
	Other non-manual/ Skilled manual	**1.16 (1.01; 1.34) (p = 0.039)**	**1.92 (1.47; 2.52) (p < 0.001)**	1.07 (0.89; 1.29) (p = 0.458)	**1.79 (1.29; 2.49) (p < 0.001)**	**1.50 (1.18; 1.89) (p < 0.001)**	**2.63 (1.59; 4.36) (p < 0.001)**
	Professional managers	1	1	1	1	1	1
Medical card status (n = 6039)	Yes, full card	**1.29 (1.13; 1.47) (p < 0.001)**	**2.15 (1.72; 2.70) (p < 0.001)**	1.15 (0.96; 1.37) (p = 0.133)	**1.97 (1.49; 2.61) (p < 0.001)**	**1.65 (1.35; 2.01) (p < 0.001)**	**2.95 (1.96; 4.44) (p < 0.001)**
	Yes, doctor only card	**1.64 (1.13; 2.38) (p = 0.009)**	0.62 (0.20; 1.88) (p = 0.397)	**1.93 (1.16; 3.10) (p = 0.011)**	0.13 (0.01; 2.59) (p = 0.184)	1.48 (0.82; 2.67) (p = 0.198)	1.85 (0.54; 6.35) (p = 0.330)
	Not covered	1	1	1	1	1	1

Table S2 Association between SES components and dentist visit behaviour. Odds of visiting the dentist for a problem visit and occasionally.

		Total		**Males**		**Females**	
	Dentist visit behaviour	**Problem visit/Never/ Almost never**	**Occasional visit**	**Problem visit/Never/ Almost never**	**Occasional visit**	**Problem visit/Never/ Almost never**	**Occasional visit**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**3.82 (2.67; 5.48) (p < 0.001)**	0.95 (0.62; 1.45) (p = 0.946)	**5.13 (3.13; 8.39) (p < 0.001)**	0.55 (0.25; 1.19) (p = 0.129)	**2.74 (1.61; 4.67) (p < 0.001)**	1.26 (0.74; 2.15) (p = 0.389)
	Secondary	**1.62 (1.31; 1.99) (p < 0.001)**	1.14 (0.97; 1.34) (p = 0.119)	**1.79 (1.34; 2.39) (p < 0.001)**	1.17 (0.94; 1.46) (p = 0.166)	**1.44 (1.07; 1.94) (p = 0.016)**	1.10 (0.87; 1.39) (p = 0.442)
	Tertiary	1	1	1	1	1	1
Family income – quintiles (n = 5586)	Lowest	**2.93 (2.19; 3.92) (p < 0.001)**	1.24 (0.99; 1.54) (p = 0.054)	**2.78 (1.89; 4.07) (p < 0.001)**	1.41 (0.84; 1.55) (p = 0.399)	**3.20 (2.05; 5.00) (p < 0.001)**	1.35 (0.99; 1.85) (p = 0.059)
	2nd	**3.36 (2.52; 4.48) (p < 0.001)**	**1.33 (1.07; 1.65) (p = 0.011)**	**3.09 (2.11; 4.54) (p < 0.001)**	1.27 (0.94; 1.72) (p = 0.127)	**3.78 (2.43; 5.88) (p < 0.001)**	**1.39 (1.02; 1.92) (p = 0.038)**
	3rd	**2.34 (1.74; 3.16) (p < 0.001)**	1.13 (0.91; 1.42) (p = 0.260)	**1.92 (1.28; 2.88) (p = 0.002)**	1.00 (0.73; 1.37) (p = 0.990)	**2.95 (1.89; 4.61) (p < 0.001)**	1.28 (0.94; 1.75) (p = 0.125)
	4th	**2.02 (1.50; 2.74) (p < 0.001)**	1.18 (0.95; 1.47) (p = 0.136)	**1.90 (1.29; 2.82) (p = 0.001)**	1.09 (0.81; 1.46) (p = 0.563)	**2.18 (1.36; 3.51) (p = 0.001)**	1.29 (0.94; 1.78) (p = 0.116)
	Highest	1	1	1	1	1	1

Table S2 Continued…

		Total		**Males**		**Females**	
		Problem visit/Never/ Almost never	**Occasional visit**	**Problem visit/Never/ Almost never**	**Occasional visit**	**Problem visit/Never/ Almost never**	**Occasional visit**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**1.68 (1.32; 2.14) (p < 0.001)**	**1.25 (1.02; 1.54) (p = 0.033)**	1.41 (0.99; 2.02) (p = 0.056)	0.89 (0.64; 1.23) (p = 0.481)	**1.97 (1.40; 2.77) (p < 0.001)**	**1.63 (1.24; 2.16) (p < 0.001)**
	Other non-manual/ Skilled manual	**1.81 (1.52; 2.16) (p < 0.001)**	**1.27 (1.10; 1.48) (p = 0.001)**	**1.96 (1.54; 2.49) (p < 0.001)**	**1.25 (1.02; 1.54) (p = 0.035)**	**1.68 (1.29; 2.19) (p < 0.001)**	**1.30 (1.05; 1.62) (p = 0.015)**
	Professional managers	1	1	1	1	1	1
Medical card status (n = 6039)	Yes, full card	**2.10 (1.80; 2.45) (p < 0.001)**	1.10 (0.96; 1.27) (p = 0.175)	**2.04 (1.65; 2.52) (p < 0.001)**	0.96 (0.78; 1.18) (p = 0.717)	**2.18 (1.75; 2.72) (p < 0.001)**	**1.24 (1.02; 1.51) (p = 0.030)**
	Yes, doctor only card	**2.89 (1.89; 4.40) (p < 0.001)**	1.49 (0.98; 2.28) (p = 0.063)	**3.46 (1.91; 6.27) (p < 0.001)**	1.71 (0.92; 3.15) (p = 0.088)	**2.46 (1.35; 4.49) (p = 0.003)**	1.34 (0.74; 2.41) (p = 0.332)
	Not covered	1	1	1	1	1	1

Table S3 Association between SES components and sugary foods intake. Odds of having dietary intake of sugary drinks once a day and more than once a day

		Total		**Males**		**Females**	
		More than once a day	**Once a day**	**More than once a day**	**Once a day**	**More than once a day**	**Once a day**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**1.69 (1.09; 2.62) (p = 0.019)**	1.43 (1.00; 2.03) (p = 0.048)	1.15 (0.61; 2.14) (p = 0.666)	1.26 (0.78; 2.03) (p = 0.349)	**2.53 (1.34; 4.78) (p = 0.004)**	1.63 (0.96; 2.78) (p = 0.070)
	Secondary	**1.30 (1.08; 1.57) (p = 0.006)**	0.96 (0.83; 1.11) (p = 0.599)	**1.38 (1.07; 1.78) (p = 0.012)**	1.21 (0.99; 1.47) (p = 0.052)	1.24 (0.93; 1.65) (p = 0.139)	**0.75 (0.61; 0.92) (p = 0.007)**
	Tertiary	1	1	1	1	1	1
Family income – quintiles (n = 5586)	Lowest	**1.49 (1.17; 1.89) (p = 0.001)**	0.96 (0.79; 1.16) (p = 0.673)	**1.74 (1.24; 2.43) (p = 0.001)**	1.21 (0.92; 1.59) (p = 0.164)	1.29 (0.91; 1.82) (p = 0.147)	0.76 (0.58; 1.00) (p = 0.053)
	2nd	1.28 (0.99; 1.64) (p = 0.051)	1.04 (0.86; 1.26) (p = 0.689)	**1.59 (1.12; 2.24) (p = 0.009)**	1.26 (0.96; 1.66) (p = 0.093)	1.03 (0.72; 1.47) (p = 0.863)	0.86 (0.65; 1.13) (p = 0.282)
	3rd	1.17 (0.91; 1.51) (p = 0.205)	1.05 (0.86; 1.27) (p = 0.642)	1.42 (1.00; 2.02) (p = 0.048)	1.12 (0.85; 1.48) (p = 0.413)	0.97 (0.68; 1.40) (p = 0.904)	0.97 (0.74; 1.28) (p = 0.855)
	4th	1.16 (0.91; 1.50) (p = 0.233)	1.16 (0.95; 1.41) (p = 0.134)	1.09 (0.78; 1.54) (p = 0.590)	1.13 (0.87; 1.46) (p = 0.366)	1.26 (0.87; 1.84) (p = 0.218)	1.21 (0.90; 1.62) (p = 0.192)
	Highest	1	1	1	1	1	1

Table S3 Continued…

		Total		**Males**		**Females**	
		More than once a day	**Once a day**	**More than once a day**	**Once a day**	**More than once a day**	**Once a day**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	1.12 (0.89; 1.41) (p = 0.337)	**0.71 (0.59; 0.85) (p < 0.001)**	1.24 (0.89; 1.72) (p = 0.205)	0.78 (0.59; 1.03) (p = 0.089)	1.06 (0.77; 1.46) (p = 0.727)	**0.65 (0.51; 0.84) (p = 0.001)**
	Other non-manual/ Skilled manual	**1.37 (1.15; 1.62) (p < 0.001)**	0.99 (0.86; 1.13) (p = 0.858)	**1.32 (1.04; 1.66) (p = 0.021)**	0.94 (0.78; 1.14) (p = 0.540)	**1.44 (1.13; 1.85) (p = 0.004)**	1.04 (0.85; 1.26) (p = 0.718)
	Professional managers	1	1	1	1	1	1
Medical card status (n = 6039)	Yes, full card	**1.28 (1.09; 1.49) (p = 0.002)**	0.92 (0.81; 1.04) (p = 0.177)	1.20 (0.97; 1.49) (p = 0.096)	0.99 (0.83; 1.18) (p = 0.909)	**1.38 (1.11; 1.71) (p = 0.004)**	0.86 (0.72; 1.02) (p = 0.082)
	Yes, doctor only card	1.22 (0.74; 2.01) (p = 0.424)	1.16 (0.78; 1.72) (p = 0.471)	1.56 (0.72; 3.39) (p = 0.263)	1.82 (0.97; 3.43) (p = 0.062)	1.08 (0.56; 2.08) (p = 0.815)	0.81 (0.48; 1.37) (p = 0.437)
	Not covered	1	1	1	1	1	1

Table S4 Association between SES components and sugary drinks intake. Odds of having dietary intake of sugary drinks once a day and more than once a day.

		Total		**Males**		**Females**	
		More than once a day	**Once a day**	**More than once a day**	**Once a day**	**More than once a day**	**Once a day**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**3.84 (2.61; 5.65) (p < 0.001)**	**3.06 (2.17; 4.30) (p < 0.001)**	**2.94 (1.64; 5.28) (p < 0.001)**	**3.21 (1.95; 5.27) (p < 0.001)**	**5.79 (3.39; 9.88) (p < 0.001)**	**3.33 (2.03; 5.46) (p < 0.001)**
	Secondary	**1.73 (1.44; 2.09) (p < 0.001)**	**1.44 (1.24; 1.67) (p < 0.001)**	**1.38 (1.09; 1.76) (p = 0.008)**	1.21 (0.99; 1.47) (p = 0.059)	**2.43 (1.79; 3.29) (p < 0.001)**	**1.91 (1.51; 2.43) (p < 0.001)**
	Tertiary	1	1	1	1	1	1
Family income – quintiles (n = 5586)	Lowest	**3.24 (2.53; 4.14) (p < 0.001)**	**1.51 (1.24; 1.84) (p < 0.001)**	**3.27 (2.35; 4.55) (p < 0.001)**	1.29 (0.99; 1.69) (p = 0.062)	**3.33 (2.29; 4.85) (p < 0.001)**	**2.03 (1.49; 2.76) (p < 0.001)**
	2nd	**2.39 (1.86; 3.08) (p < 0.001)**	**1.52 (1.25; 1.85) (p < 0.001)**	**1.78 (1.26; 2.52) (p = 0.001)**	1.24 (0.95; 1.61) (p = 0.111)	**3.33 (2.28; 4.85) (p < 0.001)**	**2.09 (1.54; 2.86) (p < 0.001)**
	3rd	**1.94 (1.50; 2.51) (p < 0.001)**	**1.37 (1.13; 1.67) (p = 0.002)**	**1.79 (1.26; 2.54) (p = 0.001)**	1.05 (0.79; 1.38) (p = 0.734)	**2.22 (1.51; 3.27) (p < 0.001)**	**2.09 (1.55; 2.83) (p < 0.001)**
	4th	**1.49 (1.14; 1.94) (p = 0.003)**	**1.34 (1.10; 1.63) (p = 0.003)**	1.34 (0.94; 1.89) (p = 0.104)	1.20 (0.93; 1.55) (p = 0.152)	**1.67 (1.11; 2.52) (p = 0.014)**	**1.52 (1.10; 2.09) (p = 0.010)**
	Highest	1	1	1	1	1	1

Table S4 Continued…

		Total		**Males**		**Females**	
		More than once a day	**Once a day**	**More than once a day**	**Once a day**	**More than once a day**	**Once a day**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**2.76 (2.22; 3.43) (p < 0.001)**	**1.74 (1.44; 2.10) (p < 0.001)**	**3.42 (2.49; 4.71) (p < 0.001)**	**2.16 (1.63; 2.87) (p < 0.001)**	**2.64 (1.93; 3.61) (p < 0.001)**	**1.70 (1.29; 2.22) (p < 0.001)**
	Other non-manual/ Skilled manual	**1.77 (1.50; 2.09) (p < 0.001)**	**1.16 (1.01; 1.32) (p = 0.033)**	**1.67 (1.34; 2.09) (p < 0.001)**	1.05 (0.87; 1.26) (p = 0.601)	**2.00 (1.56; 2.56) (p < 0.001)**	**1.40 (1.15; 1.72) (p = 0.001)**
	Professional Managers	1	1	1	1	1	1
Medical card status (n = 6039)	Yes, full card	**2.55 (2.21; 2.95) (p < 0.001)**	**1.59 (1.40; 1.80) (p < 0.001)**	**2.11 (1.72; 2.58) (p < 0.001)**	**1.43 (1.20; 1.71) (p < 0.001)**	**3.30 (2.68; 4.08) (p < 0.001)**	**1.87 (1.56; 2.24) (p < 0.001)**
	Yes, doctor only card	1.38 (0.87; 2.17) (p = 0.169)	0.99 (0.67; 1.48) (p = 0.985)	0.99 (0.50; 1.94) (p = 0.967)	0.77 (0.43; 1.37) (p = 0.376)	**2.01 (1.08; 3.75) (p = 0.027)**	1.36 (0.78; 2.36) (p = 0.278)
	Not covered	1	1	1	1	1	1

TABLE S5 Association between SES components and DEIS school status. Odds of attending a DEIS school.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**17.13 11.93; 24.59) (p < 0.001)**	**19.81 (11.85; 33.11) (p < 0.001)**	**17.43 (10.14; 29.98) (p < 0.001)**
	Secondary	**3.13 (2.48; 3.95) (p < 0.001)**	**2.45 (1.83; 3.27) (p < 0.001)**	**4.45 (3.01; 6.58) (p < 0.001)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**4.85 (3.65; 6.46) (p < 0.001)**	**5.67 (3.72; 8.63) (p < 0.001)**	**4.18 (2.83; 6.18) (p < 0.001)**
	2nd	**4.72 (3.55; 6.29) (p < 0.001)**	**6.53 (4.29; 5.94) (p < 0.001)**	**3.40 (2.29; 5.06) (p = 0.033)**
	3rd	**2.86 (2.12; 3.85) (p < 0.001)**	**3.40 (2.18; 5.31) (p < 0.001)**	**2.40 (1.61; 3.59) (p < 0.001)**
	4th	**2.45 (1.81; 3.31) (p < 0.001)**	**3.58 (2.33; 5.49) (p < 0.001)**	1.53 (0.98; 2.38) (p = 0.060)
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**5.10 (4.13; 6.29) (p < 0.001)**	**4.35 (3.23; 5.85) (p < 0.001)**	**6.20 (4.56; 4.45) (p < 0.001)**
	Other non-manual/ Skilled manual	**3.00 (2.52; 3.58) (p < 0.001)**	**2.78 (2.20; 3.52) (p < 0.001)**	**3.39 (2.59; 4.45) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**3.19 (2.77; 3.68) (p < 0.001)**	**3.13 (2.57; 3.81) (p < 0.001)**	**3.27 (2.67; 4.02) (p < 0.001)**
	Yes, doctor only card	**2.78 (1.86; 4.15) (p < 0.001)**	**3.29 (1.91; 5.68) (p < 0.001)**	**2.32 (1.28; 4.21) (p = 0.006)**
	Not covered	1	1	1

Table S6 Association between SES components and financial difficulties. Odds of having financial difficulties in families.

		Total	**Males**	**Females**
		OR (95% CI) ***(p-value)***	**OR (95% CI)** ***(p-value)***	**OR (95% CI)** ***(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**6.30 (4.28; 9.28) (p < 0.001)**	**5.73 (3.35; 9.81) (p < 0.001)**	**6.91 (3.95; 12.09) (p < 0.001)**
	Secondary	**1.95 (1.72; 2.21) (p < 0.001)**	**1.82 (1.53; 2.16) (p < 0.001)**	**2.09 (1.74; 2.52) (p < 0.001)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**13.00 (10.58; 15.98) (p < 0.001)**	**13.34 (10.01; 17.78) (p < 0.001)**	**12.59 (9.37; 16.92) (p < 0.001)**
	2nd	**9.98 (8.18; 12.16) (p < 0.001)**	**10.28 (7.80; 13.55) (p < 0.001)**	**9.62 (7.24; 12.78) (p < 0.001)**
	3rd	**4.25 (3.54; 5.09) (p < 0.001)**	**3.80 (2.94; 4.91) (p < 0.001)**	**4.63 (3.58; 5.99) (p < 0.001)**
	4th	**2.17 (1.82; 2.59) (p < 0.001)**	**2.58 (2.03; 3.29) (p < 0.001)**	**1.76 (1.35; 2.29) (p < 0.001)**
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**3.15 (2.64; 3.77) (p < 0.001)**	**3.34 (2.58; 4.34) (p < 0.001)**	**2.94 (2.29; 3.76) (p < 0.001)**
	Other non-manual/ Skilled manual	**2.34 (2.11; 2.68) (p < 0.001)**	**2.41 (2.04; 2.85) (p < 0.001)**	**2.31 (1.95; 2.75) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**5.08 (4.47; 5.78) (p < 0.001)**	**4.43 (3.71; 5.28) (p < 0.001)**	**5.84 (4.83; 7.05) (p < 0.001)**
	Yes, doctor only card	**3.24 (2.21; 4.75) (p < 0.001)**	**3.79 (2.13; 6.77) (p < 0.001)**	**2.81 (1.68; 4.70) (p < 0.001)**
	Not covered	1	1	1

Table S7 Association between SES components and private medical insurance. Odds of not having a private medical insurance.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**26.12 (16.16; 42.21) (p < 0.001)**	**17.59 (9.82; 31.53) (p < 0.001)**	**48.36 (19.84; 117.88) (p < 0.001)**
	Secondary	**3.21 (2.79; 3.68) (p < 0.001)**	**3.09 (2.56; 3.74) (p < 0.001)**	**3.30 (2.71; 4.09) (p < 0.001)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**23.01 (18.40; 28.87) (p < 0.001)**	**22.45 (16.40; 30.73) (p < 0.001)**	**23.61 (17.07; 32.65) (p < 0.001)**
	2nd	**14.89 (11.98; 18.52) (p < 0.001)**	**12.62 (9.34; 17.05) (p < 0.001)**	**17.85 (12.99; 24.51) (p < 0.001)**
	3rd	**7.69 (6.22; 9.50) (p < 0.001)**	**7.51 (5.56; 10.14) (p < 0.001)**	**7.76 (5.75; 10.48) (p < 0.001)**
	4th	**3.25 (2.62; 4.02) (p < 0.001)**	**3.27 (2.43; 4.39) (p < 0.001)**	**3.24 (2.37; 4.44) (p < 0.001)**
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**8.68 (7.18; 10.50) (p < 0.001)**	**8.87 (6.75; 11.67) (p < 0.001)**	**8.39 (6.44; 10.92) (p < 0.001)**
	Other non-manual/ Skilled manual	**4.15 (3.67; 4.69) (p < 0.001)**	**3.81 (3.21; 4.52) (p < 0.001)**	**4.64 (3.74; 5.33) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**18.16 (15.63; 21.09) (p < 0.001)**	**18.12 (14.71; 22.32) (p < 0.001)**	**18.07 (14.56; 22.42) (p < 0.001)**
	Yes, doctor only card	**3.35 (2.38; 4.72) (p < 0.001)**	**2.42 (1.48; 3.96) (p < 0.001)**	**4.49 (2.75; 7.34) (p < 0.001)**
	Not covered	1	1	1

Table S8 Association between SES components and homeownership. Odds of renting or not owning a house.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**8.10 (5.87; 11.18) (p < 0.001)**	**7.52 (4.73; 11.96) (p < 0.001)**	**8.52 (5.44; 13.36) (p < 0.001)**
	Secondary	**2.05 (1.69; 2.49) (p < 0.001)**	**1.98 (1.50; 2.60) (p < 0.001)**	**2.09 (1.60; 2.74) (p < 0.001)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**9.00 (6.68; 12.14) (p < 0.001)**	**7.50 (4.95; 11.35) (p < 0.001)**	**10.67 (6.92; 16.45) (p < 0.001)**
	2nd	**7.31 (5.41; 9.89) (p < 0.001)**	**6.62 (4.36; 10.05) (p < 0.001)**	**8.04 (5.19; 12.46) (p < 0.001)**
	3rd	**4.87 (3.58; 6.62) (p < 0.001)**	**4.18 (2.71; 6.45) (p < 0.001)**	**5.49 (3.53; 8.55) (p < 0.001)**
	4th	**1.59 (1.13; 2.25) (p = 0.008)**	**1.61 (1.01; 2.57) (p = 0.047)**	1.58 (0.95; 2.64) (p = 0.080)
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**7.58 (6.11; 9.41) (p < 0.001)**	**7.28 (5.30; 9.99) (p < 0.001)**	**7.57 (5.63; 10.17) (p < 0.001)**
	Other non-manual/ Skilled manual	**3.28 (2.71; 3.96) (p < 0.001)**	**3.27 (2.48; 4.30) (p < 0.001)**	**3.20 (2.46; 4.17) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**9.95 (8.52; 11.61) (p < 0.001)**	**10.34 (8.25; 12.95) (p < 0.001)**	**9.49 (7.67; 11.74) (p < 0.001)**
	Yes, doctor only card	**5.14 (3.47; 7.63) (p < 0.001)**	**2.32 (1.09; 4.91) (p = 0.028)**	**7.95 (4.85; 13.04) (p < 0.001)**
	Not covered	1	1	1

Table S9 Association between SES components and family composition Odds of having a single parent family.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**3.34 (2.42; 4.61) (p < 0.001)**	**3.59 (2.25; 5.70) (p < 0.001)**	**3.07 (1.97; 4.80) (p < 0.001)**
	Secondary	**1.38 (1.16; 1.64) (p < 0.001)**	**1.44 (1.13; 1.85) (p = 0.004)**	**1.31 (1.02; 1.67) (p = 0.032)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**3.12 (2.44; 3.98) (p < 0.001)**	**2.82 (2.01; 3.96) (p < 0.001)**	**3.44 (2.41; 4.92) (p < 0.001)**
	2nd	**3.16 (2.47; 4.04) (p < 0.001)**	**2.74 (1.95; 13.86) (p < 0.001)**	**3.63 (2.54; 5.19) (p < 0.001)**
	3rd	**2.70 (2.10; 3.46) (p < 0.001)**	**2.30 (1.62; 3.27) (p < 0.001)**	**3.10 (2.17; 4.44) (p < 0.001)**
	4th	**1.40 (1.07; 1.83) (p = 0.015)**	**1.61 (1.13; 2.29) (p = 0.009)**	1.12 (0.74; 1.71) (p = 0.586)
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**4.14 (3.33; 5.16) (p < 0.001)**	**4.11 (2.98; 5.67) (p < 0.001)**	**4.05 (2.99; 5.47) (p < 0.001)**
	Other non-manual/ Skilled manual	**2.32 (1.93; 2.80) (p < 0.001)**	**2.72 (2.09; 3.53) (p < 0.001)**	**1.96 (1.50; 2.56) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**6.40 (5.53; 7.40) (p < 0.001)**	**6.63 (5.39; 8.15) (p < 0.001)**	**6.14 (5.00; 7.52) (p < 0.001)**
	Yes, doctor only card	**2.61 (1.69; 4.02) (p < 0.001)**	**2.02 (1.01; 4.07) (p = 0.048)**	**3.08 (1.76; 5.40) (p < 0.001)**
	Not covered	1	1	1

Table S10 Association between SES components and job stress. Odds of PCG having job stress.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**2.69 (1.76; 4.12) (p < 0.001)**	**2.44 (1.35; 4.43) (p = 0.003)**	**2.92 (1.58; 5.39) (p < 0.001)**
	Secondary	**0.86 (0.75; 0.99) (p = 0.034)**	0.85 (0.71; 1.03) (p = 0.096)	0.86 (0.71; 1.06) (p = 0.162)
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	0.89 (0.74; 1.07) (p = 0.207)	0.87 (0.67; 1.12) (p = 0.280)	0.90 (0.69; 1.19) (p = 0.465)
	2nd	**0.79 (0.66; 0.96) (p = 0.016)**	**0.75 (0.58; 0.98) (p = 0.032)**	0.83 (0.63; 1.10) (p = 0.194)
	3rd	**0.78 (0.65; 0.94) (p = 0.009)**	**0.72 (0.55; 0.93) (p = 0.013)**	0.83 (0.63; 1.08) (p = 0.164)
	4th	0.83 (0.69; 1.00) (p = 0.048)	0.88 (0.68; 1.13) (p = 0.313)	0.77 (0.58; 1.02) (p = 0.070)
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	0.85 (0.71; 1.02) (p = 0.078)	0.78 (0.60; 1.00) (p = 0.051)	0.89 (0.69; 1.14) (p = 0.357)
	Other non-manual/ Skilled manual	0.94 (0.83; 1.07) (p = 0.360)	1.01 (0.85; 1.21) (p = 0.866)	0.85 (0.71; 1.02) (p = 0.088)
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	0.95 (0.85; 1.07) (p = 0.419)	0.98 (0.83; 1.15) (p = 0.791)	0.92 (0.78; 1.09) (p = 0.325)
	Yes, doctor only card	0.81 (0.57; 1.16) (p = 0.261)	**0.46 (0.28; 0.75) (p = 0.002)**	1.56 (0.88; 2.78) (p = 0.128)
	Not covered	1	1	1

Table S11 Association between SES components and depression status. Odds of having depressed PCG.

		Total	**Males**	**Females**
		OR (95% CI) *(p-value)*	**OR (95% CI) *(p-value)***	**OR (95% CI) *(p-value)***
Primary care giver's highest level of education (n = 6039)	None or primary	**2.37 (1.59; 3.53) (p < 0.001)**	**2.95 (1.76; 4.95) (p < 0.001)**	1.85 (0.97; 3.54) (p = 0.062)
	Secondary	**1.32 (1.07; 1.63) (p = 0.011)**	1.12 (0.85; 1.48) (p = 0.422)	**1.64 (1.17; 2.30) (p = 0.004)**
	Tertiary	1	1	1
Family income – quintiles (n = 5586)	Lowest	**3.00 (2.22; 4.06) (p < 0.001)**	**2.22 (1.50; 3.29) (p < 0.001)**	**4.61 (2.80; 7.61) (p < 0.001)**
	2nd	**2.61 (1.92; 3.55) (p < 0.001)**	**2.54 (1.73; 3.74) (p < 0.001)**	**2.91 (1.73; 4.91) (p < 0.001)**
	3rd	**2.46 (1.80; 3.35) (p < 0.001)**	**1.73 (1.14; 2.61) (p = 0.009)**	**3.91 (2.36; 6.48) (p < 0.001)**
	4th	1.12 (0.79; 1.59) (p = 0.516)	0.95 (0.61; 1.47) (p = 0.810)	1.46 (0.82; 2.62) (p = 0.199)
	Highest	1	1	1
Family class (Occupation) (n = 5481)	Semi-skilled/ Unskilled manual	**2.11 (1.63; 2.74) (p < 0.001)**	**2.58 (1.83; 3.65) (p < 0.001)**	**1.77 (1.19; 2.62) (p < 0.001)**
	Other non-manual/ Skilled manual	**1.99 (1.63; 2.43) (p < 0.001)**	**1.91 (1.46; 2.50) (p < 0.001)**	**2.12 (1.57; 2.85) (p < 0.001)**
	Professional managers	1	1	1
Medical card status (n = 6039)	Yes, full card	**2.71 (2.30; 3.20) (p < 0.001)**	**2.61 (2.08; 3.27) (p < 0.001)**	**2.88 (2.26; 3.67) (p < 0.001)**
	Yes, doctor only card	1.55 (0.90; 2.66) (p = 0.110)	1.71 (0.82; 3.57) (p = 0.149)	1.42 (0.64; 3.16) (p = 0.389)
	Not covered	1	1	1

Table S12 Association between SES components and parental stress scale. Parental stressor scale scores mean differences among the SES groups.

		Total		**Males**		**Females**	
		Mean (sd)	**P value**	**Mean (sd)**	**P value**	**Mean (sd)**	**P value**
Primary care giver's highest level of education (n = 5957 M = 3045 F = 2929)	None or primary	11.41 (5.34)	< 0.001	11.67 (5.97)	< 0.001	11.16 (4.68)	< 0.001
	Secondary	10.23 (4.18)		10.26 (4.24)		10.21 (4.12)	
	Tertiary	10.33 (3.90)		10.52 (4.17)		10.11 (3.55)	
Family income – quintiles (n = 5549 M = 2721 F = 2721)	Lowest	10.03 (3.93)	< 0.001	9.93 (3.76)	0.019	10.12 (4.10)	< 0.001
	2nd	10.76 (4.64)		10.82 (4.75)		10.70 (4.53)	
	3rd	10.39 (4.01)		10.36 (4.54)		10.41 (3.83)	
	4th	10.20 (4.18)		10.38 (4.54)		9.98 (3.65)	
	Highest	10.12 (4.09)		10.41 (4.26)		9.78 (3.87	
Family class (Occupation) (n = 5429 M = 2800 F = 2629)	Semi-skilled/ Unskilled manual	10.68 (4.72)	< 0.001	11.08 (4.89)	< 0.001	10.35 (4.55)	0.264
	Other non-manual/ Skilled manual	10.24 (3.96)		10.32 (4.03)		10.17 (3.89)	
	Professional managers	10.03 (3.98)		10.05 (4.04)		10.00 (3.89)	
Medical card status (n = 5974 M = 3045 F = 2929)	Yes, full card	10.93 (4.55)	< 0.001	10.98 (4.74)	< 0.001	10.89 (4.37)	< 0.001
	Yes, doctor only card	9.52 (3.24)		8.9 (2.49)		10.06 (3.72)	
	Not covered	9.98 (3.94)		10.10 (4.07)		9.83 (3.79)	

Appendix D

Check for update

Received: 6 February 2023 | Revised: 22 May 2023 | Accepted: 18 July 2023

DOI: 10.1111/cdoe.12897

ORIGINAL ARTICLE

Community Dentistry and Oral Epidemiology WILEY

Dental caries in children in Ireland: A systematic review

Vinay Sharma[1] | Michael Crowe[1] | Oscar Cassetti[1] | Lewis Winning[1] | Aifric O'Sullivan[2] | Michael O'Sullivan[1]

[1]Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Dublin, Ireland

[2]Institute of Food and Health, Science Centre, South, UCD, Dublin, Ireland

Correspondence
Vinay Sharma, Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Lincoln Place, Dublin 2, Ireland.
Email: vinay.sharma@dental.tcd.ie

Funding information
The Dublin Dental University Hospital; Trinity College Dublin, Ireland

Abstract

Background: Dental caries is the most common childhood disease worldwide. In the mid-1960s, mandatory Community Water Fluoridation (CWF) was introduced in the Republic of Ireland (RoI) aimed at reducing the prevalence and severity of dental caries in the population. In 2017, approximately, 71% of the Irish population was supplied with fluoridated drinking water.

Objectives: To review all children's dental health surveys at National, Regional and County-levels conducted in the Republic of Ireland from 1950 to 2021 and describe trends in dental caries prevalence. The secondary objective was to compare dental caries experience in children living in areas with and without CWF.

Methods: Seven databases (Embase, Medline Ovid, PubMed, Cochrane, Web of Science, Scopus and Lenus Ireland) were systematically searched followed by lateral searches from reference lists. Studies reporting the caries experience of Irish children were eligible for inclusion. Two authors independently evaluated the quality of included studies using the Joanna Briggs Institute Critical Appraisal Checklist.

Results: Thirty-one studies were included. Over the last 70 years, at National, Regional and County levels, mean dmft/DMFT (decayed, missing and filled teeth) scores have decreased and the percentage of caries-free children has increased in 5, 8, 12, and 15-year-olds. The decline in dental caries indices observed throughout the country was greater in children living in areas with CWF. Between the 1960s and 2002, the mean dmft scores for 5-year-olds living in the RoI were reduced by approximately 82% and 69% for the fluoridated and non-fluoridated groups respectively. Reduction in the mean DMFT scores for the 12-year-olds were 75% and 71%, respectively, for the fluoridated and non-fluoridated groups. Between 1961 and 2014, reductions in the mean dmft/DMFT scores among 5 and 12-years-olds living in County Dublin were approximately 88% and 90% respectively. These results should be interpreted in the context of widespread use of fluoridated toothpaste in the RoI.

Conclusions: Large reductions in the prevalence of dental caries in Irish children have been observed over the last seven decades. Greater dental caries reductions have been reported among children living in areas with CWF compared to those without CWF.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2023 The Authors. *Community Dentistry and Oral Epidemiology* published by John Wiley & Sons Ltd.

KEYWORDS
children, community water fluoridation, dental caries, prevalence, Republic of Ireland, systematic review

1 | INTRODUCTION

Dental caries is the most common childhood disease worldwide.[1] In 2017, the global prevalences of dental caries in primary and permanent teeth were 531 million and 2.3 billion respectively.[2] The consequences of untreated dental caries in children include severe pain, reduced quality of life, lost study hours, sepsis and decreased performance at school and sports.[1] In addition, the treatment cost of dental caries imposes a substantial economic burden on families and societies.[3–5]

Fluoride is effective in preventing dental caries.[6] Fluoridation of public water supplies, use of fluoridated toothpastes, professionally applied topical fluorides and school-based fluoride mouthrinse are established public health programmes for dental caries prevention.[7,8] These programmes when coupled with healthier lifestyles, reduced sugar consumption, improved living conditions, access to oral health services and improved self-care practices have resulted in reductions in dental caries prevalences and severity in many countries.[8–10]

Community Water Fluoridation (CWF), the controlled addition of fluoride to the public water supply to prevent dental caries, is considered an effective and safe public health intervention.[11–14] The Republic of Ireland (RoI) is the only European country with a legislative mandate for the fluoridation of the public water supplies as a core component of its oral health policy.[14] CWF was first introduced in the RoI in County Dublin on 15 July 1964. Subsequently, it was introduced in County Cork on May 1965, and by 1970, most cities and larger towns in the country were fluoridated.[15] In 1981, approximately, 60% of the total population of Ireland was supplied with fluoridated drinking water.[16] In the first National post-fluoridation children's oral health survey, in 1984 (65% of the total population supplied with CWF), it was reported that due to the introduction of CWF at 0.8–1.0 ppm fluoride and widespread use of fluoridated toothpaste, the prevalence of dental caries had declined considerably among Irish children.[16] However, between 1984 and 2002, an increase in the prevalence of dental fluorosis among Irish children, particularly in those living in areas with CWF had been reported.[17] By 2002, 71% of the Irish population was supplied with CWF and there was an almost universal use of fluoridated toothpaste (more than 95% of toothpastes sold in Ireland were fluoridated). In 2007, to reduce the prevalence of dental fluorosis while maintaining reductions in dental caries, the level of fluoride in drinking water was adjusted from 0.8–1.0 to 0.6–0.8 ppm fluoride (target value of 0.7 ppm fluoride).[12,18]

The first comprehensive review on the effectiveness of CWF reported that CWF was associated with an increased proportion of children without dental caries and a decreased number of teeth affected by dental caries.[19] A Cochrane systematic review in 2015 also supported the role of CWF as an effective public health intervention for reducing dental caries in children.[20] With the introduction of CWF, the dmft/DMFT (decayed, missing and filled teeth) scores were reduced and the percentage of caries-free children increased. There was a 35% reduction in dmft, and a 26% reduction in DMFT in children living in areas with CWF compared to the median control group mean values. In addition, the percentage of caries-free children increased by 15% and 14% in primary and permanent dentitions. However, the majority (71%) of the included studies, which provided data for analysis, were conducted before 1975 and the universal introduction of fluoridated toothpaste to the market.[20] More recently, a systematic review evaluated the effectiveness of CWF in the context of the widespread use of fluoridated toothpaste in Brazil.[21] The authors reported that between 1998 and 2010, a mean difference in the dmft between children living in areas with and without CWF was −2.28 and −1.12 for 5 to 8-year-olds and 3 to 12-year-olds respectively. For children aged 7–12 years, between 1998 and 2018, the mean difference in the DMFT between areas with and without CWF was −0.61. In addition, between 1998 and 2018, caries prevalence in the primary (3–8 year-olds) and permanent (7–12 year-olds) dentitions of children living in areas with CWF areas was 142% and 57%, respectively, lower than those living in areas without CWF.[21] Public health policy in countries with mandatory CWF advocates for frequent studies to update scientific evidence on the efficacy and safety of CWF.[21]

Periodic dental health surveys at National, Regional (Health Board) and County levels have been conducted in the RoI to estimate the prevalence and severity of dental caries among Irish children. For National surveys the selected samples of children were nationally representative.[16,17] Similarly, for Regional and County surveys, the selected samples of children were representative of the Regions and Counties respectively.[12,22] In the RoI, there are 26 counties which have been grouped respectively from 1971 to 1999 as the eight Regional Health Boards (Eastern Health Board [EHB], Western Health Board [WHB], North-Western Health Board [NWHB], Southern Health Board [SHB], Mid-Western Health Board [MWHB], Midland Health Board [MHB], North-East Health Board [NEHB], and South-Eastern Health Board [SEHB]). Each Health Board was assigned a functional area (comprising of two or more counties) for their operation.[23] In 1999, the Eastern Regional Health Authority (earlier the EHB) was divided and three new health areas were created resulting in a total of 10 Health Boards in the RoI.[24] County Dublin is the most populous County in the RoI, and in 2022, the population of Dublin was 1.45 million persons which is approximately 28% of the country's total population (5.12 million).[25]

Evidence-based public health practice should use the best available peer-reviewed evidence (both quantitative and qualitative

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

research) for evaluating the success and impact of public health interventions.[26] The primary objective of this systematic review was to describe all children's dental caries surveys at National, Regional and County-levels conducted in the Republic of Ireland from 1950 to 2021 and summarize trends in dental caries. The secondary objective was to explore the effectiveness of CWF, qualitatively, by comparing dental caries experience in children living in areas with and without CWF.

2 | METHODOLOGY

This review was reported following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[27] The protocol for this systematic review was registered in PROSPERO International Prospective Register of Systematic Reviews (CRD42022343732).[28]

2.1 | Eligibility criteria

The eligibility criteria have been described according to the modification of the Population, Intervention/exposure, Comparator, Outcome and Study Design P(I/E)COS as Condition, Context and Population (CoCoPop) criteria[29] (Table 1).

2.2 | Search strategy

A literature search was conducted until 24 June 2022. The following electronic databases were searched: MEDLINE (OVID), Embase, PubMed, Scopus, Web of Science, Cochrane, Lenus Ireland and Google Scholar. The Dublin Dental University Hospital (DDUH) library database was also searched for grey literature. Search strategies using combinations of keywords and specific medical subject headings (MeSH) terms were drafted for individual databases in collaboration with the Librarian in the DDUH library. The search strategies included relevant terms for dental health surveys, dental diseases including dental caries and other conditions, children and the Republic of Ireland (Tables S1–S6, Appendix S1). In addition, a manual search of the reference lists of all eligible studies was completed.

2.3 | Study selection

Screening and evaluation of identified studies was carried out using a web-based app for systematic reviews.[30] Duplicates were removed using an automated tool and later by manual checking before deletion. Two reviewers (VS and MOS) independently screened the studies by reading titles and abstracts. Disagreements were resolved through discussion. During the

TABLE 1 Eligibility criteria according to modification of Population, Intervention/exposure, Comparator, Outcome and study design P(I/E)COS as Condition, Context and Population (CoCoPop) criteria.

Inclusion criteria	Exclusion criteria
Population	
• Children <18 years of age • Any socio-economic status • Any gender, ethnicity, culture or race	• Adults • Children with medical conditions and other oro-facial abnormalities
Context	
• Children living in the Republic of Ireland • Studies representative of the country, health board or county	• Children living outside Ireland • Studies with samples that were not representative of the population being examined
Condition (Outcomes)	
• Dental caries experience in children measured by validated dmft(s)/DMFT(S)[a], dft(s)/DFT(S)[b] and dt(s)/DT(S)[c] • Percentage of children with a caries free dentition (dmft/DMFT = 0)	• Non-validated measures of dental diseases
Study designs	
• Human observational studies ◦ Case–control ◦ Cohort/longitudinal (prospective, retrospective) ◦ Cross-sectional ◦ Cross-sectional nested within a cohort • Studies published in the English language only	• Studies conducted outside Ireland • Qualitative studies • Case reports and case series • Quasi-experiments or randomized control trials • Systematic reviews, literature reviews and review protocols

Note: The scores by convention are referred to by lower case letters (dmft) for primary teeth while by upper case letters (DMFT) for permanent teeth.[62]

[a]Decayed, missing or filled teeth/surfaces.

[b]Decayed or filled teeth/surfaces.

[c]Decayed teeth/surfaces.

16000328, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

second stage of study selection, full texts of the shortlisted studies were accessed and independently evaluated for eligibility by the two reviewers. If additional information was required, attempts were made to contact the study authors. The results were discussed and the conflicts resolved. The final selection of included studies was made after discussion with a third reviewer (MC). The flow diagram of the study selection process was completed based on the PRISMA checklist.[27]

2.4 | Data collection and variable selection

A standardized data extraction form was developed based on the checklist provided by the methodological working group of the Joanna Briggs Institute, Adelaide, South Australia, for conducting a systematic review of observational studies.[29] The form was calibrated and pilot tested using five excluded studies. Independent data extraction was performed by the two reviewers (VS and MOS) and later independently checked by the third reviewer (MC). Based on the sample representation, included studies were categorized into National, Regional (Health Board) and County-level surveys. The following information was extracted from the included studies: first and corresponding author, years of publication and survey, study design and setting, sample size, dental caries measures, key findings and funding sources.

2.5 | Quality assessment of studies and risk of bias

The methodological quality and risk of bias assessment of included studies was performed independently by two reviewers (VS and MOS) using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data.[29] The JBI appraisal checklist has nine explicit criteria, and each item is assessed by scoring yes (=1), no (=0), unclear (=0) and not applicable (=0). Disagreements between the two reviewers (VS and MOS) regarding assigning scores to studies were resolved and, if necessary, final agreement was determined after consulting the third reviewer (MC). The studies with a final score of 7 or more were classified as having low risk of bias, between 4 and 6 as moderate risk and with scores less than 4 were classified as high risk (Table S7, Appendix S2).

2.6 | Data management and analysis

During the data extraction process, data inconsistencies were identified. Missing and inconsistent data issues were resolved after consultation with the two authors (DOM and JM) of the 1984 and 2002 children's dental health surveys in the RoI. All data files were converted into .csv format and exported to R for data transformation and analysis.[31]

3 | RESULTS

A total of 5066 studies were identified from the databases and grey literature search. After removing duplicates ($n=1840$), a total of 3226 titles and abstracts were screened as per the eligibility criteria. Sixty-nine studies were identified for full-text review, and finally, 31 studies were included in the systematic review. The list of the excluded studies ($n=38$) and the reasons for exclusion were recorded (Table S9, Appendix S3). The inter-rater reliability for the entire search process was 94% (Cohen's kappa: 0.94). The study selection process is presented as a PRISMA flow diagram showing the identification, screening, eligibility and included studies (Figure 1).

3.1 | Study characteristics

All included studies in the review were cross-sectional except for one study which was cross-sectional within a nested longitudinal study.[32] A summary of the included studies is presented in Table S8 (Appendix S2). Three studies were conducted at the National-level,[16,17,33] eight were conducted at the Health Board level,[22,34–40] and the remaining 20 studies were County-level surveys.[12,41–59] The results of seven County-level surveys conducted between 1961 and 1963[41–47] were assumed to be representative of a National-level study in previous publications.[16,17,60,61] In these publications, the samples of children selected to represent different age groups for each County in the County-level surveys were combined and interpreted as representative of the country.[16,17,60,61]

The use of dmft/DMFT index[62] for clinical and epidemiological studies has been promoted because of its global acceptance, convenience, reproducibility and the advantage of comparing past dental caries data with future findings.[63] Instead of recording the presence or absence of disease, this index records the stage of the disease.[63] In this review, all included studies reported caries levels using the dmft/DMFT index.[62] However, the dental caries diagnostic thresholds varied among the surveys. Twelve studies used the *Grade 4 (cavity into dentine) and above lesions* threshold,[41–50,52,54] one study[33] used both *Grade 3 (deep pitting reaching down to dentine) and above lesions* and *grade 4 and above lesions* thresholds, one study[53] used the visual dentinal caries threshold described by Whittle and Downer.[64] One study[59] used the visual dentinal caries threshold originally described by Backer-Dirks et al.,[65] 11 studies[34–37,39,40,52,55–58] used the cavitated dentinal caries (*3C*) threshold recommended by the WHO[63] and five studies[12,17,22,38,51] used both cavitated dentinal caries (*3C*) threshold recommended by the WHO[63] and the 1990s amended criteria of the British Association for the Study of Community Dentistry (BASCD) (*3VC*)[66] for reporting caries experience in children. The variations of dental caries diagnosis thresholds among the National dental health surveys are presented in Table 2.

14690328, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

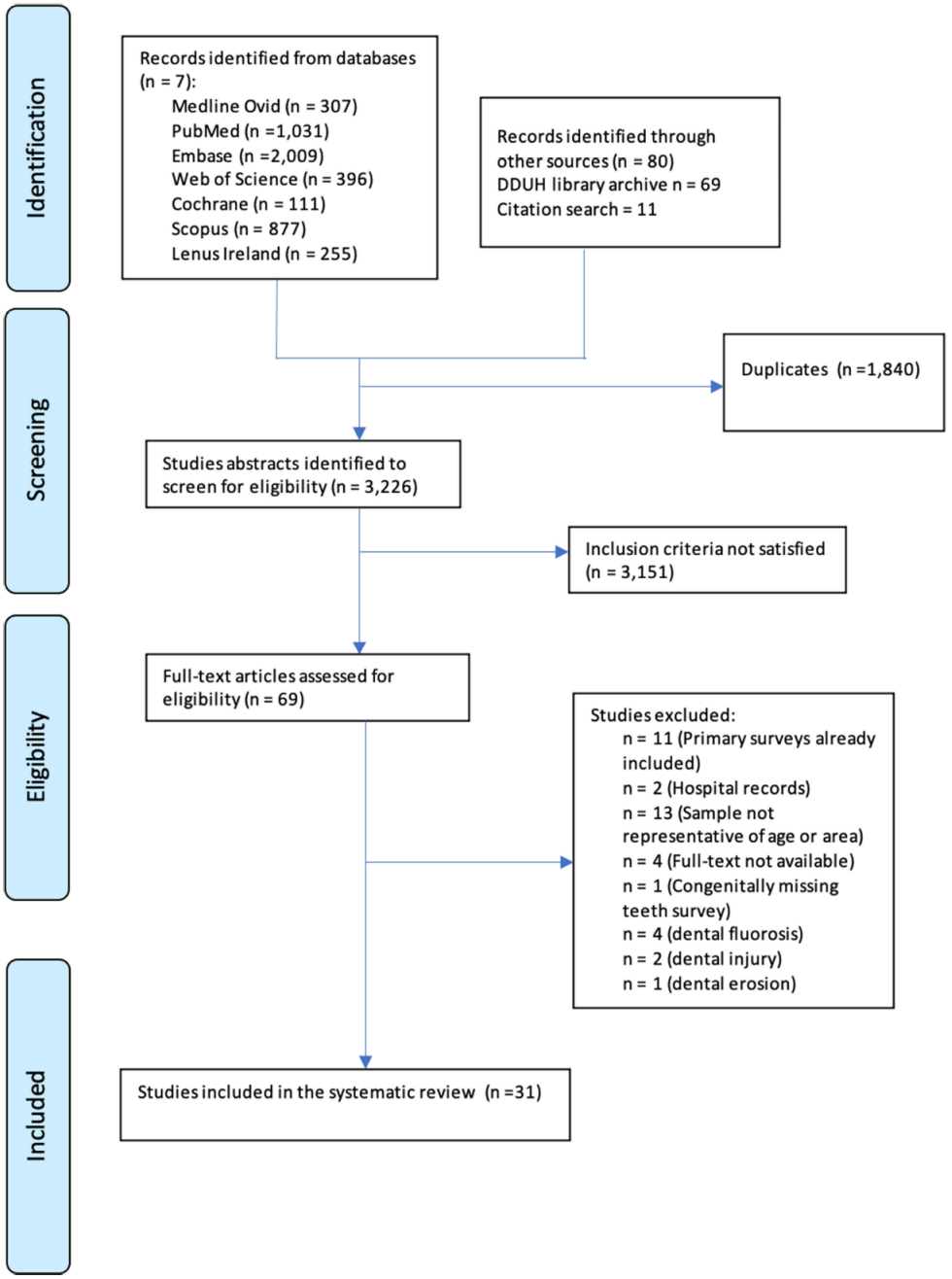


FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram of literature search and study selection process.

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 The diagnostic criteria and dental caries threshold used in the national surveys while reporting the level of dental caries in the primary and permanent dentition of Irish children.

Outcome variables	1952 Survey	1960s Survey	1984 Survey	2002 Survey
Mean dmft/DMFT count	Grade 4 and above lesions Comparable to the WHO examination criteria (3C)	Grade 4 and above lesions Comparable to the WHO examination criteria (3C)	Grade 4 and above lesions Comparable to the WHO examination criteria (3C)	WHO examination criteria (3C)[67]
Percentage of caries-free children	Grade 3 and above lesions	Grade 4 and above lesions	Grade 4 and above lesions	BASCD criteria (3VC) criteria[66]
Distribution of dmft/DMFT counts	Grade 3 and above lesions	Grade 4 and above lesions	Grade 4 and above lesions	BASCD criteria (3VC) criteria[66]

Note: The system of grading the degrees of caries which was adopted followed by the British Ministry of Health in the 1950s surveys in Britain. Six grades were recognized: Grade 1: Discoloration without destruction of enamel believed to be caused by caries; Grade 2: Pitting of enamel; Grade 3: Deep pitting reaching into dentine; Grade 4: Cavity into dentine; Grade 5: Large cavity penetrating deeply into dentine, generally of a few years' standing and with the pulp involvement; Grade 6: Cavity with definite and unmistakable evidence of periapical infection fistula on buccal gingiva or possibly on palatal mucosa in case of upper molar involvement.

Abbreviations: BASCD, British Association for the Study of Community Dentistry; 3C, Dentinal cavity; 3VC, Visual dentinal caries; WHO, World Health Organization.

The age groups of children examined also varied among the National surveys. During the 1952 survey, children examined for the 5-year-old age group were aged 5–6 years, the 8-year-old age group were aged 8–9 years and the 12-year-old age group were aged 12–13 years.[33] However, during the 1960s surveys, examined children were 3–19 years old.[41–47] For the 1960s surveys, the results for 5-year-olds were the combined average of the data for 4 and 5-year-olds; for 8-year-olds, the combined average of the data for 7 and 8-year-olds; for 12-year-olds, combined average for 11 and 12-year-olds; and for 15-year-olds, the combined average for 14 and 15-year-olds.[16] For the 1984 and 2002 surveys, examined children were representative of 5, 8, 12 and 15-year-olds.[16,17]

3.2 | Dental caries trends

The mean $d_{3c}mft/D_{3C}MFT$ scores and percentage of caries-free children (mean dmft/DMFT = 0) in primary (5-year-olds) and permanent dentitions (8, 12 and 15-year-olds) of Irish children reported in the National dental health surveys are shown in Tables S10–S12 (Appendix S4).

At the National level, the reductions in mean $d_{3c}mft/D_{3C}MFT$ scores were most apparent between the 1960s and 1984 surveys. During the period between 1984 and 2002 surveys, there were further declines in mean $d_{3c}mft/D_{3C}MFT$ scores (Figure 2A). The percentage of children with caries-free primary and permanent dentitions increased between 1952 and 2002 (Figure 2B).

The percentage distributions of dmft/DMFT scores for 5 and 12-year-olds reported in 1952, the 1960s, 1984 and 2002 surveys are shown in Figure 3. The dmft/DMFT scores = 0 represent caries-free children and dmft/DMFT scores >4 represent the percentage of children having greater than average caries experience.[63,67] Over the last 70 years, dental caries prevalence (dmft/DMFT >0) and percentage of children having greater than average caries experience in the primary and permanent dentitions of 5 and 12-year-olds, respectively, have decreased. In addition, the decline in dental caries prevalence was higher for children living in areas with CWF than those without CWF.

The mean $d_{3c}mft/D_{3C}MFT$ scores and percentage of caries-free children in primary (5-year-olds) and permanent dentitions (8, 12 and 15-year-olds) of Irish children reported in the Health Board Surveys are shown in Tables S13–S16 (Appendix S4). Between the 1960s and 1990s, mean $d_{3c}mft/D_{3C}MFT$ scores declined and percentage of caries-free children increased in all eight Health Board areas (Figure 4A,B). Between the 1990s and 2002, mean $d_{3c}mft/D_{3C}MFT$ scores and percentage of caries-free children remained relatively unchanged. However, results from the North-Western and South-Eastern Health Boards surveys indicated that percentage of caries-free children decreased between the 1990s and 2002 (Figure 4B).

At the County level, the data required for outlining dental caries trends in children were only available for County Dublin. Between 1961 and 1970, a reduction of almost 75% was observed in mean $d_{3c}mft$ scores for 5-year-olds. The decline in mean $d_{3c}mft$ scores

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

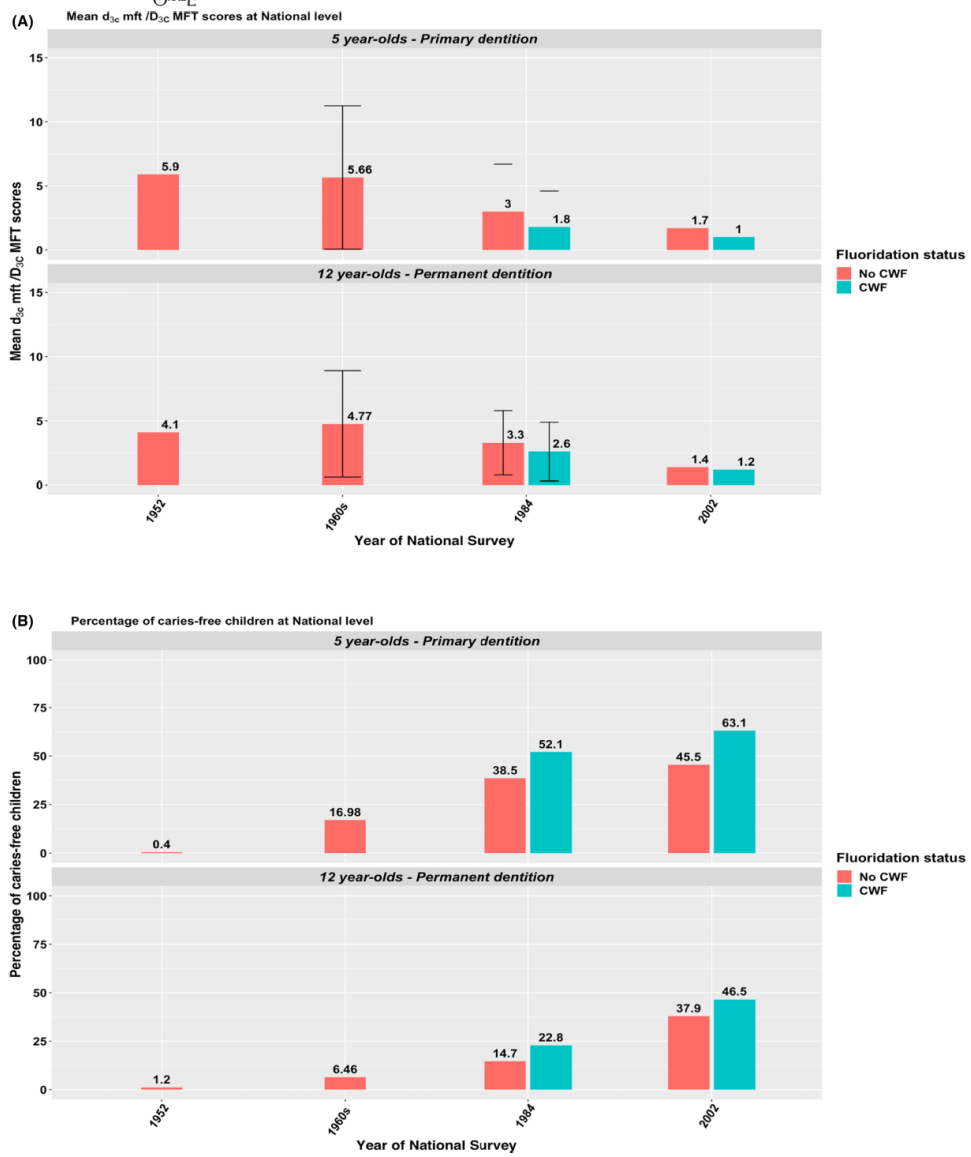


FIGURE 2 (A) The mean $d_{3c}mft/D_{3C}MFT$ scores (mean ± standard deviation) at National level by fluoridation status: The *x*-axis represents the year of National surveys (1952, 1960s, 1984 and 2002) and the *y*-axis represents the mean $d_{3c}mft/D_{3C}MFT$ scores. Red and green colours represent the areas without and with Community Water Fluoridation (CWF) respectively. For reporting the mean $d_{3c}mft/D_{3C}MFT$ scores, the dental caries diagnostic threshold used during 1952, the 1960s and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and *3C (cavity into dentine)* in 2002 survey. (B) Percentage of caries-free children among 5 and 12-year-olds at National level by fluoridation status: For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1952 survey was *Grade 3 (deep pitting reaching down to dentine) and above lesions, Grade 4 (cavity into dentine) and above lesions in the 1960s and 1984 survey* and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey.

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

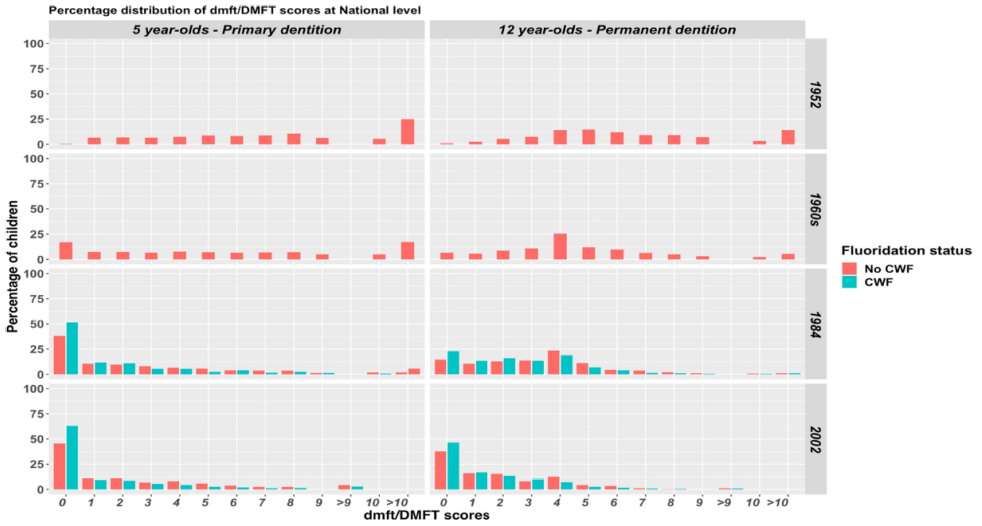


FIGURE 3 Percentage distribution of dmft/DMFT scores among 5 and 12-year-olds reported during the National surveys by fluoridation status: The *x*-axis represents dmft/DMFT scores and the *y*-axis represents percentage of children. The columns represent age groups and the rows represent year of National survey (1952, 1960s, 1984 and 2002). Red and green colours represent the areas without and with Community Water Fluoridation (CWF) respectively. For reporting the dmft/DMFT score distribution, the dental caries diagnostic threshold used in the 1952 survey was *Grade 3 (deep pitting reaching down to dentine) and above lesions, Grade 4 (cavity into dentine) and above lesions* in the 1960s and 1984 survey and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey.

continued in the 1980s and 1990s and then remained relatively unchanged over the last two decades. Between 1961 and 2014, the total reduction in mean d_{3c}mft scores was approximately 88% (Figure 5A). For 12-year-olds, mean D_{3C}MFT scores declined by 50% between 1961 and 1975. Over the last four decades, a steady decline has been observed in reported mean D_{3C}MFT scores for 12-year-olds. The total reduction in mean D_{3C}MFT scores among 12-years-olds between the 1960s and 2014 was nearly 90% (Figure 5A). In 2014, percentage of caries-free children among 5 and 12-year-olds living in County Dublin were 76% and 73% respectively (Figure 5B). The d_{3c}mft/D_{3C}MFT scores and percentage of caries-free children reported during County Dublin dental health surveys are shown in Table S17 (Appendix S4).

4 | DISCUSSION

This is the first systematic review summarizing studies on the dental caries experience of Irish children at National, Regional and County levels in the RoI over the last seven decades. There has been a marked reduction in dental caries prevalence in the primary and permanent dentitions of Irish children. A substantial decline in dental caries levels was evident in all surveys including those areas without CWF. The most recent dental health survey in the RoI for 5 and 12-year-olds was conducted for Counties Dublin, Cork and Kerry in the years 2013–14.[32] Approximately one quarter of the population of Ireland lives in County Dublin with access to CWF.[57] In 2013–14, the mean DMFT scores for 12-year-olds living in County Dublin (0.6) were lower than those living in Northern Ireland (1.4),[68] while the percentage of caries-free 12-year-olds living in Dublin was higher (73%) than those living in Northern Ireland (48%) which does not have National CWF.[69] The data obtained from the oral health country/area profile project database of the WHO[70] was used for international comparison of mean DMFT levels among 12-year-olds living in County Dublin with those living in the Western European countries, Australia, New Zealand, Canada and the USA between 1950s and 2021, as shown in Figure 6. Between 2010 and 2021, the mean DMFT scores for 12-year-olds living in Dublin County (0.6) were lower than those living in Italy (1.2), Spain (0.79), Belgium (0.9), Sweden (0.70), the United Kingdom (0.74), Portugal (1.2), Switzerland (0.9), Finland (1.1), New Zealand (1.12) and Norway (0.98). However, the mean DMFT levels were higher than those living in Denmark (0.5) and Germany (0.5). The countries were grouped as having community water fluoridation (Ireland, United States of America, Australia and New Zealand), having salt fluoridation (France, Germany and Switzerland) and non-fluoridated (Denmark, the Netherlands, Sweden, Spain, United Kingdom, Portugal, Norway, Italy, Finland, Belgium and Austria).[71] The market shares of fluoridated salts in Spain and Austria were 10% and 6%, respectively; therefore, classified as non-fluoridated countries.[72] On the other

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

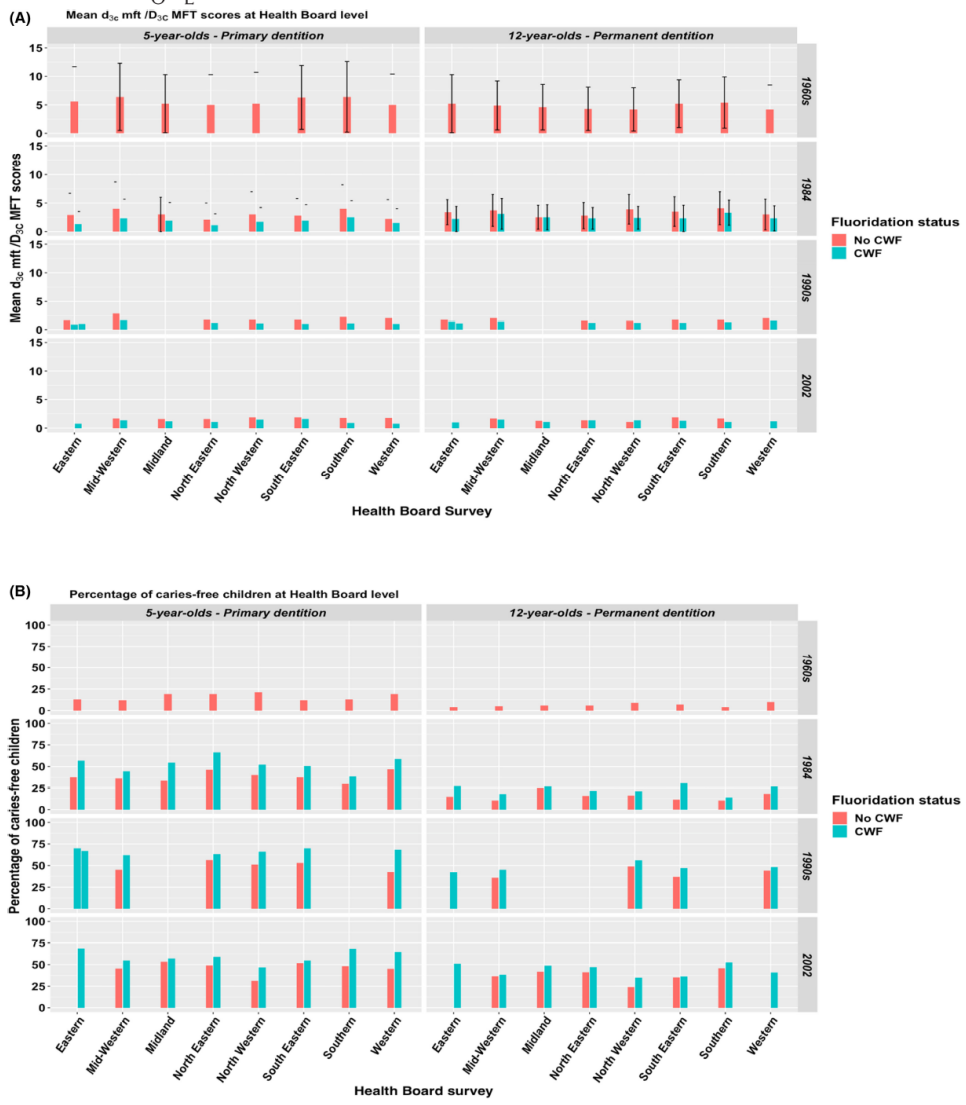


FIGURE 4 (A) The mean d_{3c}mft/ D_{3C}MFT scores (mean ± standard deviation) at Health Board level by fluoridation status: The *x*-axis represents Health Board survey and *y*-axis represents mean d_{3c}mft/D_{3C}MFT scores. Red and green colours represent the areas without and with Community Water Fluoridation (CWF) respectively. The columns represent age groups and the rows represent year of Health Board surveys. For reporting the mean d_{3c}mft/D_{3C}MFT scores, the dental caries diagnostic threshold used in the 1960s, and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and *3C (cavity into dentine)* in the 1990s and 2002 surveys. (B) The percentage of caries-free children at Health Board level by fluoridation status: For reporting the percentage of caries-free children, the dental caries diagnostic threshold used in the 1960s and 1984 survey was *Grade 4 (cavity into dentine) and above lesions, 3C (cavity into the dentine)* in the 1990s and *3VC (dentinal caries visible underneath the enamel without a detectable cavity through the enamel)* in 2002 survey.

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

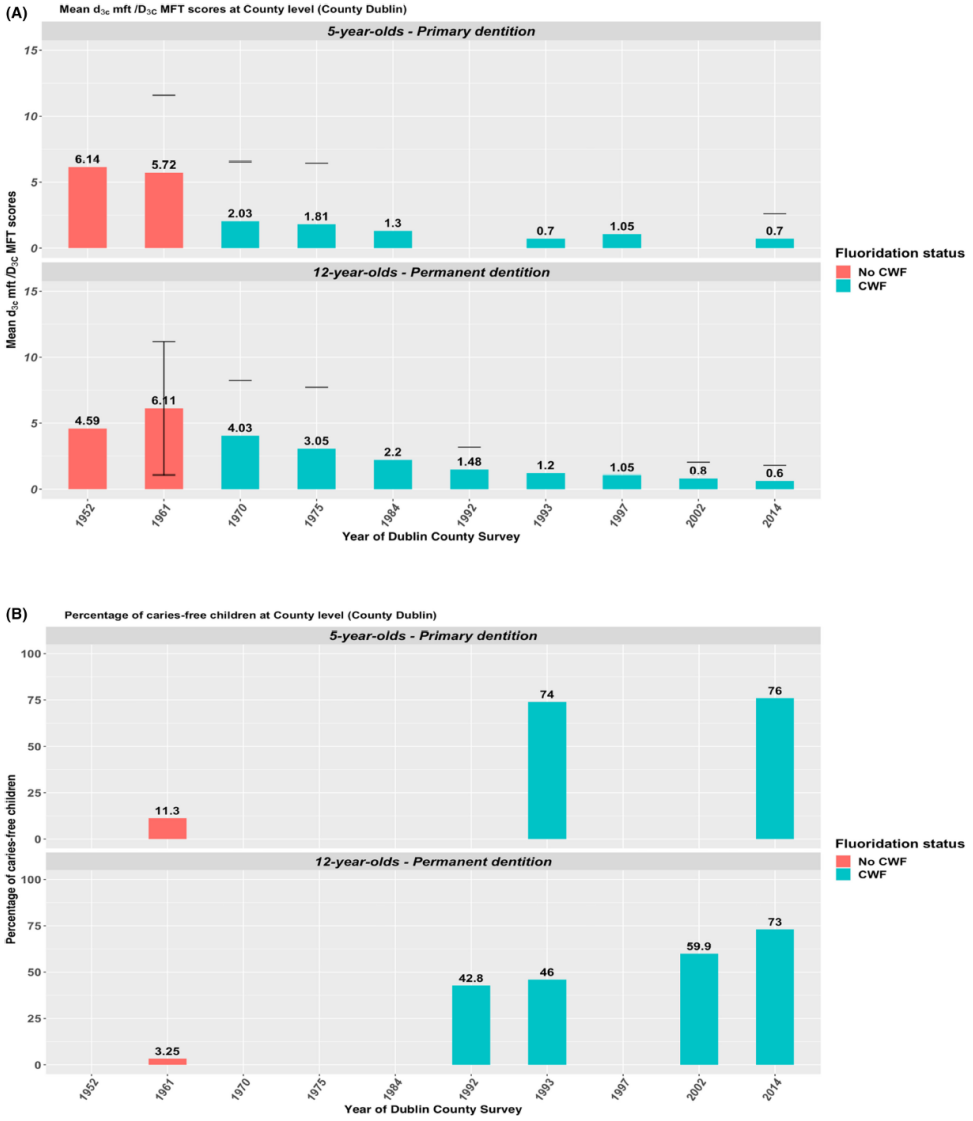


FIGURE 5 (A) Mean d_{3c}mft/D_{3C}MFT scores (mean ± standard deviation) at the County level (County Dublin) by fluoridation status: The x-axis represents the year of County Dublin survey and y-axis represents mean d_{3c}mft/D_{3C}MFT scores. Red and green colours represent areas without and with Community Water Fluoridation (CWF) respectively. Upper plots represent the 5-year-olds and lower plots represent the 12-year-olds. For reporting the mean d_{3c}mft/D_{3C}MFT scores, dental caries diagnostic threshold used in 1952, 1961, 1970, 1975 and 1984 surveys was *Grade 4 (cavity into dentine) and above lesions* and in the 1990s, 2002 and 2014 surveys was *3C (cavity into dentine)*. (B) Percentage of caries-free children at the County level (County Dublin) by fluoridation status: The x-axis represents the year of County Dublin survey and y-axis represents percentage of caries-free children. For reporting the percentage of caries-free children, dental caries diagnostic threshold used in 1961 was *Grade 4 (cavity into dentine) and above lesions*, in the 1990s, 2002 and 2014 surveys was *3C (cavity into dentine)*. The 1992 survey used the visual criteria by Backer-Dirks et al.[65]

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

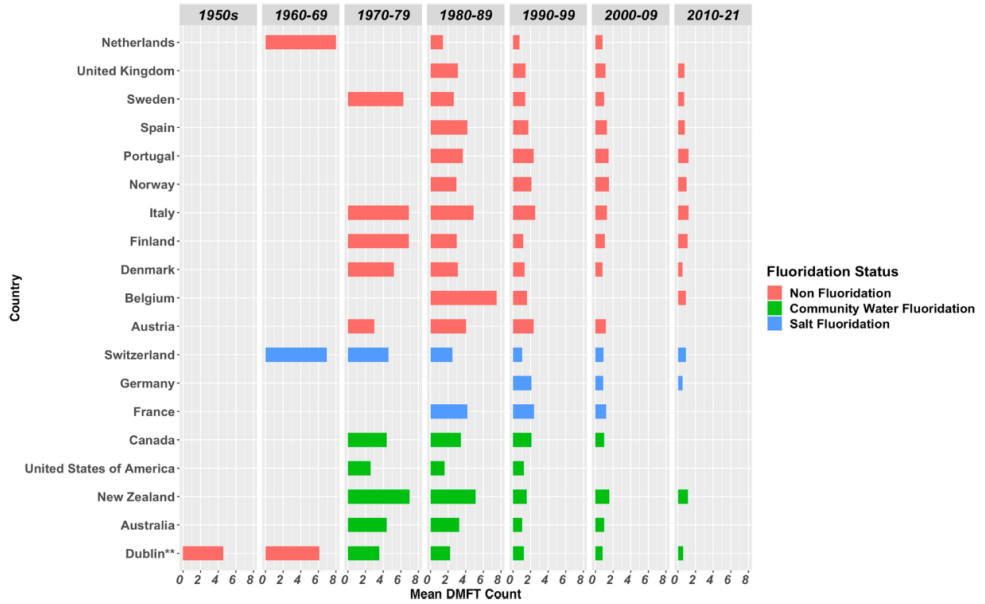


FIGURE 6 International comparison of mean DMFT scores among 12-year-olds living in the County Dublin over the last seven decades (from 1950s to 2021). The *x*-axis represents mean DMFT scores and the *y*-axis represents the countries. The countries were classified as: (a) With Community Water Fluoridation (green bars), (b) with salt water fluoridation (blue bars) and (c) with no fluoridation red bars). Country-specific data for the 12-year-olds were obtained from the oral health country/area profile project database of the WHO.[70]

hand, the market shares of fluoridated salts in Germany, Switzerland and France were 65%, 88% and 27% respectively.[72] Similarly, the percentage of the populations supplied with fluoridated water in the United Kingdom and Portugal was 9% and 1%, therefore, these two countries were also classified as non-fluoridated.[71] The percentage of population supplied with fluoridated water in the United States was 73% (2018),[73] Canada 39% (2022),[74] Australia 70% (2010),[75] New Zealand 60% (2021),[76] Republic of Ireland 71% (2017)[14] and Dublin 98% (1993).[37] The comparability of the national data for DMFT scores among the 12-year-olds may have been affected because of variations in sampling techniques, diagnostic criteria and methods to train and calibrate examiners employed during the national oral health surveys among the European countries.[77]

The observed reductions in dental caries were greater in younger than older age groups and children living in areas with CWF. The trends presented in this review were consistent with the results of previously published systematic reviews on the effectiveness of CWF.[19-21] Potential confounders of relevance to the association between dental caries and CWF include the use of other fluoride sources, specifically fluoridated toothpastes, socio-economic status (SES), oral health behaviours, sugar consumption/dietary habits and ethnicity.[20] Most of the included studies in this review did not adjust for potential confounders. Therefore, the magnitude of the differences in caries levels among the two groups presented in the review should be interpreted with caution. The use of fluoridated toothpastes in early childhood and increased frequency of toothbrushing has probably contributed to the reduction in caries severity in children both with and without CWF.[12,17,78] Fluoridated toothpastes were introduced in the RoI in the early 1970s, and by the end of 2002, over 95% of the toothpastes sold in Ireland were fluoridated.[17] The daily use of fluoridated toothpaste, ideally twice, has been suggested as the single most important factor responsible for caries decline among children in Western Europe between the 1960s and 1980s.[79,80] Findings from two Cochrane systematic reviews concluded that the dental caries preventive effect of fluoridated toothpaste increased with higher baseline dental caries, increased frequency of use and increased fluoride concentration up to 1500ppm of fluoride.[81,82] In the RoI, the reduction in dental caries prevalence among children living without CWF has been attributed to the use of fluoridated toothpastes and benefits of fluoride obtained from consuming foods and drinks processed using fluoridated water (the 'halo effect').[17] Fluoride from other sources such as fluoridated mouthrinses, fluoride tablets and professional applications such as fluoride solutions, varnishes and gels may also have contributed to the decline. It should be noted that these measures were not routinely employed on a public health basis in Ireland except for the school fluoride mouthrinse programme in the Southern Health Board.[7]

The public dental services in the RoI has targeted fissure sealants as a key caries-preventive strategy for children.[83] In 2002, among

16000828, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

the 8 and 12-year-olds living in areas with and without CWF, pit and fissure caries accounted for approximately 83% and 77% of the caries experience respectively. For 15-year-olds, living in areas with and without CWF, 74% and 69% of the caries experiences were due to pit and fissure caries respectively.[17] In 2002, the prevalence of fissure sealants among 8, 12 and 15-year-olds were 47%, 70% and 68% respectively.

Information about Irish children's SES, dietary behaviours and sugar consumption were not reported in most of the surveys. Therefore, the role of SES and diet/sugar consumption as a risk factor could not be determined. During the early 1990s, the mean consumption of sugar in the RoI was approximately 55 kg/person/year.[84] In the late 1990s, the amount of sugar consumed had dropped to an average of 45 kg/person/year, while from 2000 to 2005, the mean consumption of sugar reduced by 40% to approximately 28 kg/person/year. The next increase in sugar consumption to approximately 35 kg/person/year occurred between 2014 and 2019.[84] The variations in dental caries diagnostic criteria among the included surveys may have impacted the findings of this review. While all included studies used the dmft/DMFT index, dental caries was diagnosed using different criteria across different studies. During the first three National surveys, a sharp probe was used to confirm the diagnosis of dentinal caries. This changed in the 2002 survey, when a ball-ended (0.5 mm diameter) probe was used to confirm dentinal caries.[17] Use of vigorous probing with sharp probes for caries diagnosis during epidemiology surveys ceased in the early 1990s.[85] Round probes confirmed slightly fewer cavities than sharp explorers but the difference could not be quantified.[17] Similarly, it was confirmed that a sharp probe reported greater number of caries lesions in a 'sticky' fissure than a blunt ball-ended probe (0.4 mm).[86] In the 2002 survey, it was stated that the impact of probes transition (from sharp to round), had minimal effect on the dental caries diagnosis.[17]

The comparability of dental caries diagnostic criteria for the first three National surveys was discussed with the survey authors (DOM and JM) (personal communication). They confirmed that the threshold of *Grade 4 and above lesions* and the WHO *3C* criteria (cavitation stage) were, essentially, similar. Using both these criteria, dental caries were diagnosed only when the lesion had reached cavitation level (cavity into dentine). The caries diagnostic threshold of *Grade 3 and above lesions* used in the 1952 survey changed to *Grade 4 and above lesions* during the 1960s and 1984 surveys. As a result of this transition, it is possible that caries-free children were under-reported in the 1952 survey relative to the 1960s and 1984 surveys. Similarly, caries-free children may have been under-reported in the 2002 survey compared with the 1960s and 1984 surveys due to the change in the diagnostic threshold of *3C* during the 1960s and 1984 surveys to *3VC* during the 2002 survey. The comparability of criteria used in the 1952 and 2002 surveys to report caries-free children was discussed with the survey authors (DOM and JM) (personal communication). It was suggested that the methods used in the 1952 survey were not comparable to the visual (*3VC*) method of caries diagnosis because *Grade 1 and Grade 2 lesions*, usually included in the visual (*3VC*) method, were excluded in the 1952 survey. Similarly, dental caries diagnostic thresholds varied among the National dental health surveys in the United Kingdom. During the 1973, 1983 and 1993 National surveys of children's oral health in the United Kingdom, the threshold for caries diagnosis was a dentinal cavity (*3C*) lesion. During the 2003 survey in the United Kingdom, the threshold was visual dentinal caries (*3VC*), and later in the 2013 survey in the United Kingdom, the threshold was enamel caries.[86] The dmft/DMFT scores reported using the *3VC* criteria were approximately 20% higher than those reported using the *3C* criteria.[17] Wang et al. reported that the reported prevalence of dental caries by epidemiological surveys which only focussed on obvious decay (non-cavitated lesions into dentine and above) was 40% less than those which used clinical decay (non-cavitated enamel caries and above) as the diagnostic threshold.[87]

The main strength of this review is that most of the included studies had low risk of bias, and the results may be viewed as the best available evidence. Literature searches were completed and personal communication with survey authors established. This review identified all children's dental health surveys conducted in the RoI, and presented trends in dental caries among the primary and permanent dentitions of Irish children at National, Regional and County levels. However, there were limitations, including trends described based on cross-sectional survey data, which lack internal validity and generalizability.[88,89] Longitudinal data from birth cohort studies or cross-sectional surveys (conducted at periodic intervals and under similar condition) may be used to outline dental caries trends over time.[90] Secondly, the contributions of the various components of the dmft/DMFT index, that is, d (decayed), m (missing) and f (filled), towards the total count were unavailable for most of included studies. Therefore, it was challenging to compare and outline the burden of untreated dental caries trends among Irish children. Lastly, the quantitative assessment of the evidence (meta-analysis) could not be conducted because of the lack of data on the standard deviation of the mean dmft/DMFT for most of the included surveys.

Based on the findings of this review, the authors suggest, consistent with previous publications[1,16,77,80,91,92] that National oral health surveys should be conducted at regular intervals to monitor dental caries prevalence and incidence and an international consensus of protocols should be formulated for epidemiological surveys of dental caries in children.

5 | CONCLUSIONS

Dental caries in children has consistently declined in the RoI in the last seven decades. Since the introduction of CWF, a greater reduction in dental caries has been reported among children living in areas with CWF compared to those without CWF.

AUTHOR CONTRIBUTIONS

Conceptualization: VS, MOS, MC, AOS, OC and LW; Methodology: VS, MOS and MC; Data acquisition and statistical analysis: VS, MOS, MC and OC; Interpretation of findings: VS, MOS, MC and LW; Drafting and critically reviewing the article: VS, MOS, MC, AOS, OC and LW; Project administration: MOS. All authors have read and approved the final article.

ACKNOWLEDGEMENTS

We thank Ms Isabel Fleischmann, Librarian at School of Dental Science, Trinity College Dublin, for her support on development of search strategy. We also thank Dr Jacinta McLoughlin and Prof Denis O'Mullane, field experts and senior participants of the National Oral Health Surveys in Ireland who provided further information on completed surveys. Open access funding provided by IReL.

FUNDING INFORMATION

This study was completed as a part of a Doctor of Philosophy (PhD) degree by VS supported by the Dublin Dental University Hospital and Trinity College Dublin, Ireland (1252 scholarship).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

All data generated and analysed during this review are not publicly available but can be made available on request from the corresponding author.

ORCID

Vinay Sharma https://orcid.org/0000-0002-1615-7294
Michael Crowe https://orcid.org/0000-0003-4761-5945
Oscar Cassetti https://orcid.org/0000-0001-5174-0584
Lewis Winning https://orcid.org/0000-0002-8783-8089
Aifric O'Sullivan https://orcid.org/0000-0002-7441-1983
Michael O'Sullivan https://orcid.org/0000-0003-2121-4254

REFERENCES

1. Peres MA, Macpherson LMD, Weyant RJ, et al. Oral diseases: a global public health challenge. *Lancet*. 2019;394(10194):249-260.
2. James SL, Abate D, Abate KH, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392(10159):1789-1858.
3. Listl S, Galloway J, Mossey PA, Marcenes W. Global economic impact of dental diseases. *J Dent Res*. 2015;94(10):1355-1361.
4. Patel R. The state of oral health in Europe. Report commissioned by the platform for better oral health in Europe. 2012 09/2012.
5. Righolt AJ, Jevdjevic M, Marcenes W, Listl S. Global-, regional-, and country-level economic impacts of dental diseases in 2015. *J Dent Res*. 2018;97(5):501-507.
6. Jürgensen N, Petersen P. Promoting oral health of children through schools–results from a WHO global survey 2012. *Community Dent Health*. 2013;30(4):204-218.
7. Holland TJ, Whelton H, O'Mullane DM, Creedon P. Evaluation of a fortnightly school-based sodium fluoride mouthrinse 4 years following its cessation. *Caries Res*. 1995;29(6):431-434.
8. Petersen PE, Lennon MA. Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. *Community Dent Oral Epidemiol*. 2004;32(5):319-321.
9. Featherstone JDB. Prevention and reversal of dental caries: role of low level fluoride. *Community Dent Oral Epidemiol*. 1999;27(1):31-40.
10. Petersen PE, Ogawa H. Prevention of dental caries through the use of fluoride–the WHO approach. *Community Dent Health*. 2016;33(2):66-68.
11. Ripa LW. A half-century of community water fluoridation in the United States: review and commentary. *J Public Health Dent*. 1993;53(1):17-44.
12. James P, Harding M, Beecher T, et al. Impact of reducing water fluoride on dental caries and fluorosis. *J Dent Res*. 2021;100(5):507-514.
13. Government of Ireland. Health (Fluoridation of Water Supplies) Act, 1960. Accesssed July 24, 2022. https://www.irishstatutebook.ie/eli/1960/act/46/enacted/en/html
14. Cronin J, Moore S, Harding M, Whelton H, Woods N. A cost-effectiveness analysis of community water fluoridation for school-children. *BMC Oral Health*. 2021;21(1):1-12.
15. Harding MA, O'Mullane DM. Water fluoridation and oral health. *Acta Med Acad*. 2013;42(2):131-139.
16. O'Mullane D, Clarkson J, Holland T, et al. *Children's Dental Health in Ireland, 1984*: A Survey Conducted on Behalf of the Minister for Health by University College Cork. Department of Health Ireland; 1986.
17. Whelton H, Crowley E, Harding M, et al. *North South Survey of Children's Oral Health in Ireland 2002*. The Department of Health and Children Health Services Executive, Ireland; The Department of Health Social Services and Public Safety, Northern Ireland; WHO Collaborating Centre for Oral Health Services Research University College Cork; 2006.
18. Government of Ireland. Fluoridation of Water Supplies Regulations 2007. Accesssed July 24, 2022. https://www.irishstatutebook.ie/eli/2007/si/42/made/en/print
19. McDonagh MS, Whiting PF, Wilson PM, et al. Systematic review of water fluoridation. *BMJ*. 2000;321(7265):855-859.
20. Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database Syst Rev*. 2015;6:1-261.
21. Belotti L, Frazão P. Effectiveness of water fluoridation in an upper-middle-income country: a systematic review and meta-analysis. *Int J Paediatr Dent*. 2021;32(4):503-513.
22. South Eastern Health Board. Oral health of children and adolescents in the South Eastern Region, 1998/'99. Oral Health Services Research Center, University College Cork; 1998/'99.
23. Houses of the Oireachtas. Health Act, 1970. Accesssed July 24, 2022. https://www-irishstatutebook-ie.elib.tcd.ie/eli/1970/act/1/section/1/enacted/en/html#sec1
24. Houses of the Oireachtas. Health (Eastern Regional Health Authority) Act, 1999. Accesssed July 24, 2022. https://www.irishstatutebook.ie/eli/1999/act/13/enacted/en/html
25. Central Statistics Office. Census 2022, preliminary actual and percentage change in population 2016–2022 Ireland. 2022. Accessed June 27, 2022. https://data.cso.ie/
26. Brownson RC, Fielding JE, Maylahn CM. Evidence-based public health: a fundamental concept for public health practice. *Annu Rev Public Health*. 2009;30(1):175-201.
27. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151(4):264-269.

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

28. Booth A, Clarke M, Dooley G, et al. The nuts and bolts of PROSPERO: an international prospective register of systematic reviews. *Syst Rev*. 2012;1(1):1-8.
29. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. *JBI Evid Implement*. 2015;13(3):147-153.
30. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1):1-10.
31. R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing; 2022.
32. James P, Harding M, Beecher T, et al. Fluoride and caring for children's teeth (FACCT): clinical fieldwork protocol. *HRB Open Res*. 2018;1:1-17.
33. Medical Research Council of Ireland. Dental caries in Ireland. 1953.
34. Mid-Western Health Board. Survey of oral health of children and adolescents, 1997. Oral Health Services Research Center, University College Cork; 1998.
35. North Eastern Health Board. Children's dental health in the North Eastern Health Board Region, 1995. Oral Health Services Research Center, University College Cork; 1996.
36. Southern Health Board. Oral health of children and adolescents, 1995. Oral Health Services Research Center, University College Cork; 1995.
37. Eastern Health Board. Children's dental health in the Eastern Health Board region, 1993: report of a study conducted by the Dental Department of the Eastern Health Board in collaboration with the Oral Services Research Centre University College Cork. Oral Health Services Research Center, University College Cork; 1994.
38. North Western Health Board. Survey of oral health of children and adolescents, 1997/'98. Oral Health Services Research Center, University College Cork; 1998.
39. Eastern Health Board. Oral health of children in the Eastern Health Board, 1997. Oral Health Services Research Center, University College Cork; 1997.
40. Western Health Board. Children's dental health in the Western Health Board region. Oral Health Services Research Center, University College Cork; 1994.
41. Department of Health (DoH). Health (Fluoridation of water supplies) Act, 1960: report on the incidence of dental caries in school children, and on the analysis of public piped water supplies in the health authority areas of Cork, Limerick and Waterford. 1962.
42. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Louth, Wexford, Laois and Galway. 1963.
43. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Tipperary (North Riding), Tipperary (South Riding), Kilkenny and Carlow. 1964.
44. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Kerry, Clare, West-Meath and Offaly. 1964.
45. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Roscommon, Longford, Leitrim, Cavan and Monaghan. 1965.
46. Department of Health (DoH). Health (Flouridation of Water Supplies Act) 1960: report on the incidence of dental caries in school children and on the analyses of public piped water supplies in the Health Authority areas of Meath, Donegal, Sligo and Mayo. 1965.
47. Department of Health (DoH). Health (fluoridation of water supplies) act, 1960: report on the incidence of dental caries in school children, and on the analysis of public piped water supplies, in Dublin, Kildare and Wicklow Health Authority Areas. 1962.
48. Collins CK, O'Mullane DM. Dental caries experience in Cork City schoolchildren aged 4-11 years after 4 1/2 years of fluoridation. *J Ir Dent Assoc*. 1970;16(5):130-134.
49. O'Hickey S, Pigott B. Dental caries experience of Dublin School-children after 5 1/2 years of fluoridation. *J Ir Dent Assoc*. 1981;27:78-83.
50. O'Hickey S, Pigott B. Dental caries experience of Dublin School-children after 10 1/2 years of fluoridation. *J Ir Dent Assoc*. 1983;29(1):5-8.
51. Creedon MI, O'Mullane DM. Factors affecting caries levels amongst 5-year-old children in County Kerry, Ireland. *Community Dent Health*. 2001;18(2):72-78.
52. Daly B, Hobdell MH, Sadlier D, Jennings N. The Kilkenny integrated oral health project. *Ir J Med Sci*. 1991;160(Suppl 9):50-54.
53. Lemasney J, O'Mullane D, Coleman M. Effect of fluoridation on dental health in 5- and 11-year-old Irish schoolchildren. *Community Dent Oral Epidemiol*. 1984;12(4):218-222.
54. Thomas WM. Report on a survey of the incidence of dental caries in national school children in the Tullamore urban area Co. Offaly. Midland Health Board (MHB); 1972.
55. Bolin AK, Bolin A, Jansson L, Calltorp J. Children's dental health in Europe. *Swed Dent J*. 1997;21(1):25-40.
56. Whelton H, O'Keefe J, O'Mullane DM. Children's dental health in County Clare, 1991. Mid-Western Health Board; 1991.
57. Oral Health Services Research Centre, University College Cork. OHSRC briefing document on HRB funded fluoride and caring for children's teeth study (FACCT). 2018.
58. Sagheri D, McLoughlin J, Clarkson JJ. A comparison of dental caries levels in two communities with different oral health prevention strategies stratified in different social classes. *J Public Health Dent*. 2007;67(1):1-7.
59. Downer M, Blinkhorn A, Holt R, Wight C, Attwood D. Dental caries experience and defects of dental enamel among 12-year-old children in north London, Edinburgh, Glasgow and Dublin. *Community Dent Oral Epidemiol*. 1994;22(5 Pt 1):283-285.
60. O'Mullane D, Clarkson J, Holland T, O'Hickey S, Whelton H. Effectiveness of water fluoridation in the prevention of dental caries in Irish children. *Community Dent Health*. 1988;5(4):331-344.
61. Clarkson J, McLoughlin J, O'Hickey S. Water fluoridation in Ireland—a success story. *J Dent Res*. 2003;82(5):334-337.
62. Klein H, Palmer CE, Knutson JW. Studies on dental caries: I. dental status and dental needs of elementary school children. *Public Health Rep*. 1938;53(19):751-765.
63. Petersen PE, Ramon JB, World Health Organization. *Oral Health Surveys: Basic Methods*. 5th ed. World Health Organization; 2013.
64. Whittle JG, Downer MC. Dental health and treatment needs of Birmingham and Salford school children. A comparison in a fluoridated and a non-fluoridated area. *Br Dent J*. 1979;147(3):67-71.
65. Dirks OB, Houwink B, Kwant GW. The results of 612 years of artificial fluoridation of drinking water in The Netherlands: the tiel—Culemborg experiment. *Arch Oral Biol*. 1961;5(3):284-300.
66. Pitts NB, Evans DJ, Pine CM. British Association for the study of community dentistry (BASCD) diagnostic criteria for caries prevalence surveys-1996/97. *Community Dent Health*. 1997;14:6-9.
67. Petersen PE. The World Oral Health report 2003: continuous improvement of oral health in the 21st century - the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol*. 2003;31(s1):3-24.

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

68. Pitts N, Chadwick B, Anderson T. Children's Dental Health Survey 2013. Report 2: dental disease and damage in children England, Wales and Northern Island England. Health & Social Care Information Centre; 2015.
69. Ravaghi V, Hill K, Ryan R, Dennes M. Children's dental health survey 2013. Country specific report: Northern Ireland. Health and Social Care Information Center; 2015.
70. Malmo University, World Health Organisation. Oral Health Country/Area Profile Project. 2022. Accesssed September 09, 2022. https://capp.mau.se/dental-caries/
71. Cheng KK, Chalmers I, Sheldon TA. Adding fluoride to water supplies. *BMJ*. 2007;335(7622):699-702.
72. Götzfried F. Legal aspects of fluoride in salt, particularly within the EU. *Schweiz Monatsschr Zahnmed*. 2006;116(4):371-375.
73. Centers for Disease Control and Prevention. Water fluoridation data & statistics. U.S. Department of Health & Human Services; 2018. Accesssed May 15, 2023. https://www.cdc.gov/fluoridation/statistics/index.htm
74. Public Health Agency of Canada. *The State of Community Water Fluoridation Across Canada*. Public Health Agency of Canada; 2022.
75. Ha D, Spencer A, Moynihan P, Thomson W, Do L. Excess risk of dental caries from higher free sugars intake combined with low exposure to water fluoridation. *J Dent Res*. 2021;100(11):1243-1250.
76. Massey University. Access to fluoridated drinking-water Wellington, New Zealand. Ministry of Health; 2023. Accesssed May 15, 2023. https://www.ehinz.ac.nz/indicators/water/drinking-water-quality/access-to-fluoridated-drinking-water/
77. Patel RN, Eaton K, Pitts N, Schulte A, Pieper K, White S. Variation in methods used to determine national mean DMFT scores for 12-year-old children in European countries. *Community Dent Health*. 2016;33(4):286-291.
78. O'Mullane D, Clarkson J, Parnell C. Report of the working group on the use of fluoride toothpaste in children under six years of age. 2018.
79. Marthaler TM, Brunelle J, Downer MC, et al. The prevalence of dental caries in Europe 1990-1995. *Caries Res*. 1996;30(4):237-255.
80. Marthaler TM. Changes in dental caries 1953–2003. *Caries Res*. 2004;38(3):173-181.
81. Marinho VC, Higgins J, Logan S, Sheiham A. Fluoride toothpastes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*. 2003;2016(11):1-93.
82. Walsh T, Worthington HV, Glenny AM, Marinho VC, Jeroncic A. Fluoride toothpastes of different concentrations for preventing dental caries. *Cochrane Database Syst Rev*. 2019;3:1-245.
83. Irish Oral Health Services Guideline Initiative. Pit and fissure sealants: evidence-based guidance on the use of sealants for the prevention and management of pit and fissure caries. 2010.
84. Food and Agriculture Organization of the United Nations. FAOSTAT, food and agriculture data 2022. Accesssed September 24, 2022. https://www.fao.org/faostat/en/#data/FBS
85. Neuhaus KW, Ellwood R, Lussi A, Pitts NB. Traditional lesion detection aids. *Monogr Oral Sci*. 2009;21:42-51.
86. Murray JJ, Vernazza CR, Holmes RD. Forty years of national surveys: an overview of children's dental health from 1973-2013. *Br Dent J*. 2015;219(6):281-285.
87. Wang X, Bernabe E, Pitts N, Zheng S, Gallagher JE. Dental caries thresholds among adolescents in England, Wales, and Northern Ireland, 2013 at 12, and 15 years: implications for epidemiology and clinical care. *BMC Oral Health*. 2021;21(1):1-14.
88. Levin KA. Study design III: cross-sectional studies. *Evid Based Dent*. 2006;7(1):24-25.
89. Kundu H, Patthi B, Singla A, Jankiram C, Jain S, Singh K. Dental caries scenario among 5, 12 and 15-year-old children in India-a retrospective analysis. *J Clin Diagn Res*. 2015;9(7):ZE01-ZE05.
90. Burt BA. How useful are cross-sectional data from surveys of dental caries? *Community Dent Oral Epidemiol*. 1997;25(1):36-41.
91. Shen A, Bernabé E, Sabbah W. Systematic review of intervention studies aiming at reducing inequality in dental caries among children. *Int J Environ Res Public Health*. 2021;18(3):1-11.
92. Antunes JLF, Narvai PC. Dental health policies in Brazil and their impact on health inequalities. *Rev Saude Publica*. 2010;44(2):360-365.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Sharma V, Crowe M, Cassetti O, Winning L, O'Sullivan A, O'Sullivan M. Dental caries in children in Ireland: A systematic review. *Community Dent Oral Epidemiol*. 2024;52:24-38. doi:10.1111/cdoe.12897

16000528, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12897 by HEALTH RESEARCH BOARD, Wiley Online Library on [27/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Check for updates

Received: 7 September 2023 | Revised: 16 April 2024 | Accepted: 14 June 2024

DOI: 10.1111/jphd.12632

ORIGINAL ARTICLE

Evaluating the harmonization potential of oral health-related questionnaires in national longitudinal birth and child cohort surveys

Vinay Sharma MPH[1] | **Michael O'Sullivan PhD**[1] | **Oscar Cassetti PhD**[1] | **Lewis Winning PhD**[1] | **Aifric O'Sullivan PhD**[2] | **Michael Crowe PhD**[1]

[1]Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Dublin, Ireland

[2]Institute of Food and Health, Science Centre, South, UCD, Dublin, Ireland

Correspondence
Vinay Sharma, Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Lincoln Place, Dublin, Ireland.
Email: vinay.sharma@dental.tcd.ie

Funding information
Dublin Dental University Hospital and Trinity College Dublin, Ireland, Grant/Award Number: 1252

Abstract

Background/Objectives: Effective use of longitudinal study data is challenging because of divergences in the construct definitions and measurement approaches over time, between studies and across disciplines. One approach to overcome these challenges is data harmonization. Data harmonization is a practice used to improve variable comparability and reduce heterogeneity across studies. This study describes the process used to evaluate the harmonization potential of oral health-related variables across each survey wave.

Methods: National child cohort surveys with similar themes/objectives conducted in the last two decades were selected. The Maelstrom Research Guidelines were followed for harmonization potential evaluation.

Results: Seven nationally representative child cohort surveys were included and questionnaires examined from 50 survey waves. Questionnaires were classified into three domains and fifteen constructs and summarized by age groups. A DataSchema (a list of core variables representing the suitable version of the oral health outcomes and risk factors) was compiled comprising 42 variables. For each study wave, the potential (or not) to generate each DataSchema variable was evaluated. Of the 2100 harmonization status assessments, 543 (26%) were complete. Approximately 50% of the DataSchema variables can be generated across at least four cohort surveys while only 10% ($n = 4$) variables can be generated across all surveys. For each survey, the DataSchema variables that can be generated ranged between 26% and 76%.

Conclusion: Data harmonization can improve the comparability of variables both within and across surveys. For future cohort surveys, the authors advocate more consistency and standardization in survey questionnaires within and between surveys.

KEYWORDS
child, cohort surveys, data discovery, data harmonization, longitudinal surveys, oral health, risk factors

INTRODUCTION

Population-based cohort studies follow a sample or an entire population longitudinally and have been considered a valuable resource for investigating the developmental origins of health and disease [1–3].

Most oral diseases are chronic, cumulative, and have multifactorial etiology so are amenable to life course epidemiological studies [4]. A comprehensive understanding of oral disease risk factors and indicators (e.g., low socioeconomic status, poor oral hygiene practices, diet rich in free sugars, infrequent dental visits behavior, and

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2024 The Author(s). *Journal of Public Health Dentistry* published by Wiley Periodicals LLC on behalf of American Association of Public Health Dentistry.

inadequate fluoride exposure) is necessary for oral disease prevention [5, 6]. These factors have been classified as modifiable (e.g., short-duration breastfeeding, sugary beverages intake, increased energy intake, poor child health, increased child weight, oral hygiene practices, fluoride exposure, oral health services use and increased stress), and non-modifiable (e.g., developmental conditions, low socioeconomic status and increased cultural acculturation) [7]. Dental caries and obesity are two of the most common, largely preventable chronic health conditions affecting children, which are significant public health concerns [8, 9]. Poor dietary and nutritional behaviors, established at a young age, are associated with a higher risk of obesity and dental caries throughout the life course [10, 11].

Nationally representative oral health data are needed to plan and evaluate oral health policies and services effectively [12]. However, this data type is scarce because of the logistical and financial burden associated with clinical data collection in national oral health surveys [13, 14]. The last National Children's Oral Health Survey in the Republic of Ireland (RoI) was completed almost 21 years ago [15]. Self-reported oral health data from national birth and child cohort surveys provide an opportunity for estimating the distributions and prevalence of oral diseases in children over time. Moreover, these surveys help in relating oral health findings to general health conditions and sociodemographic factors in the same cohort [16–18]. Furthermore, they can provide useful information about factors related to a child's early life, family and environment. This information can predict health outcomes and disease susceptibility at later life stages [3, 6].

In oral health epidemiology, domains are broad categories representing particular research fields, such as oral health status and oral health behaviors. Within the respective domains, constructs are theoretical concepts or ideas based on empirical observation, for example, an individual's self-perceived oral health and daily toothbrushing frequency. The indicators or variables are more specific items/measures used to measure these concepts. A single self-rated oral health (SROH) question with a response scale of five points (excellent, very good, good, fair, and poor) is a useful and valid summary measure of people's oral health [19, 20]. Construct validity of a measure represents the degree to which it correctly measures its targeted construct or concept [21].

Secondary data analysis (analysis of data collected in the past by others for another primary purpose) provides a viable option for researchers when it is not feasible to independently collect data from a sufficiently large sample to investigate population oral health issues [22, 23]. For efficient use of secondary data, data discovery, the ability to find relevant data to a research project is a critical component [24]. However, for large-scale cohort surveys, data discovery may be challenging as these studies are under-documented and have varied data structures and labelling conventions [24, 25]. Studying essential aspects of data collection and management may provide a better understanding of study-specific variables [26].

A single cohort study data may be used to study disease distributions, exposure-outcome relationships, disease trends and changes over time among the same individuals. However, collating, comparing, and pooling data from multiple cohort studies facilitates validating, tracking and quantifying changing characteristics at the population level and across generations [25]. International comparisons of child oral and well-being data have had a political and public impact [27, 28]. Data pooling increases statistical power, further facilitates replication of analyses, detection of smaller associations and investigation of rare events [29–32].

A pre-requisite for efficient data discovery and co-analysis of individual participant data is data harmonization [3, 24, 29]. This is a practice used to achieve comparability between two or more variables by inferring a latent construct that the variables are considered to represent [24]. This facilitates the coherent combination of varied datasets [32, 33]. Prospective harmonization ideally occurs before data collection. This requires agreement between investigators on a standard set of variables, compatible data collection tools, and standard operating procedures [32]. Even though prospective harmonization ensures a high degree of homogeneity across studies, implementing this approach is not always suitable or feasible [29, 32]. Using retrospective harmonization, researchers define a core set of variables to be generated and evaluate the harmonization potential of the already collected information across the studies involved [3, 29, 31, 34]. Data harmonization provides an infrastructure supporting the reuse of survey data by making data findable, accessible, interoperable, and reusable [35].

In the last 20 years, harmonization initiatives for population health have increased significantly [3]. These initiatives can be classified as (1) hypothesis-specific initiatives across multiple datasets or (2) initiatives targeting a broad range of objectives [3, 24]. These projects have included studies in the EU [36–39], UK, [24, 25] and Canada [31, 32, 40, 41].

Rationale for the study

The global distribution of oral health-related birth cohort studies and available oral health data were summarized recently [6]. However, to the best of our knowledge, there has been no oral health-related questionnaire data harmonization initiative for nationally representative birth/child cohort surveys. The primary aim of this study was to evaluate the harmonization potential of oral health-related questionnaire data in selected nationally representative birth/child cohort surveys in high-income countries.

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 The Maelstrom Research guidelines checklist for evaluating the harmonization potential of the study-specific variables [29].

Steps	Description
Step 0: Define the questions and objectives	The research question was defined in terms of population, exposure, comparator, outcome, and timing.
Step 1: Assemble information and select studies	
Step 1a: Document individual study designs, methods, and content	Study specific information such as study design, timeline, population characteristics and data contents were gathered and documented.
Step 1b: Select participant studies	Studies were selected based on the explicit selection criteria.
Step 2: Define variables and evaluate harmonization potential	The DataSchema variables were defined based on their relevance to the research question, likelihood to be generated across multiple studies and input from experts.
Step 2a: Select and define core variables to be harmonized (DataSchema)	The DataSchema variables were clearly defined along with their data type, format, and level of heterogeneity.
Step 2b: Determine the potential to generate the DataSchema variables making use of study-specific data items	The potential (or not) for each study wave to create DataSchema variables were assessed and documented.

The objectives were to:

a. Review and compare study-specific questionnaires published by each cohort survey across each wave.
b. Evaluate the harmonization potential of study-specific questionnaires.
c. Identify data coverage gaps in the existing questionnaires.
d. Provide recommendations for the effective use of existing datasets as well as for the improvement of future survey waves.

METHODOLOGY

The Maelstrom Research guidelines for retrospective data harmonization were used for evaluating the harmonization potential of the study-specific variables [29]. The Maelstrom Research guidelines checklist is presented in Table 1:

Study selection

Eligibility criteria

Inclusion criteria:

1. A nationally representative birth/child cohort survey in an English-speaking (Countries where English is spoken as a first language by the majority of the population) high-income country.
2. Baseline data collection after the year 2000 with plans for future data collection.
3. Studying the growth and development of children at different age groups across a broad range of internationally recognized child outcomes.
4. Parent/self-reported oral health-related data collected through at least one follow-up.

Exclusion criteria

1. Not nationally representative.
2. Low or middle-income country survey.
3. Started data collection before 2000.
4. Discontinued surveys.

Study search

The freely accessible database, Birthcohorts.net4 (https://www.birthcohorts.net/) and the cohort network of the Society for Longitudinal and Life Course Studies (SLLS) (https://www.slls.org.uk/pages/longitudinal-studies) were used to locate potential birth and child cohort surveys worldwide. In addition, a manual search of the reference list of two scoping reviews on birth cohort studies was also completed [6, 42].

The main focus of the present study was to include cohort surveys from high-income countries sharing similar survey methodologies and themes/objectives. The high-income countries, as defined by the World Bank, were those with a GNI (Gross National Income) per capita of $13,846 or more [43].

After initial screening using official survey documentation published online, survey wave questionnaires were used for the final selection of studies. Excluded studies and the reasons for their exclusion are presented in Table 3.7, Supplementary material for review S1.

Data extraction and variable selection

A standardized data extraction form was developed, and the following information was extracted: the study name, country name, cohort baseline and follow-up calendar years, sample size, study child age, and the response percentage of the original sample. Study-specific questionnaire data were collected from the published

17577325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ipd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Domains and constructs included for harmonization potential evaluation of parent/self-reported oral health-related questionnaire data in nationally representative birth/child cohort studies.

Domain	Construct	Description
Oral health status	Dental injury	Whether the study child had dental injuries. And, the number of times the study child had been taken to the hospital, emergency, health center, or dentist as a result of dental injuries.
	Dental treatments	Type and number of dental treatments received by the study child.
	Dental problems	Type and number of dental problems the study child presented with.
	Parent/Self-perceived oral health status	Parent/study child's subjective perception of their oral health status.
Oral health behaviors	Toothbrushing frequency	Daily toothbrushing frequency of the study child.
	Toothbrushing supervision	Supervision of the study child by their parents while they cleaned their teeth.
	Toothbrushing assistance	Assistance provided to the study child while toothbrushing.
	Toothbrushing starting age	Study child's toothbrushing starting age.
	Toothpaste use	Type of toothpaste used by the study child for cleaning their teeth.
	Night brushing	Toothbrushing before going to bed.
	Dentist visit behavior	Study child's dental visit patterns.
	Dental services use	Accessibility and use of community dental services.
General health, body weight status, and diet	Parent/Self-perceived general health	Parent/study child's subjective perception of general health status.
	Parent/Self-perceived weight status	Parent/study child's subjective perception of weight status.
	Dietary behavior	Study child's usual eating patterns as reported by the parent or the study child themselves.

questionnaires for each wave across all surveys. The primary focus of this study was to include oral health and related modifiable factors questionnaires (e.g., diet behaviors, oral hygiene measures, dentist visit behavior, dental services use, general health, and weight status). A literature search was conducted to develop an overview of the required domains and constructs used in observational studies that analyzed parent/self-reported oral health-related data [6, 44–46]. The constructs for defining oral health outcomes and commonly associated risk factors were identified. Questionnaires from the selected studies were also reviewed. The information collected from both the literature search and study questionnaires was then shared with oral health and nutrition experts from two national Irish universities (Trinity College Dublin and University College Dublin). Their opinions and recommendations were obtained during a group discussion. Finally, the list of domains and constructs to be included was agreed using a consensus approach. The collected questionnaires were classified into three domains and fifteen constructs for building a common data model [47] (Table 2).

Oral health and risk indicator DataSchema and harmonization potential evaluation

A final list of DataSchema variables which is a list of core variables representing the suitable version of the oral health outcomes and risk factors, was created using a consensus approach among the study authors (Supplementary material for review S3). This enables analyses to be conducted across the combined data set. When defining the DataSchema variables, questionnaires and data dictionaries were referenced. Standardized specifications, including the name, label, format, description, and categories, were followed to define the DataSchema variables. A harmonization status (whether a study could construct or not each of the DataSchema variables) was assigned to each wave of the included surveys. A complete harmonization status was assigned to studies that used the exact question wording and categories as defined for the DataSchema variables and to studies in which survey items could be transformed or combined to match the created DataSchema variable. An incomplete status was assigned to the survey wave when the required information to match the DataSchema variable was incomplete or missing in the survey questionnaires. An example of harmonization status assignment for the variable "TOOTH_BRUSH_FREQ_DAILY" across survey waves is shown in Table 3. Variable transformations to match the core variables included collapsing, renaming or changing assigned values to the categories of the variables (Table 3). The variable characteristics were reported using frequency tables of simple counts.

RESULTS

The birth cohorts database contained 134 birth cohort surveys, and access links to 63 studies were available from the SLLS cohort network. After the initial screening as per the eligibility criteria, 15 studies were identified for full documentation review, and seven surveys were included in the current study. These seven nationally

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghn1.2632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ipd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 An example of harmonization status assignment across the survey waves for the DataSchema variable. "TOOTH_BRUSH_FREQ_DAILY."

Variable name: TOOTH_BRUSH_FREQ_DAILY; label: toothbrushing frequency; description and coding: Number of times in a day the study child's teeth were cleaned/brushed. Categories and coding: Twice a day or more (1); once a day (2); less than once a day (3); never (4); missing (999)	
Cohort-specific questionnaires	**Harmonization status**
LSAC B cohort survey wave 2, 3, 4, 5 and LSAC K wave 2, 3, 4: How often are the child's teeth currently cleaned? GUS cohort survey wave 2: How often is a toothbrush used to clean a child's teeth? Categories: More than twice a day (1); twice a day (2); once day (3); less often than once a day (4); do not clean teeth (5); missing ()	Complete (direct match to the DataSchema variable, but the "More than twice a day" and 'Twice a day" categories were collapsed and classified as "Twice a day or more." The category "Don't clean teeth" was classified as "Never."
GUI infant cohort wave 2: How often is a toothbrush used to clean child's teeth? GUI infant cohort wave 5: How often does child brush his/her teeth? Categories: More than twice a day (1); Twice a day (2); once day (3); less often than once a day (4); rarely (5); not at all (6); missing ()	Complete (direct match to the DataSchema variable, but the "More than twice a day" and 'Twice a day" categories were collapsed and classified as "Twice a day or more." The categories "Rarely" and "Not at all" were classified as "Never."
GUN cohort study wave 2: How often are child's teeth brushed? Categories: twice a day or more (4); once a day (3); less than once a day (2); never (1); ref (98); DK (99)	Complete (direct match to the DataSchema variable, but categories value labels were changed to match DataSchema variable categories labels. The categories "Ref" and "DK" were classified as "Missing."
GUN cohort study wave 5: How are child's teeth brushed? Categories: twice a day or more (5); once a day (4); less than once a day (3); less than weekly (2); never (1); ref (98); DK (99)	Complete (direct match to the DataSchema variable, but categories value labels were changed to match DataSchema variable categories labels. The categories "Less than weekly" was classified as "Never" and categories "Ref" and "DK" were classified as "Missing."
GUN cohort study wave 8: How often are child's teeth brushed? Categories: more than twice a day (4); twice a day (3); once a day (2); less than once a day (1); ref (98); DK (99)	Complete (direct match to the DataSchema variable, but the "More than twice a day" and "Twice a day" categories were collapsed and classified as "Twice a day or more." The categories "Ref" and "DK" were classified as "Missing." Also, the value labels were changed to match the DataSchema variable categories.
MCS cohort study wave 5 and 6: How often does the child brush his/her teeth? Categories: twice a day or more (1); once a day (2); at least once a week but not daily (3); less than once a week (4); never (5); missing	Complete (direct match to the DataSchema variable, but the categories "At least once a week but not daily" and "Less than once a week" were classified as "Less than once a day "and "Never," respectively.
GUI child study wave: Does the study child brush his/her teeth at least once per day? Categories: yes (); no ()	Incomplete (Respondents were asked to report whether the study child brushes their teeth once a day, cannot be matched with the DataSchema variable).
GUS cohort survey wave 5: How often is a toothbrush with fluoride toothpaste used to clean child's teeth? Categories: More than once (); Once a day (); Less than once a day ()	Incomplete (Respondents were specifically asked to report the toothbrushing frequency using a fluoridated toothpaste).

Abbreviations: GUI, (Growing Up in Ireland); GUS, (Growing Up in Scotland); LSAC B, (Longitudinal Study of Australian Children Birth cohort); LSAC K, (Longitudinal Study of Australian Children Kindergarten cohort); GUN, (Growing Up in New Zealand); MCS, (Millennium Cohort Study).

represented birth/child cohort surveys were Growing Up in Ireland (GUI), Growing Up in Scotland (GUS), Longitudinal Study of Australian Children Birth (LSAC B) cohort, Longitudinal Study of Australian Children Kindergarten (LSAC K) cohort, Growing Up in New Zealand (GUN), and Millennium Cohort Study (MCS). The assessment age, sample size, response percentage of the original sample and year of data collection for the included surveys are presented in Table 4. Sampling details, data collection methods, thematic objectives, funding, and management of the included studies were summarized (Supplementary material for review S1). Except for the GUI child and LSAC K cohort surveys, data collection started during the first year of the child's life. For the GUI child and LSAC K-cohort surveys, data collection started when the study children were 9 and 4–5 years of age, respectively. While a majority of surveys have collected childhood and early adolescent data the GUI child, LSAC K-cohort and MCS surveys have also captured late adolescence data. Participant responses of the original sample in the last follow-up before the COVID-19 pandemic (excluding the online COVID-19 online surveys) ranged from 55% to 76%. The age groups surveyed at different waves were broadly comparable across cohort surveys.

Available information in survey questionnaires

The study-specific questionnaires were summarized by cohort and age (Tables S1–S3, Supplementary material for review S2). The most frequently investigated oral

TABLE 4 Summary of included surveys waves and sample size.

	Cohort/year of data collection Sample size at each wave (response as a % of the original sample)						
Child age	**GUI infant**	**GUI child**	**GUS**	**LSAC B cohort**	**LSAC K cohort**	**GUN**	**MCS**
0–1 year	2008–09 11,134 (100)		2005–06 5217(100)	2003–04 5107 (100)		2010–11 6853 (100)	2001–02 18,818 (100)
2 years			2006–07 4512 (86.5)	2005–06 4606 (90.2)		2011–12 6327 (92.3)	
3 years	2010–11 9793 (88)		2007–08 4193 (80.4)				2003–04 15,808 (84)
4 years			2008–09 3994 (76.6)	2007–08 4386 (85.9)	2003–04 4983 (100)		
5 years	2013 8712 (78.2)		2009–10 3833 (73.5)			2014–15 6156 (89.8)	2006 15,460 (82.15)
6 years			2010–11 3657 (70.1)	2009–10 4242 (83)	2005–06 4464 (89.6)	2015–16	
7 years	2016 5344 (48)						2008 14,043 (74.6)
8 years			2012–13 3456 (66.2)	2011–12 4077 (80)	2007–08 4332 (86.9)	2017–19 5241 (76.4)	
9 years	2017–18 7770 (69.8)	2007–08 8568 (100)					
10 years			2014–15 3150 (60.4)	2013–14 3764 (73.7)	2009–10 4169 (83.7)		
11 years						2020 2421 (35.3)	2012 13,469 (71.6)
12 years	2020		2017–18 2917 (55.9)	2015–16 3381 (66.2)	2011–12 3956 (79.4)		
13-years		2011–12 7525 (87.8)					
14 years			2019–20 2669 (51.2)	2017–18 3127 (61.2)	2013–14 3537 (71)		2015 11,938 (63.4)
15 years							
16 years				2020 2017 (39.5)	2015–16 3089 (62)		
17 years		2015–16 6216 (72.5)		2021 2688 (52.6)			2018–19 10,345 (54.9)
18 years					2017–18 3.037 (60.9)		
19 years							
20 years		2018–19 5190 (60.1)			2020 1789 (35.9)		
21 years					2021 2463 (49.4)		
22 years		2020					2022

Abbreviations: GUI, (Growing Up in Ireland); GUS, (Growing Up in Scotland); LSAC B, (Longitudinal Study of Australian Children Birth cohort); LSAC K, (Longitudinal Study of Australian Children Kindergarten cohort); GUN, (Growing Up in New Zealand); MCS (Millennium Cohort Study).

health status construct was dental injury, followed by dental problems (teething, tooth decay or cavities, tooth pain, gum pain), dental treatments (teeth filled, teeth extracted, or orthodontic treatment), and parent/self-perceived dental health status. Daily toothbrushing frequency was the most frequently investigated construct for the oral health-related components domain. All cohort surveys included parent/self-perceived general health and weight status questionnaires in most survey waves. A 24-h recall was the most frequently used dietary assessment instrument with food frequency questionnaires being the next most utilized. Food diaries were rarely used while GUS and MCS surveys used screening instruments to record the typical daily intake of specific foods and drinks of interest, including fruit, vegetables, soft drinks (diet and non-diet), sweets, and chocolates. The GUN survey wave 8 asked the parents to recall and report the child's dietary intake over the last 7 days.

Survey questionnaires comparison

Age-wise distribution of survey questionnaires by construct and comparability between cohort surveys were

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 Age-wise distribution and comparison of survey questionnaires among the 50 waves of seven surveys.

Domain Construct	Age groups in years																					
	0–1		2–3		4–5		6–7		8–9		10–11		12–13		14–15		16–17		18–20	
	C	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*	*C*	*NC*
Oral health status																				
• Dental problems	1, 3		3, 4	4, 6	3, 7		4, 5	3, 6	4, 5	3	4, 5	7	4, 5		4, 5			5		5
• Dental treatments					3			4		1, 4	4, 5		4, 5	2	4, 5			2, 5		
• Parent/Self-perceived oral health status					3				1, 6									2		2
• Dental injury	3, 4	6, 7	3, 4	1, 6, 7, 4, 5	3	4, 5	3, 7	4, 5	1, 3	4, 5	1, 3	3, 7	4, 5		4, 5	7		5		5
Oral health behaviors																				
• Toothbrushing frequency		1, 3, 4, 6		4, 6	3	4, 5		1, 4, 5, 6	2	5, 7 & 4, 5		4, 5	2	4, 5	7		5, 7			
• Toothbrushing Supervision			3		4				5, 6											
• Toothbrushing assistance	3, 6		3, 4, 6		4, 6	4, 5			4											
• Toothbrushing starting age			3, 4		4	4, 5		4, 5				5								
• Toothpaste use			3, 6																	
• Night brushing			6		3															
• Dental visit behavior			1, 3, 6		1, 3, 6			1, 2, 6	3			7		2, 3		7		2, 5		2, 5
• Dental services use	4		3, 4		1, 3, 4, 5, 6			3, 4, 5, 6	4, 5	1, 2, 3, 6	4, 5		4, 5	2	4, 5			5		2
General health, weight, and diet																				
• Parent/Self-perceived general health status	3, 4, 6	1	3, 4, 6	1	3, 4, 5, 6, 7	1		3, 4, 5, 7	1	3, 4, 5, 6	1, 2	3, 4, 5, 7		3, 4, 5	2	3, 4, 5, 7		2, 5, 7		2, 5
• Parent/Self-perceived weight status	4, 6		1, 4, 6		1, 4, 5, 6			4, 5		1, 2, 4, 5, 6		4, 5		2, 4, 5		4, 5, 7		5, 7	2	2, 5
• Dietary behavior	1, 4	3, 6	2, 4	3, 6	1, 6, 4, 5, 3, 7			1, 4, 5		1, 2, 4, 5	6	4, 5	3, 6	2, 4, 5		4, 5	7	2, 5	7	2, 5

Note: GUI INFANT: 1; GUI CHILD: 2; GUS: 3; LSAC B: 4; LSAC K: 5; GUN: 6; MCS: 7.

Abbreviations: GUI, (Growing Up in Ireland); GUS, (Growing Up in Scotland); LSAC B, (Longitudinal Study of Australian Children Birth cohort); LSAC K, (Longitudinal Study of Australian Children Kindergarten cohort); GUN, (Growing Up in New Zealand); MCS, (Millennium Cohort Study); C, Comparable; NC, Not comparable.

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ipbd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 6 Illustration of the variations in the question wordings and response levels within and across cohort surveys. The parent/self-perceived general health status questions used in the Growing Up in Ireland surveys.

Survey	Question	Response levels
GUI infant cohort Wave 1, 2, 3, 4 & 5	How would you describe child's current health?	• Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite well • Almost always unwell
GUI child cohort wave 1 & 2	In general, how would you describe the study child's health in the past year?	• Very healthy, no problems • Healthy, but a few minor problems • Sometimes quite well • Almost always unwell
GUI child cohort wave 3 & 4	In general, how would you say your current health is?	• Excellent • Very good • Good • Fair • Poor

Abbreviations: GUI: Growing Up in Ireland.

summarized in Table 5. For the ten defined age groups (age range, 0–20 years), a comparable status was assigned when two or more surveys asked similar questions and used the same response categories. A non-comparable status was assigned when different questions or response categories were used across two or more surveys or when a single survey covered the construct. Generally, survey questionnaires were not consistent either across or within cohort surveys. For oral health status and oral health behaviors questionnaires, the least inconsistencies were observed for the LSAC surveys and the greatest for GUS and MCS. Dietary questionnaires also differed both within and across the survey waves. For example, during GUI infant survey, a 24-h recall method was used for children aged 3 years, which changed to a food frequency questionnaire for children aged 5 years and then back to a 24-h recall for children aged 7/8 and 9 years. Parent/self-perceived general health and weight status questionnaires were broadly consistent in most surveys. A brief illustration of the variation in the question wordings and response categories used across and within cohort surveys has been outlined in Table 6. In GUI infant cohort survey waves, parents were asked to describe the study child's current health, while in the GUI child cohort survey waves (waves 1 and 2), the question was framed differently as the parents were asked to describe the study child's health in the past year. During the GUI child cohort survey, for waves 3 and 4, study children were asked to describe their current health; however, the response levels differed from those used in waves 1 and 2.

Harmonization potential evaluation

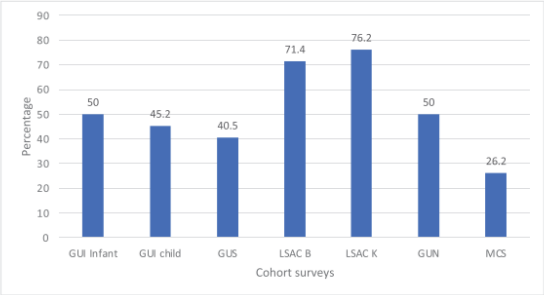
An oral health and risk indicator questionnaire DataSchema was compiled, which comprised 42 variables (Supplementary material for review S3). For each study wave, the potential (or not) to generate each DataSchema variable was evaluated. Of the 2100 harmonization status assessments, 543 (26%) were considered complete. Approximately 50% ($n = 21$) of the DataSchema variables can be generated across at least 4 cohort surveys, while only 10% ($n = 4$) of variables can be generated across all surveys. For each survey, the DataSchema variables that can be generated ranged between 26% and 76% (Figure 1). The main reason for assigning an incomplete harmonization status was the absence of information (construct not covered) in the survey questionnaires. The complete harmonization exercise, including creating DataSchema variables, harmonization rules, inclusion, and exclusion reasons, proposed transformations of study variables to match DataSchema variables and harmonization status assignments, are detailed in Supplementary material for review S3. The harmonization potential summary of the most commonly measured oral health-related constructs in the included cohort surveys is presented in Table 7.

DISCUSSION

As far as the authors are aware, this study, based on nationally representative child cohort surveys from five high-income countries (Ireland, England, Scotland, New Zealand, and Australia) conducted over the last two decades, is the first to evaluate the consistency and comparability of oral health-related questionnaires. A framework was developed for reviewing, collating, and comparing study-specific questionnaire data across and within cohort surveys. The authors also demonstrated how data harmonization can be used to improve the comparability of oral health-related variables both within and across survey datasets. This research adds to the extensive literature of harmonized initiatives undertaken for inferential equivalence, that is, the potential for harmonization of study-specific information from individual studies [24, 25, 30–32, 36, 39, 40].

The DataSchema (a set of 42 variables), created for the harmonization potential evaluation of oral health-related questionnaire data, was applied to questionnaire data from seven cohort surveys. For each cohort survey, the DataSchema variables that can be generated ranged between 26% and 76%. The MCS survey had a score of 26% which was mainly the result of the non-availability

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghd.12652 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License



Abbreviations: GUI (Growing Up in Ireland); GUS (Growing Up in Scotland); LSAC B (Longitudinal Study of Australian Children Birth cohort; LSAC K (Longitudinal Study of Australian Children Kindergarten cohort; GUN (Growing Up in New Zealand); MCS (Millennium Cohort Study).

FIGURE 1 Percentage of DataSchema variables ($n = 42$) that could be generated across cohort surveys. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 7 Harmonization potential status of variables used to measure most commonly studied oral health-related constructs in the included national cohort surveys.

Domain	Commonly measured constructs	Harmonization potential (%)
Oral health status	Parent/Self-perceived oral health status	8
	Dental decay	30
	Dental pain	12
	Dental injury in last 12 months	48
	Dental fillings	36
	Dental extractions	36
Oral health behaviors	Daily toothbrushing frequency	34
	Dentist visit behavior	14
	Dental service use	40
General health and diet	General health	88
	Self-perceived weight	48
	Dietary consumption of sugary drinks	62
	Dietary consumption of sugary foods	58
	Dietary consumption of savory foods	58
	Fruit juice consumption	44

of oral health-related questionnaires in the survey waves. The LSAC surveys scored between 71 and 76% due to consistent and comprehensive coverage of oral health-related questions across the survey waves. Survey coordinators may consider LSAC surveys questionnaire data when designing oral health and risk factor questionnaires for future cohorts. However, at both international and national levels, frequent communication and increased collaboration between researchers, policymakers, and developers of longitudinal surveys should be promoted and supported to improve the consistency and comparability of survey questionnaires.

In addition, this study found that 50% ($n = 21$) of the DataSchema variables can be generated across at least four cohort surveys, while only 10% ($n = 4$) of variables can be generated across all surveys. The generation of the harmonized variables increased as the number of participating studies decreased. The present study results were consistent with the findings of the previous harmonization potential evaluations [24, 31, 32, 34]. Fortier et al. while evaluating chronic diseases and risk factors questionnaire data across 53 studies (48 cohorts and 5 cross-sectional) reported that 38% of the created harmonized variables ($n = 148$) could be harmonized across all studies and the generation proportion increased to 50% when only nine studies (deemed facilitating harmonization) were considered in the analysis [34]. Similarly, during the evaluation of health and risk factor questionnaire data across 12 cohort survey datasets, the authors used 432 harmonized variables and found that the harmonized variables generation across all the datasets was 27%, which increased to 60% for at least 11 datasets. While harmonized variable generation increased with the exclusion of studies, for studies involving a limited number of studies ($n = 2$–4) at the project's initiation resulted in higher generation potential across the participating studies [3, 29]. For instance, Adhikari et al. evaluated two prospective pregnancy cohort studies for risk factors for pre-term birth and reported that out of the 20 harmonized variables, 18 (90%) were successfully harmonized [32].

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ipd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Likewise, in a more recent study, authors reported 93% success in harmonizing neurodegeneration variables ($n = 120$) across four diverse cohort datasets [24].

Variations in survey questionnaires across cohort surveys may be partially due to regional and language variations and within survey variations could arise due to adjustments to comply with maturing cohorts [31, 48]. In the current research, as the included cohort surveys had similar methodologies and were representative of English-speaking high-income countries, questionnaire data variations due to study design and cultural or language differences were unlikely. Therefore, the authors believed that the lack of standardized international oral health and risk factor questionnaires and consensus among the cohort survey coordinators could have been the main reason for the observed differences in survey questionnaires both within and across the surveys [14]. In the absence of standardized formats for data collection, longitudinal studies gather inaccurate or unusable data [49]. Another consideration could be the differing policy environments in respective countries, reflecting a need for specific measures to evaluate the role of interventions in reducing disease burden for specific age groups. For dental caries prevention, countries like the RoI, New Zealand, and Australia have a mandatory public policy for the controlled addition of fluoride to the public water supply to prevent dental caries [50–52]. Therefore, a survey item to record study participants' fluoridation status of domestic water supplies, if included, could help study the policy impact and the interactive effect of fluoride on the association between sugar-rich diets and dental caries in children [53]. These study-specific measures may not apply easily to other countries.

The authors followed a flexible approach for harmonization potential evaluation which allowed for the inclusion of studies that may not be included if strict rules for text and construct matching were used. For example, in wave 2 of the GUI infant and GUS surveys, respondents were asked to report the number of times a toothbrush was used to clean the study child's teeth. However, other surveys asked, "How often were the study child's teeth cleaned." Even if the questions in wave 2 of the GUI infant and GUS surveys differed, the variability was accommodated, and the variables were matched with the DataSchema variable for daily toothbrush frequency.

Comprehensive documentation, from study selection to the quality estimation of harmonized products, has been recommended for reproducing prior harmonization works [29, 30, 54]. Our proposed harmonization template can easily be updated as new variables become available from future waves and, thus, support the constant improvement of the content of cohort survey datasets. Furthermore, the created DataSchema template can be incrementally expanded to add non-modifiable risk indicators of dental diseases, such as socioeconomic status, ethnicity, and level of parental education. Moreover, cohort surveys from middle and low-income countries could also be added to the list of nationally representative cohort surveys for evaluating harmonization potential on a global stage.

TABLE 8 Oral health-related questionnaires coverage gaps by construct (with supporting literature) in national child cohort surveys.

Construct (supporting literature)	Coverage gaps
Dental injury [62, 63]	Dental injury extent, dentition type (primary or permanent), number of teeth, number of untreated injuries, location of injury, and cause of injury.
Dental problems [6, 65–68]	Other dental problems such as bleeding gums, dry mouth, dental crowding, enamel discolorations and defects, bad breath, orofacial pain, and bruxism (teeth clenching or grinding).
Dental treatments [6, 69]	Preventive dental treatments (fluoride varnish, pit and fissure sealants), type of anesthesia used during dental procedures (local or general), complex dental treatments (e.g., root canal treatments).
Parent/Self-perceived oral health status [19, 70–72]	Self-perceived oral health needs, impact of poor oral health on the study child's social and emotional needs.
Toothbrushing behavior [73–76]	Age when starting toothpaste use, type of toothpaste used, use of dental floss or interdental brushes.
Dentist visit behavior [77–79]	Age and purpose of first dental visit, study child's dental fears and anxiety.
Dental services use [80–82]	Frequency of dental service use and type of service received.
Dietary behavior [15, 83, 84]	In between meals snacks, and use of multiple 24-h recalls.

Assessing the construct validity of the survey questions or measures was not the focus of the present study. The measures used in the included cohort surveys were not necessarily formally validated, even if they were piloted and tested. However, like the self-reported general health measure, the SROH measure has been reported as a valid and reliable indicator for assessing an individual's oral health status [19, 55–57]. Similarly, studies have also investigated the validity of self-reported measures related to dental decay [58–60]. The number of carious teeth is generally underreported in self-reports [58]. However, self-reported information about dental decay has been shown to be valid for population-based health surveys to plan and monitor oral health actions directed at children and adolescents [60]. Furthermore, in adolescents, clinical dental health signs (untreated dental decay) were found to be associated with

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghd.12652 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

both self- and parent-reported oral health status and the need for treatment [61].

Coverage gaps in existing questionnaires

Identifying coverage gaps in survey questionnaires has two main advantages: (1) provides evidence for the designing of questionnaires for future surveys, and (2) facilitates data users to appropriately interpret the consistency of available data [28]. The data coverage gaps identified in the survey questionnaires of the majority cohort surveys by construct were summarized in Table 8.

Common causes of dental injuries in preschool children are accidental falls while young school-going children tend to suffer from collisions during contact sports, and, finally, for adolescents and young adults, injuries are often as a result of assaults and traffic accidents [62]. Other less frequently associated factors with dental injuries in children are the physical and environmental characteristics of their houses, schools, and neighborhoods [63]. Therefore, specific questions regarding dental injury extent, dentition type (primary or permanent), number of teeth injured, and number of untreated dental injuries would be useful to develop a more valid measure to study dental injury construct. In addition, including items in the cohort surveys asking about the cause and location of dental injuries and treatment provided to the child could provide evidence for planning interventions to reduce the prevalence of dental injuries.

Similarly, for the dental problems construct, apart from dental decay, no information was available for other dental issues such as periodontal diseases, dry mouth, dental crowding, dental fluorosis, and other enamel defects, halitosis, bruxism and orofacial pain. Information about these problems, albeit much less frequent, could have provided a more complete picture of the survey population's oral health status. Regarding dental treatments services, cohort surveys may consider collecting information about the use of preventive services for example, fluoride varnish or fissure sealants and the type of anesthesia (local or general anesthesia) used during dental procedures. This information could provide a better understanding of the extent of dental resource utilization in the community. In addition, information about complex dental procedures such as root canal treatments, veneers, and crowns could aid policy development and service planning. Similarly, self-perceived oral health status questionnaires for adolescents and young adults could be supplemented with questions related to the social and well-being impacts of their oral health conditions.

Recommendations

The authors propose general recommendations for cohort survey co-ordinators planning future survey waves and researchers planning retrospective data harmonization initiatives using cohort survey datasets, consistent with previous publications [14, 29–31, 33, 34, 37, 47]:

1. Data sharing should be considered at the time of survey initiation, and survey participants should be informed of and consent to use their data beyond the primary study.
2. Funding agencies should mandate the sharing of publicly funded data.
3. Care must be taken before data collection at the design and validation stage such that the collected data complies with harmonization and inter-linkable data standards [64].
4. Data harmonizing from multiple studies should be transparent, rigorous, and well-documented to ensure validity.
5. Harmonization should be avoided for non-comparable data derived from different data collection methods.

Strengths and limitations

The main strength of this analysis is that the results may be viewed as the best available evidence for comparative cross-national longitudinal oral health research using questionnaire data. Sampling details and data collection methods used across the survey waves were evaluated. Outlining these details could facilitate understanding the level of homogeneity across the cohort surveys and potential sample sizes available for analysis [37]. A consensus and iterative approach involving the authors was used for creating an oral health and risk indicator DataSchema. A limited number of surveys were included in the current study, which may introduce selection bias and affect the study's external validity. However, given the study's limited generalisability, the included studies were nationally representative and shared similar thematic objectives, which ensured some degree of homogeneity. In addition, the data harmonization process becomes more complex with an increasing number of studies or datasets [32]. Although variable selection, data coverage gaps, and pairing rule definitions were undertaken through consensus and advice from subject experts, there is, inevitably, a degree of subjectivity. Oral health-related and other data collected using survey questionnaires rely on parent/self-reported information and are subject to recall bias. Finally, the actual cohort datasets were not acquired for each survey and harmonized versions were not generated to assess the output quality. In line with guidelines on the life course of a harmonization initiative [3], future steps could include: (1) acquisition of cohort survey datasets, (2) processing each cohort data under the harmonized format and finally, (3) estimating the quality of the harmonized data.

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ipd.13032 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Conclusions

A framework was developed for reviewing, collating, and comparing oral health-related data across and within nationally representative cohort surveys. Data harmonization can improve the comparability of variables both within and across survey datasets. For each cohort survey, the DataSchema variables that can be generated ranged between 26% and 76%. The generation of the harmonized variables increased as the number of participating studies decreased. For future cohort survey waves, the authors advocate using highly sensitive and specific questions for a given population and maintaining consistency and standardization in survey questionnaires within and between surveys.

ACKNOWLEDGMENTS

This study was completed as a part of a Doctor of Philosophy (PhD) degree supported by the Dublin Dental University Hospital and Trinity College Dublin, Ireland (1252 scholarship).

FUNDING INFORMATION

This study was completed as a part of a Doctor of Philosophy (PhD) degree by Vinay Sharma supported by the Dublin Dental University Hospital and Trinity College Dublin, Ireland (1252 scholarship).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ORCID

Vinay Sharma https://orcid.org/0000-0002-1615-7294
Michael O'Sullivan https://orcid.org/0000-0003-2121-4254
Michael Crowe https://orcid.org/0000-0003-4761-5945

REFERENCES

1. Szklo M. Population-based cohort studies. Epidemiol Rev. 1998; 20(1):81–90.
2. Grimes DA, Schulz KF. Cohort studies: marching towards outcomes. The Lancet. 2002;359(9303):341–5.
3. Fortier I, Wey TW, Bergeron J, Pinot De Moira A, Nybo-Andersen A-M, Bishop T, et al. Life course of retrospective harmonization initiatives: key elements to consider. J Dev Orig Health Dis. 2023;14(2):190–8.
4. Crall JJ, Forrest CB. A life course health development perspective on Oral health. In: Halfon N, Forrest CB, Lerner RM, Faustman EM, editors. Handbook of life course health development. Cham (CH); Springer; 2018. p. 299–320.
5. Fisher-Owens SA, Gansky SA, Platt LJ, Weintraub JA, Soobader MJ, Bramlett MD, et al. Influences on Children's Oral health: a conceptual model. Pediatrics. 2007;120(3):e510–20.
6. Peres KG, Nascimento GG, Gupta A, Singh A, Cassiano LS, Rugg-Gunn AJ. Scoping review of Oral health-related birth cohort studies: toward a global consortium. J Dent Res. 2022;101(6): 632–46.
7. Chi DL, Luu M, Chu F. A scoping review of epidemiologic risk factors for pediatric obesity: implications for future childhood obesity and dental caries prevention research. J Public Health Dent. 2017;77(Suppl 1):S8–S31.
8. Hayden C, Bowler JO, Chambers S, Freeman R, Humphris G, Richards D, et al. Obesity and dental caries in children: a systematic review and meta-analysis. Community Dent Oral Epidemiol. 2013;41(4):289–308.
9. Paisi M, Kay E, Bennett C, Kaimi I, Witton R, Nelder R, et al. Body mass index and dental caries in young people: a systematic review. BMC Pediatr. 2019;19(1):1–9.
10. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in Young adulthood from childhood and parental obesity. New England Journal of Medicine. 1997;337(13):869–73.
11. Lock NC, Susin C, Brusius CD, Maltz M, Alves LS. Obesity and dental caries among south Brazilian schoolchildren: a 2.5-year longitudinal study. Braz Oral Res. 2019;33:1–9.
12. Li KY, Okunseri CE, McGrath C, Wong MCM. Trends in self-reported oral health of US adults: National Health and nutrition examination survey 1999-2014. Community Dent Oral Epidemiol. 2018;46(2):203–11.
13. Patel RN, Eaton K, Pitts N, Schulte A, Pieper K, White S. Variation in methods used to determine national mean DMFT scores for 12-year-old children in European countries. Community Dent Health. 2016;33(4):286–91.
14. Taylor S, Baker SR, Broomhead T, England R, Mason S, Sereny M, et al. Standardised practice-based Oral health data collection: a pilot study in different countries. Int Dent J. 2023;73(4): 566–73.
15. Whelton H, Crowley E, Harding M, Guiney H, Cronin M, Flannery E, et al. North south survey of Children's Oral health in Ireland 2002. Ireland: the Department of Health and Children Health Services Executive, Ireland; the department of health social services and public safety. Northern Ireland: WHO Collaborating Centre for Oral Health Services Research University College Cork; 2006.
16. Crowe M, O'Sullivan A, McGrath C, Cassetti O, Swords L, O'Sullivan M. Early childhood dental problems. JDR Clinical & Translational Research. 2016;1(3):275–84.
17. Skafida V, Chambers S. Positive association between sugar consumption and dental decay prevalence independent of oral hygiene in pre-school children: a longitudinal prospective study. J Public Health. 2018;40(3):e275–83.
18. Thornley S, Bach K, Bird A, Farrar R, Bronte S, Turton B, et al. What factors are associated with early childhood dental caries? A longitudinal study of the growing up in New Zealand cohort. Int J Paediatr Dent. 2021;31(3):351–60.
19. Locker D, Clarke M, Payne B. Self-perceived Oral health status, psychological well-being, and life satisfaction in an older adult population. J Dent Res. 2000;79(4):970–5.
20. Thomson WM, Mejia GC, Broadbent JM, Poulton R. Construct validity of Locker's global oral health item. J Dent Res. 2012; 91(11):1038–42.
21. O'Leary-Kelly SW, Vokurka RJ. The empirical assessment of construct validity. J Oper Manag. 1998;16(4):387–405.
22. Johnston MP. Secondary data analysis: a method of which the time has come. Qualitative and Quantitative Methods in Libraries. 2014;3(3):619–26.
23. Ikeda N. Secondary data analysis of National Surveys in Japan toward improving population health. J Epidemiol. 2016;26(3): 106–14.
24. Bauermeister S, Phatak M, Sparks K, Sargent L, Griswold M, McHugh C, et al. Evaluating the harmonisation potential of diverse cohort datasets. Eur J Epidemiol. 2023;38(6):605–15.
25. O'Neill D, Benzeval M, Boyd A, Calderwood L, Cooper C, Corti L, et al. Data resource profile: cohort and longitudinal studies enhancement resources (CLOSER). Int J Epidemiol. 2019; 48(3):675–6.
26. Kołczyńska M, Schoene M. Survey data harmonization and the quality of data documentation in cross-national surveys. In:

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/ghd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Johnson TP, Pennell B-E, Stoop IAL, Dorer B, editors. Advances in comparative survey methods: multinational, multiregional, and multicultural contexts (3MC). Hoboken, NJ: John Wiley & Sons, Inc.; 2018. p. 963–84.
27. Bradshaw J, Hoelscher P, Richardson D. An index of child well-being in the European Union. Soc Indic Res. 2006;80(1):133–77.
28. Richardson D, Ali N. An evaluation of international surveys of children. France: Directorate for Employment, Labour and Social Affairs; 2014 Contract No: 146.
29. Fortier I, Raina P, Van Den Heuvel ER, Griffith LE, Craig C, Saliba M, et al. Maelstrom research guidelines for rigorous retrospective data harmonization. Int J Epidemiol. 2016;46(1):103–15.
30. Atkin AJ, Biddle SJH, Broyles ST, Chinapaw M, Ekelund U, Esliger DW, et al. Harmonising data on the correlates of physical activity and sedentary behaviour in young people: methods and lessons learnt from the international Children's Accelerometry database (ICAD). Int J Behav Nutr Phys Act. 2017;14(1):1–12.
31. Fortier I, Dragieva N, Saliba M, Craig C, Robson PJ. Harmonization of the health and risk factor questionnaire data of the Canadian Partnership for Tomorrow Project: a descriptive analysis. CMAJ Open. 2019;7(2):E272–82.
32. Adhikari K, Patten SB, Patel AB, Premji S, Tough S, Letourneau N, et al. Data harmonization and data pooling from cohort studies: a practical approach for data management. Int J Popul Data Sci. 2021;6(1):1–15.
33. Sánchez-Niubo A, Sialm A, Bickenbach J, Gonzalez JR. Strategy brief on harmonisation and integration methods Including analytic approaches to maximise the value of cohort. European Union's Horizon 2020 Research and Innovation Programme, Project S. 2020:1–34.
34. Fortier I, Doiron D, Little J, Ferretti V, L'Heureux F, Stolk RP, et al. Is rigorous retrospective harmonization possible? Application of the DataSHaPER approach across 53 large studies. Int J Epidemiol. 2011;40(5):1314–28.
35. Wilkinson MD, Dumontier M, Aalbersberg IJ, Appleton G, Axton M, Baak A, et al. The FAIR guiding principles for scientific data management and stewardship. Scientific Data. 2016;3(1):1–9.
36. Vrijheid M, Casas M, Bergström A, Carmichael A, Cordier S, Eggesbø M, et al. European birth cohorts for environmental Health Research. Environ Health Perspect. 2012;120(1):29–37.
37. Doiron D, Burton P, Marcon Y, Gaye A, Wolffenbuttel BHR, Perola M, et al. Data harmonization and federated analysis of population-based studies: the BioSHaRE project. Emerg Themes Epidemiol. 2013;10(1):1–8.
38. Lakerveld J, Loyen A, Ling FCM, De Craemer M, Van Der Ploeg HP, O'Gorman DJ, et al. Identifying and sharing data for secondary data analysis of physical activity, sedentary behaviour and their determinants across the life course in Europe: general principles and an example from DEDIPAC. BMJ Open. 2017;7(10):1–10.
39. Jaddoe VWV, Felix JF, Andersen A-MN, Charles M-A, Chatzi L, Corpeleijn E, et al. The LifeCycle project-EU child cohort network: a federated analysis infrastructure and harmonized data of more than 250,000 children and parents. Eur J Epidemiol. 2020;35(7):709–24.
40. Joly M-P, Boivin M, Junker A, Bocking A, Kramer MS, Atkinson SA. An inventory of Canadian pregnancy and birth cohort studies: research in progress. BMC Pregnancy Childbirth. 2012;12(1):1–8.
41. Bergeron J, Massicotte R, Atkinson S, Bocking A, Fraser W, Fortier I, et al. Cohort profile: research advancement through cohort cataloguing and harmonization (ReACH). Int J Epidemiol. 2020;50(2):396–7.
42. Counihan D, O'Shea* M T, Guigui D, Sloan S, Chzhen Y, Taylor LK, et al. Scoping review to inform the development of a potential new birth cohort for growing up in Ireland. Dublin, Ireland: Growing Up in Ireland, The Department of Children E, Disability, Integration and Youth; 2023.
43. The World Bank. World Bank country and lending groups. Washington, D.C.: The World Bank Group; 2024 https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
44. Peres KG, Thomson WM, Chaffee BW, Peres MA, Birungi N, Do LG, et al. Oral health birth cohort studies: achievements, challenges, and potential. J Dent Res. 2020;99(12):1321–31.
45. Pabbla A, Duijster D, Grasveld A, Sekundo C, Agyemang C, Van Der Heijden G. Oral health status, Oral health Behaviours and Oral health care utilisation among migrants residing in Europe: a systematic review. J Immigr Minor Health. 2021;23(2):373–88.
46. Su S, Lipsky MS, Licari FW, Hung M. Comparing oral health behaviours of men and women in the United States. J Dent. 2022;122:1–8.
47. Fortier I, Burton PR, Robson PJ, Ferretti V, Little J, L'Heureux F, et al. Quality, quantity and harmony: the DataSHaPER approach to integrating data across bioclinical studies. Int J Epidemiol. 2010;39(5):1383–93.
48. Bath PA, Deeg D, Poppelaars J. The harmonisation of longitudinal data: a case study using data from cohort studies in The Netherlands and the United Kingdom. Ageing and Society. 2010;30(8):1419–37.
49. Joda T, Waltimo T, Probst-Hensch N, Pauli-Magnus C, Zitzmann NU. Health data in dentistry: an attempt to master the digital challenge. Public Health Genomics. 2019;22(1–2):1–7.
50. Fluoridation of Water Supplies Regulations 2007. 2007.
51. Moore D, Poynton M, Broadbent JM, Thomson WM. The costs and benefits of water fluoridation in NZ. BMC Oral Health. 2017;17(1):1–8.
52. Stormon N, Kazantzis N, Ford PJ, Lalloo R. Children's oral health in Australia: the past decade's research agenda. Community Dent Oral Epidemiol. 2019;47(2):153–61.
53. Ha D, Spencer A, Moynihan P, Thomson W, Do L. Excess risk of dental caries from higher free sugars intake combined with low exposure to water fluoridation. J Dent Res. 2021;100(11):1243–50.
54. Winters K, Netscher S. Proposed standards for variable harmonization documentation and referencing: a case study using QuickCharmStats 1.1. PLoS One. 2016;11(2):1–15.
55. Wamala S, Merlo J, Boström G. Inequity in access to dental care services explains current socioeconomic disparities in oral health: the Swedish National Surveys of public health 2004–2005. J Epidemiol Commun H. 2006;60(12):1027–33.
56. Sanders AE, Spencer AJ, Slade GD. Evaluating the role of dental behaviour in oral health inequalities. Community Dent Oral Epidemiol. 2006;34(1):71–9.
57. Sabbah W, Tsakos G, Sheiham A, Watt RG. The role of health-related behaviors in the socioeconomic disparities in oral health. Soc Sci Med. 2009;68(2):298–303.
58. Pitiphat W, Garcia RI, Douglass CW, Joshipura KJ. Validation of self-reported oral health measures. J Public Health Dent. 2002;62(2):122–8.
59. Pinelli C, de Castro Monteiro Loffredo L. Reproducibility and validity of self-perceived oral health conditions. Clin Oral Investig. 2007;11(4):431–7.
60. Silva AER, Menezes AMB, Assunção MCF, Gonçalves H, Demarco FF, Vargas-Ferreira F, et al. Validation of self-reported information on dental caries in a birth cohort at 18 years of age. PLoS One. 2014;9(9):e106382.
61. Weyant RJ, Manz M, Corby P, Rustveld L, Close J. Factors associated with parents' and adolescents' perceptions of oral health and need for dental treatment. Community Dent Oral Epidemiol. 2007;35(5):321–30.
62. Andersson L. Epidemiology of traumatic dental injuries. J Endod. 2013;39(3):S2–5.
63. Malikaew P, Watt RG, Sheiham A. Associations between school environments and childhood traumatic dental injuries. Oral Health Prev Dent. 2003;1(4):255–66.

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jphd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons Licer

64. Joda T, Waltimo T, Pauli-Magnus C, Probst-Hensch N, Zitzmann NU. Population-based linkage of big data in dental research. Int J Environ Res Public Health. 2018;15(11):1–5.
65. Sheiham A. Oral health, general health and quality of life. Bull World Health Organ. 2005;83(9):644.
66. Tagliaferro EPDS, Pereira AC, Meneghim MDC, Ambrosano GMB. Assessment of dental caries predictors in a seven-year longitudinal study. J Public Health Dent. 2006;66(3):169–73.
67. Daher A, Abreu MH, Costa LR. Recognizing preschool children with primary teeth needing dental treatment because of caries-related toothache. Community Dent Oral Epidemiol. 2015;43(4):298–307.
68. Dye BA. The global burden of Oral disease: research and public health significance. J Dent Res. 2017;96(4):361–3.
69. Luzzi L, Chrisopoulos S, Brennan DS. Decline in usually visiting the dentist for a problem in Australia, 1994 to 2010: an age-period-cohort analysis. Community Dent Oral Epidemiol. 2014;42(4):349–57.
70. Locker D, Jokovic A. Using subjective oral health status indicators to screen for dental care needs in older adults. Community Dent Oral Epidemiol. 1996;24(6):398–402.
71. Robinson PG, Nadanovsky P, Sheiham A. Can questionnaires replace clinical surveys to assess dental treatment needs of adults? J Public Health Dent. 1998;58(3):250–3.
72. Reissmann DR, John MT, Schierz O, Kriston L, Hinz A. Association between perceived oral and general health. J Dent. 2013;41(7):581–9.
73. Marthaler TM. Changes in Dental Caries 1953–2003. Caries Res. 2004;38(3):173–81.
74. O'Mullane D, Clarkson J, Parnell C. Report of the working group on the use of fluoride toothpaste in children under six years of age. Dublin, Ireland: Department of Health, Republic of Ireland; 2018.
75. Davison J, McLaughlin M, Giles M. Factors influencing Children's tooth brushing intention: an application of the theory of planned behaviour. Health Psychol Bull. 2019;3(1):58–66.
76. Worthington HV, Macdonald L, Poklepovic Pericic T, Sambunjak D, Johnson TM, Imai P, et al. Home use of interdental cleaning devices, in addition to toothbrushing, for preventing and controlling periodontal diseases and dental caries. Cochrane Database Syst Rev. 2019;2020(4):1–162.
77. Sheiham A. Is there a scientific basis for six-monthly dental examinations? The Lancet. 1977;310(8035):442–4.
78. Duane B, McGovern E, Ni Chaollai A, FitzGerald K. First tooth, first visit, zero cavities: a review of the evidence as it applies to Ireland. J Ir Dent Assoc. 2017;63(2):105–11.
79. Clarkson JE, Pitts NB, Fee PA, Goulao B, Boyers D, Ramsay CR, et al. Examining the effectiveness of different dental recall strategies on maintenance of optimum oral health: the INTERVAL dental recalls randomised controlled trial. Br Dent J. 2021;230(4):236–43.
80. Locker D, Maggirias J, Quiñonez C. Income, dental insurance coverage, and financial barriers to dental care among Canadian adults. J Public Health Dent. 2011;71(4):327–34.
81. Onyejaka NK, Folayan MO, Folaranmi N. Barriers and facilitators of dental service utilization by children aged 8 to 11 years in Enugu state. BMC Health Serv Res. 2016;16:1–9.
82. Mayo CD, Farzam-Kia N, Ghahari S. Identifying barriers to and facilitators of health service access encountered by individuals with multiple sclerosis. Int J MS Care. 2021;23(1):37–44.
83. Ma Y, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS, et al. Number of 24-hour diet recalls needed to estimate energy intake. Ann Epidemiol. 2009;19(8):553–9.
84. Rankin D, MacIntyre U, Hanekom S, Steyn H, Wright H. Reproducibility of two, three, four and five 24-hour recalls in peri-urban African adolescents in the north west province. South Afr J Clin Nut. 2012;25(1):27–32.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Sharma V, O'Sullivan M, Cassetti O, Winning L, O'Sullivan A, Crowe M. Evaluating the harmonization potential of oral health-related questionnaires in national longitudinal birth and child cohort surveys. J Public Health Dent. 2024. https://doi.org/10.1111/jphd.12632

17527325, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jphd.12632 by HEALTH RESEARCH BOARD, Wiley Online Library on [21/08/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Sharma *et al. BMC Oral Health* (2023) 23:238
https://doi.org/10.1186/s12903-023-02895-2

BMC Oral Health

RESEARCH Open Access

Protocol for developing a dashboard for interactive cohort analysis of oral health-related data

Vinay Sharma[1], Oscar Cassetti[1], Lewis Winning[1], Michael O'Sullivan[1] and Michael Crowe[1*]

Abstract

Introduction A working knowledge of data analytics is becoming increasingly important in the digital health era. Interactive dashboards are a useful, accessible format for presenting and disseminating health-related information to a wide audience. However, many oral health researchers receive minimal data visualisation and programming skills.

Objectives The objective of this protocols paper is to demonstrate the development of an analytical, interactive dashboard, using oral health-related data from multiple national cohort surveys.

Methods The `flexdashboard` package was used within the R Studio framework to create the structure-elements of the dashboard and interactivity was added with the `Shiny` package. Data sources derived from the national longitudinal study of children in Ireland and the national children's food survey. Variables for input were selected based on their known associations with oral health. The data were aggregated using tidyverse packages such as `dplyr` and summarised using `ggplot2` and `kableExtra` with specific functions created to generate bar-plots and tables.

Results The dashboard layout is structured by the YAML (YAML Ain't Markup Language) metadata in the R Markdown document and the syntax from Flexdashboard. Survey type, wave of survey and variable selector were set as filter options. Shiny's render functions were used to change input to automatically render code and update output. The deployed dashboard is openly accessible at https://dduh.shinyapps.io/dduh/. Examples of how to interact with the dashboard for selected oral health variables are illustrated.

Conclusion Visualisation of national child cohort data in an interactive dashboard allows viewers to dynamically explore oral health data without requiring multiple plots and tables and sharing of extensive documentation. Dashboard development requires minimal non-standard R coding and can be quickly created with open-source software.

Keywords Dashboards, R Markdown, Shiny, Data visualisation, Oral health

Background

Open data science tools and a working knowledge of data analytics is becoming increasingly important in the digital health era [1–4]. Data visualisation is a widely accepted means of deriving insights from large datasets with complex variables [5, 6]. Dashboards have been defined as "a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance" [7]. While data-driven dashboards are commonly used as an information exploration and communication tool in a wide range of domains this tool has not been widely deployed in oral health epidemiology [2, 3, 8]. Interactive dashboards

*Correspondence:
Michael Crowe
michael.crowe@dental.tcd.ie
[1] Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Dublin 2, Ireland

© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

may be the ideal data technique for presenting and disseminating health-related information in an accessible format [9–11]. National cohort surveys routinely collect data from different developmental age groups to monitor and track the development and health of children. While there are obvious benefits for policy makers in analysing national survey data, there is also an onus on researchers to extract and disseminate findings in a useful and accessible manner [9, 12]. The impact of these national cohort surveys on improved understanding of the factors affecting child health and well-being outcomes has been acknowledged as they continue to inform health policies and strategies [12]. Monitoring and analysing large-scale observational data can help improve our understanding of the risk factors associated with oral disease [13–16]. Deploying multiple sources of population-level oral health data in an accessible dashboard could help monitor trends, explore risk factors and provide support for policy decisions. Extracting information from large-scale survey data-sets using summary statistics and simple contingency tables with open-source programming languages such as R is relatively straightforward and computationally reproducible [1, 17]. Ultimately, what is desirable is increased access for researchers, clinicians and policy makers to reported data analysis-visualisation that could benefit individual and population oral health [2, 18].

For an interactive analytical dashboard, the data is presented (on the same or separate screens) in a visual format that supports exploration and interrogation. The viewer can change the underlying parameters and run the document to see the output or allow for incremental updates of the dashboard as the input data changes [19]. This increases the potential impact of the data analysis by allowing interactivity and dynamic visualisations in "real-time" [6]. Communicating data analysis output through a dashboard can improve public awareness of research output and encourage greater transparency with other researchers who are able to easily assess initial findings. Integration with Git (a version control system) and deployment via GitHub pages (web pages hosted through a Github repository) promotes rapid communication, enhances collaboration and improves transparency and reproducibility. The process of creating a dashboard is described as "dashboarding" and has been outlined in detail by multiple authors [7, 8].

`Flexdashboard` [20] is a package developed for R Markdown which, in turn, has been described as an ecosystem for creating computational documents in R [19]. A flexdashboard layout can be created from a template within an R markdown file. This template can be customised to provide the type of framework for visual display of the elements of the dashboard which can be either dynamic or static. Adding R `Shiny` [21] to the flexdashboard provides reactivity which allows viewers to change the parameters or variables and immediately see the results providing a dynamic rather than static dashboard. The main focus of this protocols paper is to demonstrate the development of an analytical, interactive dashboard for researchers, policy makers or those interested in exploring national cohort surveys who may not have sufficient training in data analytics or coding skills. We demonstrate the development and deployment of the dashboard with R Markdown, Shiny and Flexdashboard, using oral health-related data from multiple Irish national child surveys.

Methods

Pre-design evaluation

The objective in pre-design was to decide on the structure and data requirements, user interaction process, visualisation design and key variable selection. The primary audience for the dashboard is the research community, including policy makers, who are interested in child oral health. The primary goal was to develop a dashboard to explore multiple variables associated with child oral health using the data-sets indicated in Table 1.

Simple interaction by adding an input sidebar in the input structure allows the end-user to facet the data through filters before 'knitting' the R Markdown document and updates visualisations automatically as the user changes inputs. Simple statistical descriptives including frequency tables and bar plots along with further displays stratified by gender and socioeconomic status were selected for input.

Table 1 Data sources

Survey	Initial sample size	Year of survey	Wave number	Child age (years)
Growing Up in Ireland infant cohort[a]	11134	1999	2, 3 and 5	3, 5 and 9
Growing Up in Ireland child cohort[a]	8500	1999	1, 2 and 3	9, 13 and 17/18
National Children Food Survey II[b]	594	2017	2	5 to 12

[a] https://www.growingup.ie/about-growing-up-in-ireland/

[b] https://www.iuna.net/surveyreports

Dashboard design

The R statistical programming language was used (within the R Studio integrated developer environment [22]) to import, clean, join and aggregate the data from the different data surveys detailed in Table 1. R Markdown which is a markup language, was used for basic data wrangling and statistical analysis. The `flexdashboard` package was used to create the structure-elements of the dashboard and the `Shiny` package, which allows for interactivity, was embedded within the Flexdashboard framework within an R Markdown notebook (v.1.1.456) [19, 21].

Consistency in presenting data in the dashboard is important for conveying information and this includes both visual consistency of the elements and data consistency of the levels. Visual consistency was handled through `Flexdashboard` and using functions to generate different graphs. Each function takes a variable to display and use consistent graphics parameters. Different surveys had different data designs, instruments, data structures and taxonomy. The key variables selected were chosen based on their known associations with oral health, cariogenic food and drink and weight status [13, 23–26]. These included: dental behaviour variables such as reported frequency of tooth brushing, dental attendance and reported history of fillings and extractions; dietary intake of food and drinks typically high in free sugars and BMI status [27]. Visualisation design was simplified to standard frequency tables and bar-plots to provide easy interactivity for examining potential variable associations.

Data sources

The data sources were static and included the national child cohort surveys listed in Table 1. The main data source was the national longitudinal survey of young people in Ireland, the Growing Up in Ireland (GUI) survey. This is a nationally representative survey which started collecting data in 2007 from a child cohort at 9 years of age. The second National Children's Food Survey (NCFSII) was carried out by the Irish Nutrition Universities Alliance (IUNA) in 2017/18 and included details on food and nutrient intakes, body weight, physical activity and eating behaviours in children aged 5-12 years.

Full details of the surveys are available at the links provided in Table 1. The GUI and IUNA/NCFSII surveys were conducted according to guidelines laid down in the Declaration of Helsinki. Ethical approval for the GUI project was received from a Research Ethics Committee convened by the Department of Health and Children while approval for the IUNA project was obtained from the Clinical Research Ethics Committee of the Cork Teaching Hospitals, University College Cork. Data from GUI was obtained from the Irish Social Science Data Archive (ISSDA, University College Dublin, (http://www.ucd.ie/issda)) and the NCFSII data files were obtained from the IUNA Database Management Committee.

Data preparation and workflow

Data preparation and workflow is outlined in Fig. 1. All data-sets were imported from either .sav or .csv formats using R Studio [22]. All documents related to this project (except the original data files) were version controlled using GitHub (with Git installed locally) via the R Studio integrated development environment (IDE) or terminal command line. Wrangling (tidying and transformation) of the data was carried out for each individual wave before joining waves for longitudinal analysis. All data used for this analysis was unweighted. The R Markdown files and packages created for importing data files, variable renaming and renaming convention, full joins for longitudinal analysis and simple descriptive analysis including frequency tables and bar plots are available for download at https://github.com/oral-health-nutrition/oral-health-nutrition.github.io.git

Programmatic renaming and conversion from the original data frames to a `tidy` data frame was carried out in R Markdown to help track lineage of the transformations and integration of code with text. The data were remapped or relabelled to provide more useful descriptive names and ensure the response levels were correctly matched before the data were aggregated [17]. The main grouping variables were gender and social class. Specific functions were created to generate bar-plots and tables. The dashboard was then populated with the data and tested before publishing with version control. Only subjects who participated in all waves of the GUI cohort surveys were included.

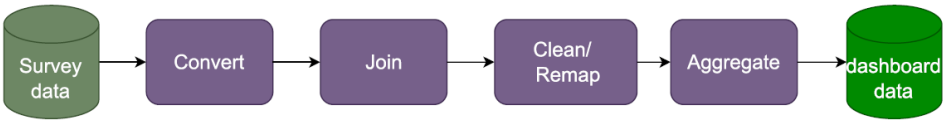


Fig. 1 Workflow from data import to dashboard development

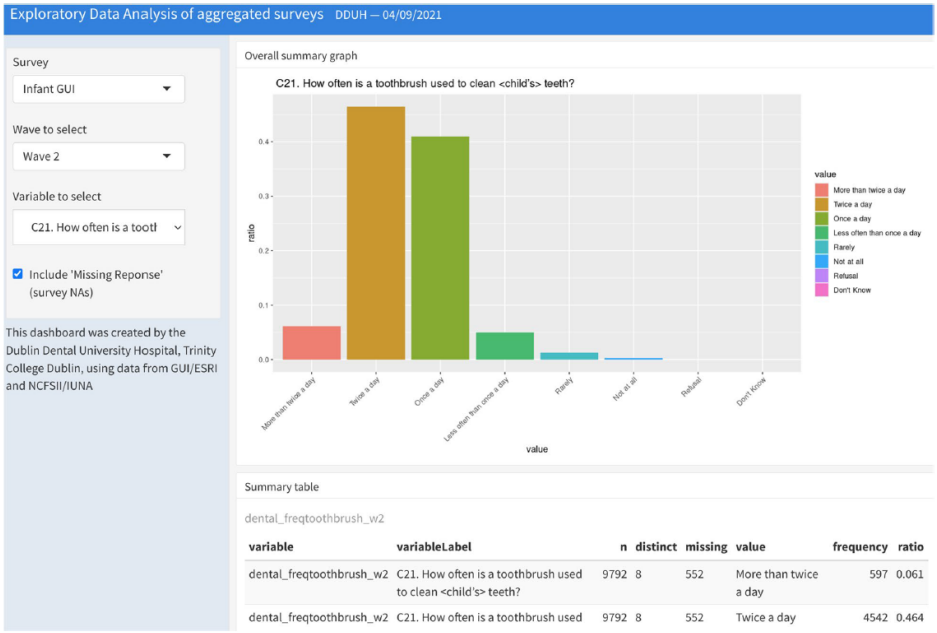


Fig. 2 Dashboard elements

Ontology mapping minimises differences between survey questions from different waves, or different surveys, aimed at capturing the same information [28]. While official data governance provided information about instruments used in questionnaires, ontology was not defined for many variables and the data were not harmonised between waves. For secondary analysis, the data harmonisation included remapping (reducing to common factors (using the `forcats` package) and custom dictionaries for programmatic mapping. Variables which were derived from different instruments such as dietary intake measurement or variables where the response levels did not match were remapped to facilitate cross wave comparisons or for longitudinal analysis. Response levels were also reordered with custom configuration for effective data visualisation. Variables not reported directly such as BMI classification were calculated. The data were aggregated mainly using tidyverse packages such as `dplyr` and summarised using `ggplot2` and `kableExtra`.

Results

Dashboard elements

The dashboard layout is structured by the YAML (YAML Ain't Markup Language) metadata at the start of the R Markdown document and the syntax from Flexdashboard. The YAML header controls the file format and output style. The other elements of the dashboard included input, functions and data as highlighted in Fig. 2. The aggregated data files were compiled in .RDS files which are more efficient when using R.

The Flexdashboard template (`flex_dashboard`) was selected within a new R Markdown document. The `Shiny` package was also loaded here (`runtime: shiny`). The general guide about the layout is that a page is generated by a first-level section while a column or row is generated by a second-level section [21]. The third-level section generates a box that contains dashboard components [19]. The layout was set to 'vertical layout: scroll' to specify scrolling through multiple charts and the default column orientation set to 'orientation: rows'. Theme appearance and colours were set using the default

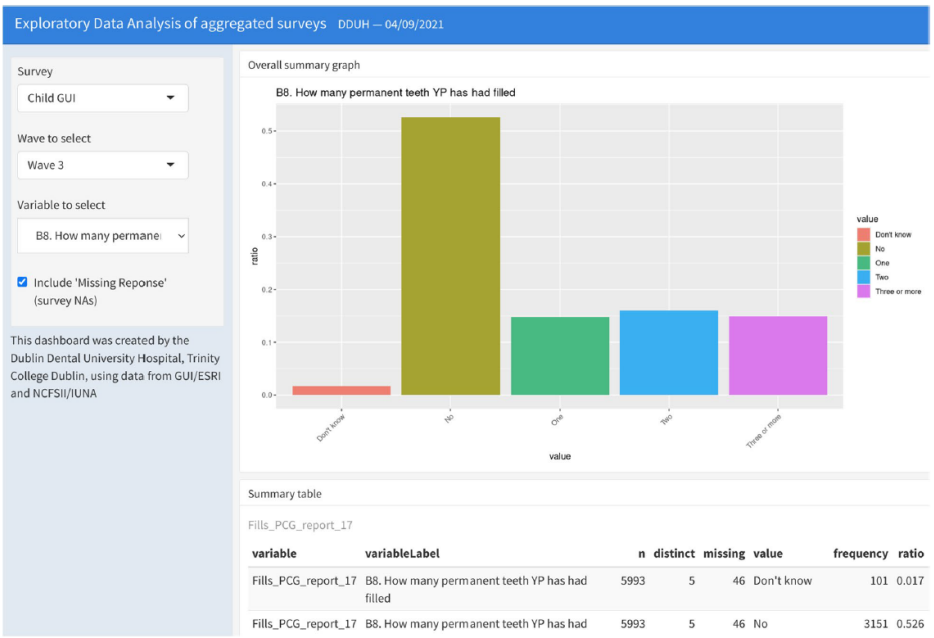


Fig. 3 Response frequency of dental fillings in GUI child cohort 17/18 years old (wave 3)

'theme: cosmo'. An input sidebar was added by inserting the '{.sidebar}' attribute to the first column (which also generates a typical Shiny-based dashboard). Survey type, wave of survey and variable selector were set as filter options in the drop-down column (Fig. 2). To make an output reactive, we used Shiny's render functions which changes input to automatically render code and update output.

The final R Markdown document was rendered (using the 'Run' button) into a HTML document to view the dashboard locally. However, this produces a static HTML file. To create reactivity the flexdashboard must be deployed using a web server.

Deployment of dashboard

The dashboard can be deployed using a personal or Shiny server. A Shiny account (free version) was set up at https://www.shinyapps.io/ to enable publishing using an online service for hosting Shiny apps in the cloud. The repository hosting service Github also provides free web hosting on GitHub pages (https://pages.github.com/) which is neatly integrated with R Studio and is useful for hosting documentation related to the dashboard or deploying a server-less dashboard. Essentially, GitHub Pages are public webpages hosted and published through GitHub. R Studio Connect is R Studio's publishing platform and the R Studio IDE has push-button publishing which conveniently provides sharing of Shiny applications with R Studio Connect for R Markdown reports and dashboards. The dashboard and can be accessed at https://dduh.shinyapps.io/dduh/.

Adding interactive controls or reactive expressions to the dashboard with Shiny generates the dynamic aspects of the components of the dashboard. Variables of interest to the viewer for a specific cohort wave (for GUI data) can be selected using the 'survey', 'wave' and 'variable to select' filters in the input panel. Once selected the dashboard generates output including bar-plots (and tables) for the selected variables. For example, for the GUI Child cohort at wave 3 (17/18 years old), the response is the number of fillings for the young person (Fig. 3). At wave 2 (13 years old) the response was a binary (Yes/No) if the child had dental fillings carried out (Fig. 4). For any variable of interest across any survey or wave the output is automatically stratified by gender and socio-economic status (Fig. 5).

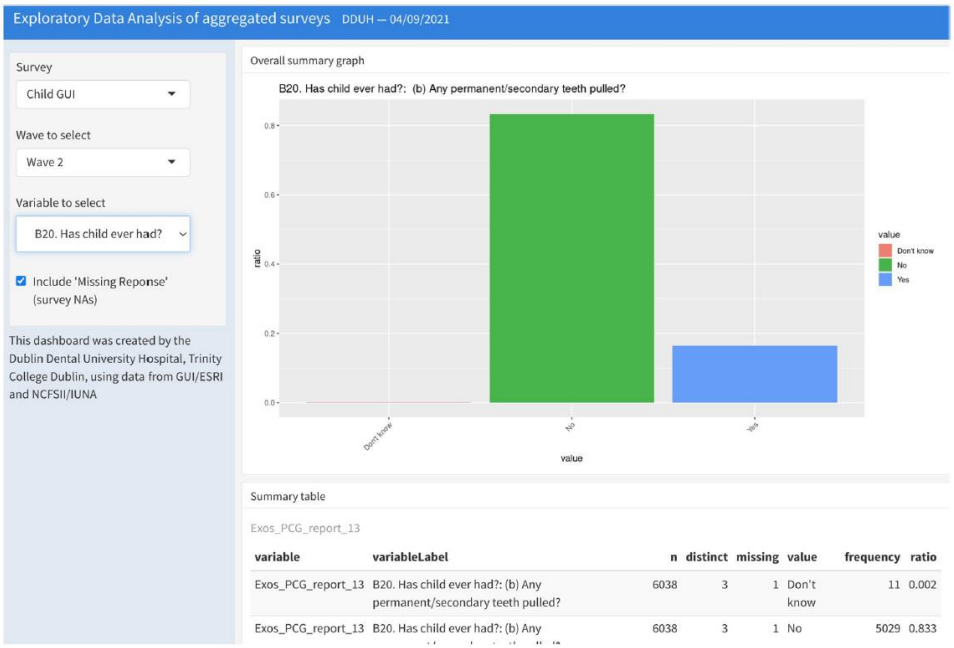


Fig. 4 Response frequency of dental fillings in GUI child cohort at 13 years old (wave 2)

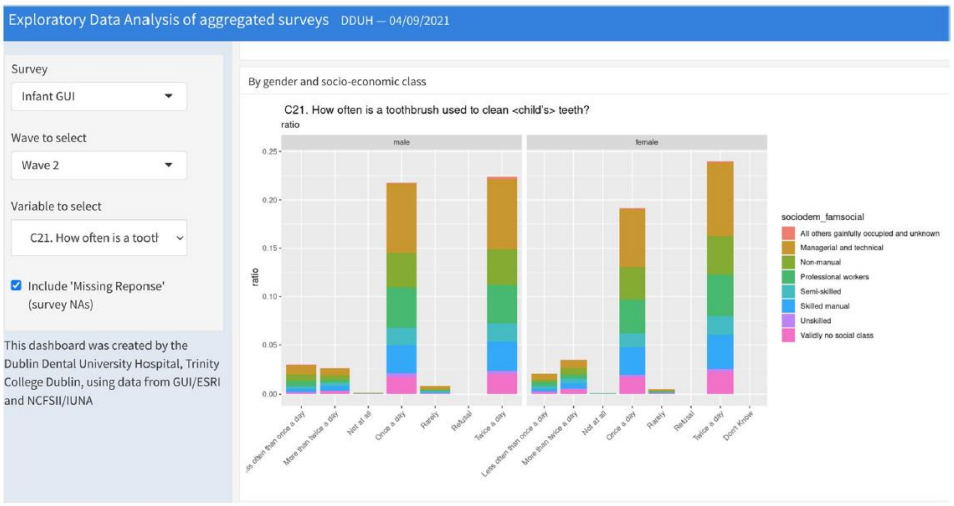


Fig. 5 Tooth brushing frequency by gender and socio-economic status

Discussion

This paper demonstrated the development of an interactive dashboard which provides a template for other researchers to incorporate as part of their own data visualisation and dissemination. The R Flexdashboard framework with some Shiny attributes included creates a reactive document which can be deployed with a basic knowledge of R. Visualisation of national child cohort data in dashboards allows viewers to dynamically explore oral health related variables from several Irish cohort surveys without requiring multiple plots and tables and sharing of extensive documentation.

There is little empirical data demonstrating the advantages of using data dashboards for public health policy or decision making [3, 18, 29]. However, we suggest that there are a number of advantages to this type of data visualisation including; easy and interactive communication of descriptive statistics, data-driven hypothesis generation, faster dissemination of results, computational reproducibility, incremental (addition of further surveys) and accessible across multiple devices with potential for interactive learning.

As a research tool the dashboard is a rapid means of communicating exploratory descriptive results, an overall summary of variables or data-driven hypothesis generation. Obervation of longitudinal changes within cohort survey participants and inter-survey comparisons of similar variables can provide useful insights into age or cohort changes occurring in developing children. For example, for national representative surveys, comparing the prevalence of dental fillings or frequency of tooth brushing across cohort waves is a useful descriptive measure for policy makers. Similarly, a readily accessible measure of the trends in other oral health behaviours such as dental attendance or dietary consumption of sugar-sweetened beverages can provide support for public health action.

In the R Studio environment version control is neatly integrated with Git which is hosted on GitHub. Git is a software version control system which allows researchers and collaborators to keep track of the code produced and the changes that any of the research team make to it. Version control is an essential element of any reproducible research project including R Markdown files used to create this dashboard. With a GitHub account (and Git installed) a repository can be created and linked to an R project as used in this dashboard project. As well as improving computational research reproducibility GitHub Pages can also be used to share other static content that can be 'pushed' from the repository such as a project related blog to improve visibility of the research and sharing of the R code used.

Another useful feature is that the dashboard can be displayed on multiple devices including tablets and mobile phones. This may provide an enhanced user experience for teaching environments for example and provide some interactive learning opportunities. It is important to note that while Flexdashboard provides an easy template to begin using dashboards there are more customisation options when using Shinydashboard alone to create a dashboard. While storing data in SQL (Structured Query Language) database would be more optimal, current restrictions on accessing the data files used in this manuscript do not permit this.

One of the issues in health sciences research is the lack of training of researchers whose primary field is neither visual design or data analytics [10, 29]. Some commentators have proposed that data literacy should be a core competence in dental curricula [2]. Data wrangling which describes the tidying and transformation of data is the most time-consuming and, arguably, demanding programming task compared to analysis and modelling [30]. Many of the toolbox of skills now required by researchers include an array of data techniques to allow them to reshape, transform, visualise and disseminate data. While a basic knowledge of R is sufficient for dashboard development the learning curve for this more complex skillset is steep. Many of the open data science tools used in this project including distributed version control systems such as Git/GitHub, R Markdown for literate programming and RStudio Projects are regarded as essential to meet the current standards for collaborative, efficient data analysis and communication. We suggest that, given the exponential growth of digital data, dental researchers need to be prepared for a more data-driven approach whether utilising novel or more traditional surveillance data [3, 10]. However, most dental researchers face a number of obstacles when analysing and disseminating research findings from secondary data including difficulties with data sharing, user capabilities, data literacy and standardisation [2, 3].

Developing an effective dashboard is only the first stage in communicating and disseminating research findings. Strategies to improve the uptake of dashboards and training for both researchers and end-users is essential to achieve any real beneficial outcomes [29]. However, data dashboards appear to be a promising means of sharing and collaborating and are an example of how literate programming and dynamic documents can contribute to research reproducibility.

Conclusions

Dashboard development requires minimal non-standard R coding which can be quickly created with open-source software. This manuscript provides an illustration of, and guidance for, the deployment of such a dashboard as a means of communicating descriptive results or for hypothesis generation for factors related to oral health.

Abbreviations

IUNA	Irish Nutrition Universities Alliance
GUI	Growing Up in Ireland
NCFSII	The second National Children's Food Survey
ISSDA	Irish Social Science Data Archive
IDE	Integrated Development Environment

Acknowledgements

We would like to acknowledge that the original data for the GUI survey was collected under the Statistics Act, 1993, by the ESRI-TCD Growing Up in Ireland survey team and accessed via the Irish Social Science Data Archive, www.ucd.ie/issda. The original data for the NPNS was collected by the Irish University Nutrition Alliance research team.

Authors' contributions

VS, MC and OC conceived ideas and wrote the initial draft of the paper. MC and OC prepared the initial data wrangling and provided the RDS files. OC, VS and MC built, tested and deployed the dashboard. MOS and LW particpated in the interpretation of the results and contributed feedback. All authors read and approved the final manuscript.

Funding

PhD candidate, Vinay Sharma, is funded through a Trinity College Dublin Postgraduate Research Studentship (code 1252). Open access funding provided by Dublin Dental University Hospital, Trinity College, Dublin.

Availability of data and materials

Data is available on application to the ISSDA - www.ucd.ie/issda.
Scripts are available at https://oral-health-nutrition.github.io/bmc-2022-protocol-dashboard-gui/gen_dashboard.

Declarations

Ethics approval and consent to participate

The GUI and IUNA/NCFSII surveys were conducted according to guidelines laid down in the Declaration of Helsinki. Informed consent was obtained from all subjects and/or their legal guardian(s). Ethical approval for the GUI project was received from a Research Ethics Committee convened by the Department of Health and Children while approval for the IUNA project was obtained from the Clinical Research Ethics Committee of the Cork Teaching Hospitals, University College Cork.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 12 December 2022 Accepted: 17 March 2023
Published online: 24 April 2023

References

1. Lowndes J, Best B, Scarborough C, Afflerbach J, Frazier M, O'Hara C, et al. Our path to better science in less time using open data science tools. Nat Ecol Evol. 2017;1(6):160. https://doi.org/10.1038/s41559-017-0160.
2. Schwendicke F, Krois J. Data Dentistry: How Data Are Changing Clinical Care and Research. J Dent Res. 2022;101(1):21–9. https://doi.org/10.1177/00220345211020265.
3. Joda T, Waltimo T, Probst-Hensch N, Pauli-Magnus C, Zitzmann NU. Health Data in Dentistry: An Attempt to Master the Digital Challenge. Public Health Genomics. 2019;22(1–2):1–7. https://doi.org/10.1159/000501643.
4. Joda T, Waltimo T, Pauli-Magnus C, Probst-Hensch N, Zitzmann NU. Population-Based Linkage of Big Data in Dental Research. Int J Environ Res Public Health. 2018;15(11). https://doi.org/10.3390/ijerph15112357.
5. Shi JQ. How Do Statisticians Analyse Big Data—Our Story. Stat Probab Lett. 2018;136:130–3. https://doi.org/10.1016/j.spl.2018.02.043.
6. Ellis DA, Merdian HL. Thinking Outside the Box: Developing Dynamic Data Visualizations for Psychology with Shiny. Front Psychol. 2015;6:1782. https://doi.org/10.3389/fpsyg.2015.01782.
7. Few S. Information Dashboard Design: The Effective Visual Communication of Data, vol. 2. Sebastopol: O'reilly; 2006.
8. Smith V. Data Dashboard as Evaluation and Research Communication Tool: Data Dashboard as Evaluation and Research Communication Tool. New Dir Eval. 2013;2013(140):21–45. https://doi.org/10.1002/ev.20072.
9. Concannon D, Herbst K, Manley E. Developing a Data Dashboard Framework for Population Health Surveillance: Widening Access to Clinical Trial Findings. JMIR Formative Res. 2019;3(2):e11342. https://doi.org/10.2196/11342.
10. Höhle M. A Statistician's Perspective on Digital Epidemiology. Life Sci Soc Policy. 2017;13:17. https://doi.org/10.1186/s40504-017-0063-9.
11. Cheng CKY, Ip DKM, Cowling BJ, Ho LM, Leung GM, Lau EHY. Digital Dashboard Design Using Multiple Data Streams for Disease Surveillance with Influenza Surveillance as an Example. J Med Internet Res. 2011;13(4):e85. https://doi.org/10.2196/jmir.1658.
12. Emery T, Pollock G, Scherpenzeel A. Securing High-quality Data on Populations: Why We Need EuroCohort, GGP and SHARE in Europe. Popul Policy Compact. 2019;19:1-5.
13. Štefanová E, Baška T, Holubčíková J, Timková S, Tatarková M, Sovičová M, et al. Selected Behavioural Factors Affecting Oral Health in Schoolchildren: Results from the Health Behaviour in School-Aged Children (HBSC) Slovak Study. Int J Environ Res Public Health. 2020;17(20):7516. https://doi.org/10.3390/ijerph17207516.
14. Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. Public Health Nutr. 2004;7(1a). https://doi.org/10.1079/phn2003589. Citation Key: Moynihan_PaulaPetersen_PoulErik.
15. Crowe M, O'Sullivan A, McGrath C, Cassetti O, Swords L, O'Sullivan M. Early Childhood Dental Problems Classification Tree Analyses of 2 Waves of an Infant Cohort Study. JDR Clin Transl Res. 2016;1(3):275–84. https://doi.org/10.1177/2380084416651834.
16. Crowe MJ. Diet and Other Risk Indicators Associated with Dental Problems in Irish Preschool Children. [Ph.D. thesis]. Trinity College Dublin; 2018.
17. Zumel N, Mount J, Porzak J. Practical data science with R. New York: Manning; 2014.
18. Twohig PA, Rivington JR, Gunzler D, Daprano J, Margolius D. Clinician Dashboard Views and Improvement in Preventative Health Outcome Measures: A Retrospective Analysis. BMC Health Serv Res. 2019;19(1):475. https://doi.org/10.1186/s12913-019-4327-3.
19. Xie Y, Allaire JJ, Grolemund G. R Markdown: The Definitive Guide. Boca Raton: Chapman and Hall/CRC; 2018.
20. Iannone R, Allaire J, Borges B, et al. flexdashboard: R Markdown Format for Flexible Dashboards. R package version 05. 2018;1. https://pkgs.rstudio.com/flexdashboard/. https://github.com/rstudio/flexdashboard/. Accessed 9 Oct 2022.
21. Chang W, Cheng J, Allaire J, Xie Y, McPherson J, et al. Shiny: web application framework for R. R Packag Version. 2017;1(5):2017. R package version 1.7.2.9000. https://shiny.rstudio.com/.
22. Team R. RStudio: Integrated Development for R. Boston: RStudio, Inc.; 2020. http://www.rstudio.com.
23. Crowe M, O'Sullivan M, Cassetti O, O'Sullivan A. Estimation and Consumption Pattern of Free Sugar Intake in 3-Year-Old Irish Preschool Children. Eur J Nutr. 2019. https://doi.org/10.1007/s00394-019-02056-8.
24. Crowe M, M OS, Cassetti O, A OS. Weight Status and Dental Problems in Early Childhood: Classification Tree Analysis of a National Cohort. Dent J. 2017;5(3). https://doi.org/10.3390/dj5030025.

25. Golafshar MA, Petersen M, Vargas CE, Samadder NJ, Kunze KL, McCormick N, et al. Utilizing Open-Source Platforms to Build and Deploy Interactive Patient-Reported Quality of Life Tracking Tools for Monitoring Protocol Adherence. Qual Life Res. 2021;30(11):3189–97. https://doi.org/10.1007/s11136-020-02617-z.
26. Gussy M, Mnatzaganian G, Dashper S, Carpenter L, Calache H, Mitchell H, et al. Identifying Predictors of Early Childhood Caries among Australian Children Using Sequential Modelling: Findings from the VicGen Birth Cohort Study. J Dent. 2020;93:103276. https://doi.org/10.1016/j.jdent.2020.103276.
27. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a Standard Definition for Child Overweight and Obesity Worldwide: International Survey. BMJ. 2000;320(7244):1240. https://doi.org/10.1136/bmj.320.7244.1240.
28. Bath PA, Deeg D, Poppelaars J. The Harmonisation of Longitudinal Data: A Case Study Using Data from Cohort Studies in The Netherlands and the United Kingdom. Ageing Soc. 2010;30(8):1419–37. https://doi.org/10.1017/S0144686X1000070X.
29. Helminski D, Kurlander JE, Renji AD, Sussman JB, Pfeiffer PN, Conte ML, et al. Dashboards in Health Care Settings: Protocol for a Scoping Review. JMIR Res Protocol. 2022;11(3):e34894. https://doi.org/10.2196/34894.
30. Smirnova E, Ivanescu A, Bai J, Crainiceanu CM. A Practical Guide to Big Data. Stat Probab Lett. 2018;136:25–9. https://doi.org/10.1016/j.spl.2018.02.014.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC