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Inequalities in the dental health needs and access to dental services amongst Looked After Children in Scotland: a population data-linkage study

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ABSTRACT

Background

There is limited evidence on the health needs and service access among children and young people who are looked after by the State. The aim of this study was to compare dental treatment need and access to dental services (as an exemplar of wider health and wellbeing concerns) among children and young people who are looked after with the general child population.

Methods

Population data linkage study utilising: national datasets of social work referrals for “looked after” placements, the Scottish census of children in local authority schools, and NHS dental health and service datasets.

Results 633204 children in publicly funded schools in Scotland during academic year 2011/12, of whom 10927 (1.7%) were known to be looked after during that or a previous (from 2007/08) year. The children in the LAC group were more likely to have urgent dental treatment need at 5-years of age: 23% vs 10% (n=209/16533), adjusted (for age, sex, and area socioeconomic deprivation) odds-ratio 2.65 (95%CI 2.30, 3.05); were less likely to attend a dentist regularly: 51% vs 63% (n=5519/388934), 0.55 (0.53, 0.58); and more likely to have teeth extracted under general anaesthetic: 9% vs 5% (n=967/30253), 1.91 (1.78, 2.04).

Conclusions

Looked after children are more likely to have dental treatment needs and less likely to access dental services even when accounting for sociodemographic factors. Greater efforts are required to integrate child social and health care for looked after children and to develop preventive care pathways upon entering and throughout their time in the care system.

Keywords; LAC-Dental, Looked after children, data-linkage, dental caries, tooth extraction.

What is already known on this subject

Little is known internationally about health and access to healthcare and preventive care services, eg dental services, among looked after children at the population level.

Small surveys have indicated that looked after children have high levels of mental and physical health needs.

There are no studies that compare the oral health of looked after children with the general child population, or use national data linkage resources.

What this study adds

This is the first population-level analysis of dental endpoints and services comparing looked after children with the general child population.

Looked after children have high levels of severe dental decay and tooth extraction under general anaesthesia, and low levels of access to preventive dental services.

Unlike other studies we were able to identify that findings were not explained by socioeconomic factors, which is a confounder in existing research.

INTRODUCTION

Over the period 2009-2014, approximately 16,000 children and young people have been looked after by the state in Scotland at any one time – less than 2% of 0-17 year olds. Looked After Children in Scotland are defined to be children and young people who are accommodated in foster, kinship and residential care placements, as well as those remaining with their families in compulsory home supervision. The latter group accounted for approximately 30% of all looked after children in 2014.[1]

There is a recognised data deficit in the health, education, and employment outcomes for looked after children.[2]. A number of small observational studies have reported poorer health among looked after children than among their peers. [3-6] Much of the knowledge about the uptake of health services by looked after children comes from studies on mental health, and we know less about the uptake of interventions which prevent or treat common physical health problems.[7, 8] While oral health problems and dental service access have been recognised as issues among looked after children [9], the epidemiological research is limited. There is only one previous study from Scotland which looked at this issue: a survey of 96 young people in and leaving care placements which found that half the respondents had not visited the dentist in the past year [7]. There are no population-wide studies which examine the oral health of looked after children and their use of preventive and hospital dental services compared with the general child population, nor studies that have utilised linkage of national data sources.[10]

The oral health of Scotland's children has long been a challenge. Despite significant improvements, such as free dental health checks for all children (including those in care), 32% of 5 year olds and 27% of 11 year olds still experience dental decay with higher levels in children from the most deprived communities. [11, 12] Dental extraction – evidence of failure of dental preventive care – remains the most common reason for elective hospital admission for general anaesthesia among children in Scotland, accounting for over 7,500 episodes per year.[13] Dental health services are free at the point of access to all children in Scotland and 91% of the 0-17 year old population are registered with a General Dental Practitioner, however there are differences in use

and type of treatment received by age, location, and socioeconomic circumstances.[14] Thus the importance of accounting for socioeconomic deprivation in analyses of oral health and dental service access in different population groups. Dental diseases are readily preventable, and it is widely recommended that all children access dental services on a “regular” basis for preventive care.[15] National Health Service (NHS) dental services are universally available in Scotland, and access to and uptake of preventive dental services can therefore be seen as a good example for access to healthcare services more generally.

Here we aimed to compare dental treatment need and access to dental services among children and young people who are looked after with the general child population.

METHODS

Data sources

Multiple datasets (Table 1, detailed descriptions in Appendix 1) were utilised: denominator data on all children in publicly funded school via ScotXed Pupil Census; looked after status and placement information via ScotXed Looked After Children (LAC) dataset;[16] NHS primary care dental data via the Management Information and Dental Accounting system (MIDAS); dental extractions under general anaesthesia via Scottish Morbidity Records (SMR01) hospital discharge dataset; and dental treatment needs of 5 / 11-year-olds via the National Dental Inspection Programme (NDIP). Details of the record linkage methods are also supplied in Appendix 1. Approval via a number of ethical and information governance procedures was successfully achieved (Appendix 2).

Table 1 Visual presentation of datasets and timeframe

2007	2008	2009	2010	2011	2012	2013
				ScotXed Pupil Census Sep11		
ScotXed LAC dataset previous LAC Aug07				ScotXed LAC dataset Current LAC Aug11		Sep12

	MIDAS -primary care dental service data	
Apr08		Mar13
	SMR01 - hospital discharge data	
Apr08		Mar13
	NDIP - 5- and 11-year dental treatment need data	
Apr08		Mar13

Creation of the study groups

The ScotXed LAC dataset included children with an open looked-after episode during the 12 month period to 31st July 2012. Secondly, it also held reliable retrospective looked after children data on these children starting from 2007/08 (i.e. from August 2007). All of these children included in the 2011/12 Pupil Census (and therefore only school-age) were included in the looked after children “LAC group”. The children who were not identified as being in the LAC group were consigned to the comparator “Non-LAC” group.

Data processing and analysis

The datasets were pre-linked using bespoke linkage techniques and stored in the National Safe Haven,[17] and each dataset included an anonymous study identifier for each child. The study cohort was created from the underlying school census dataset and subdivided into the LAC group and the Non-LAC group. Age, sex and small area socioeconomic status as measured by the Scottish Index of Multiple Deprivation (SIMD 2011) were provided at the time of the school census. SIMD is scored with five categories (fifths of the population), with ‘1’ representing the most deprived areas and ‘5’ for the most affluent areas. The children in the LAC group were characterised by the number of placements they received and the location of the most recent placement. The placement locations were pooled into the following categories for the analyses: at home with a parent or parents, with friends or relatives such as grandparents (i.e. kinship care); in foster care; or in a residential unit (group home).

Dental extractions under general anaesthesia were defined using the appropriate procedure and diagnostic codes from the hospital in-patient episode file (SMR01). Attendance at primary care

dental services was recorded in each of the five years 2009-2013. Dental inspections are carried out in the first and last years of primary school education, however, this arrangement does not provide a perfect contemporaneous link with all of the children in the school census. We therefore restricted the analyses to those children aged 5-years (P1) and those aged 11-years (P7) in any of the study years. Dental treatment need was identified by the follow-up letters sent to parents after the inspections (specified as urgent, non-urgent, not needed, see Appendix 1).

All comparisons of the LAC group with the Non-LAC group were analysed both univariately and with adjustment for age, sex and SIMD, using logistic regression. We also compared the most recent placement locations within the LAC group as a priori sub-group analyses, and investigated dental outcomes by placement type.

RESULTS

There were 670952 children included in the 2011/12 pupil census. Of these, 10009 and 1757 respectively (totalling 11766, 1.8%) were known to be currently or recently looked after. Of these, 9409 and 1674 respectively (totalling 11083, 1.5%) were linked to the CHI database. Only children with good linkages were included, some duplicate records were deleted, and children with an unknown SIMD category were removed. The final numbers for analysis were 10924 for the currently or recently looked after LAC group, and 622280 for the other children in the comparator Non-LAC group. Most children were placed 'at home' (n=4992/46%), a smaller number were placed 'away from home' with foster carers (n=2686/25%), friends/other relatives (n=2448/22%) and 7% (n=798) were placed in residential care. The age of the children in the master cohort ranged from 4-17 years old with a mean of 11.7 years in the LAC group and 10.3 years in the Non-LAC group, and 53% (n=5815) and 51% (n=316719) were male in the two groups, respectively (Table 2). There was a greater proportion of children in the most deprived SIMD fifth of the population in the LAC group (n=4548/42%) compared with the Non-LAC group (n=129741/21%).

Table 2: Comparison of Age, Sex and Scottish Index of Multiple Deprivation (SIMD)

Demographic	LAC* Group		Non-LAC Group	
N	10924		622280	
Age	Mean	(SD)	Mean	(SD)
	11.7	(2.6)	10.3	(3.7)
	N	(%)	N	(%)
4-8	1648	(15%)	221388	(36%)
9	1078	(10%)	46896	(8%)
10	1139	(10%)	48167	(8%)
11	1053	(10%)	44482	(7%)
12	1292	(12%)	54891	(9%)
13	1315	(12%)	51502	(8%)
14	1614	(15%)	53333	(9%)
15-17	1785	(16%)	101621	(16%)
Sex				
Female	5109	(47%)	305561	(49%)
Male	5815	(53%)	316719	(51%)
SIMD				
1 (most deprived)	4548	(42%)	129741	(21%)
2	2610	(24%)	118446	(19%)
3	1793	(16%)	123120	(20%)
4	1289	(12%)	129683	(21%)
5 (least deprived)	684	(6%)	121290	(19%)

* LAC = Looked After Children

A lower proportion of children in the LAC group regularly attended dental services, 51% vs 63% (n=5519/388934), with an adjusted odds ratio (OR) of 0.55 (0.53-0.58) (Table 3). As the sample size is very large all of the reported analyses from this project have small p-values (p<0.001).

There was a greater proportion with recent dental extractions under general anaesthetic in the LAC group (9%, n=967) than the Non-LAC group (5%, n=30253), with an OR of 1.91 (1.78 to 2.04). This result varied by socioeconomic status with an unadjusted OR of 1.21 (1.09 to 1.34) for the most deprived SIMD fifth, and an unadjusted OR of 3.12 (2.30 to 4.23) for the least deprived SIMD fifth

(due to a relatively larger drop in extractions in the non LAC group for the more affluent SIMD subgroups).

Table 3: Comparison of Endpoints

Endpoint	LAC* Group		Non-LAC Group	
	N	(%)	N	(%)
Regular Attendance **				
Yes	5519	(51%)	388934	(63%)
No	5405	(49%)	233346	(38%)
Total	10924		622280	
Adjusted odds-ratio† = 0.55 (0.53, 0.58)				
Tooth Extraction				
Yes	967	(9%)	30253	(5%)
No	9957	(91%)	592027	(95%)
Total	10924		622280	
Adjusted odds-ratio = 1.91 (1.78, 2.04)				
NDIP 5-year olds				
Urgent dental needs				
Yes	209	(23%)	16533	(10%)
No	685	(77%)	15465	(90%)
Total	894		171098	
Adjusted odds-ratio = 2.06 (1.76, 2.42)				
Urgent & non-urgent dental needs				
Yes	595	(67%)	61789	(36%)
No	299	(33%)	109309	(64%)
Total	894		171098	
Adjusted odds-ratio = 2.65 (2.30, 3.05)				
NDIP 11-year olds				
Urgent dental needs				
Yes	310	(7%)	4709	(2%)
No	3987	(93%)	193801	(98%)
Total	4297		198510	
Adjusted odds-ratio = 2.35 (2.08, 2.65)				
Urgent & non-urgent dental needs				
Yes	3221	(75%)	115987	(58%)
No	1076	(25%)	82553	(42%)
Total	4297		198510	
Adjusted odds-ratio = 1.79 (1.70, 1.92)				

* LAC = Looked After Children. ** Regular Attendance = attended dental services in all five study years. † Odds-ratios are adjusted by age, sex and Scottish Index of Deprivation (SIMD), NDIP = National Dental Inspection Programme. The analyses are restricted to those with inspection data and age group restrictions, namely age 4-8 at the 2011/12 Pupil Census for the 'age 5' NDIP and 9-14 for the 'age 11' NDIP.

Despite smaller numbers in the LAC group there was still a noticeable difference in urgent and non-urgent dental treatment need between the groups in primary one children (age five), 67% (n=595) vs 36% (n=61789), with an OR of 2.65 (2.30-3.05) (Table 3). There was a greater proportion in the older primary seven (age 11) linkage that covers more contemporaneous children, namely 3221 (75%) and 115987 (58%) in the LAC and Non-LAC groups, respectively, with an OR for any treatment need (urgent and non-urgent) of 1.79 (1.67-1.92). The results were even more pronounced for urgent dental treatment need, with an OR 2.35 (2.08-2.65) for the LAC relative to Non-LAC group.

LAC Group subgroup analyses

The LAC group were sub-divided by number of placements and described by placement type (Table 4), with roughly equal mean ages for the grouping of the number of placements (range 11.5 to 11.9 years old). Of the LAC children in the most deprived areas (SIMD1), 46% (n=3220) had one placement, and 28% (n=304) had four or more placements.

Table 4: Comparison of Age, Sex and Scottish Index of Multiple Deprivation (SIMD) for Last Placement Types in the LAC* Group

Demographic	Placement Type							
	Home		Kinship		Foster		Residential	
N	4992		2448		2686		798	
Age	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
	11.9	(2.6)	11.1	(2.5)	11.4	(2.6)	13.5	(1.8)
	N	(%)	N	(%)	N	(%)	N	(%)
4-8	702	(14%)	485	(20%)	445	(17%)	16	(2%)
9	465	(9%)	293	(12%)	300	(11%)	20	(3%)
10	483	(10%)	292	(12%)	336	(13%)	28	(4%)
11	436	(9%)	272	(11%)	312	(12%)	33	(4%)
12	593	(12%)	304	(12%)	313	(12%)	82	(10%)

13	599	(12%)	270	(11%)	286	(11%)	160	(20%)
14	839	(17%)	256	(10%)	303	(11%)	216	(27%)
15-17	875	(18%)	276	(11%)	391	(15%)	243	(30%)
Sex	N	(%)	N	(%)	N	(%)	N	(%)
Female	2257	(45%)	1188	(49%)	1306	(49%)	358	(45%)
Male	2735	(55%)	1260	(51%)	1380	(51%)	440	(55%)
SIMD								
1 (most deprived)	2528	(51%)	1204	(49%)	572	(21%)	244	(31%)
2	1238	(25%)	573	(23%)	583	(22%)	216	(27%)
3	670	(13%)	342	(14%)	631	(23%)	150	(19%)
4	386	(8%)	206	(8%)	546	(21%)	133	(17%)
5 (least deprived)	170	(3%)	123	(5%)	336	(13%)	55	(7%)

* LAC = Looked After Children

Kinship = family / friends

Recent regular attendance at dental services was lowest for placements at home (45%, n=2266), intermediate for kinship placements (53%, n=1303), and highest for foster placements (57%, n=1527) (Table 5). Tooth extractions under general anaesthesia varied from 6.5% (n=52) for residential placements to 10.3% (n=252) for kinship placements. Treatment need (urgent and non-urgent combined) from the P7 (age 11) inspection was found in 78% (n=1471) with home placements, 77% (n=789) with kinship placements, 71% (n=174) in residential placements, and 69% (n=787) with foster carers; which also contrasts with 58% (115987) among the Non-LAC group.

Table 5: Comparison of Endpoints by Last Placement Types in the LAC* Group

Endpoint	Placement Type			
	Home	Kinship	Foster	Residential
N	4992	2448	2686	798
Regular Attendance **				
Yes	2266 (45%)	1303 (53%)	1527 (57%)	423 (53%)
No	2726 (55%)	1145 (47%)	1159 (43%)	375 (47%)

Tooth Extraction

Yes	429	(9%)	252	(10%)	234	(9%)	52	(7%)
No	4563	(91%)	2196	(90%)	2452	(91%)	746	(93%)

NDIP 5-year olds**Urgent & non-urgent dental needs**

Yes	255	(68%)	196	(71%)	140	(59%)	4	(67%)
No	120	(32%)	81	(29%)	96	(41%)	2	(33%)

NDIP 11-year olds**Urgent & non-urgent dental needs**

Yes	1471	(78%)	789	(77%)	787	(69%)	174	(71%)
No	412	(22%)	242	(23%)	352	(31%)	70	(29%)

* LAC = Looked After Children ** Regular Attendance = attended dental services in all five study years. NDIP = National Dental Inspection Programme. The analyses are restricted to those with inspection data and age group restrictions, namely age 4-8 for the 'age 5' NDIP and 9-14 for the 'age 11' NDIP.

DISCUSSION

We created the first study successfully linking data across the social care, education, and health sectors to systematically compare health and access to health services in looked after and non looked after school age children in Scotland. Looked after children have higher treatment needs and poorer access to dental health services (including preventive care) than children in the general population. We found that looked after children have double the rates of urgent dental treatment need (severe dental decay experience or dental abscess), were half as likely to regularly attend dental services, and were nearly twice as likely to have had teeth extracted under general anaesthetic than the general child population. These results prevailed after adjustment for age, sex, and socioeconomic status. Childhood dental treatment need – particularly when urgent (severe dental decay or associated with an abscess), or requiring dental extraction under general anaesthesia – is an early marker of poor physical health.[18] Moreover, since dental decay is readily preventable it is a marker of failure of care or of preventive care services or sub-optimal use of such services.

Utilising and linking large national routine administrative datasets is a strength of this study.

However, there are some limitations – including a number of potential linkage issues, whereby

incomplete linkage could mean that some children within the 2011/12 pupil census who were LAC have been misclassified as non-LAC. The potential for incomplete linkage, does not seem to have been a major problem (Appendix 1). We identified 1.5% children in the 2011/12 pupil census as LAC which is similar to the 1.6% of the school aged population classified as LAC in the published national statistics.[1] Given our focus on school age children, we do not have the complete history of contact with the care system prior to starting school. This includes children in the general child population, some of whom may have had contact with the care system prior to starting school, or (for older children) in earlier school years. The population of LAC is subject to considerable flux. Approximately 3000 school-age children start and cease to be looked after each year.[1] In our analysis, the Non-LAC group is nearly 60 times larger, and the impact of having current or previous LAC children in the Non-LAC group would likely have had minimal influence on the findings.

The main caution in interpretation of findings is associated with the temporal relationships of the data. In effect, we have cross-sectional data for when the children were looked after, linked to recent dental inspection and dental service / treatment history. Thus, we have been unable to disentangle whether the dental health and access to services issues in LAC are related to the factors that led to the children becoming looked after in the first place or whether the State is failing to fully look after these children.

The study adds to the international evidence in two ways. First, we developed innovative linkage methods to successfully link large national administrative datasets from social care to health services to investigate health and service access of looked after children. Second, while our study confirms findings of previous smaller and ad hoc reports, [7, 8, 9] we were able to identify that dental treatment needs, infrequent use of dental services, and extractions under general anaesthesia among looked after children are not explained by socioeconomic factors, which is a confounder in existing studies.[4] However, there may be other confounding factors, for example, comorbidities or disabilities which may also more prevalent among looked after children. In the future, as data on care histories improve and more data points become available, a cohort study

design could overcome the limitations of this cross-sectional design and investigate the impact of LAC placements on health over time.

There is a policy recommendation in Scotland that all children who become looked after (including looked after at home) should have a health assessment, which should also include a dental assessment and checking they are registered with a dentist, within four weeks.[19] However, no data from these local assessments is returned centrally to the NHS Information Services Division hence we could not include it in our analysis. It is our understanding that dental assessments and pathways into care vary by both Health Board and placement location. Moreover, the national oral health improvement programme for Scotland (Childsmile) has been established which has reorientated child dental services towards prevention,[20] but thus far it has not been particularly focused on looked after children.

CONCLUSIONS

We have been able to link data from social and health sectors. School-age looked after children have a history of greater dental health needs and higher levels of hospital admissions for dental extractions, and poorer levels of access to regular dental services where preventive dental care is delivered (and even in a Scottish context where preventive dental care is freely available to all). Cross-sectoral working is essential to develop care pathways to meet the dental needs and improve the healthcare for looked after children.

Declaration of competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors

LE, GC, IM, PW, LM, and DIC conceived the study. KS led on navigating the approvals required. DC, AK, KS, AM, RW, and DIC were involved in the data linkage. All authors were involved in the study design and analysis plan. AM, KS supported by DC undertook the analysis which was further shaped by LM and DIC. AM and DIC can take responsibility for the integrity of the data and the accuracy of the data analysis. AM with LE, LM and DIC undertook the first drafts of the manuscript and all authors reviewed and contributed to producing the final version.

Ethics approval

The NHS West of Scotland Ethics Service confirmed that NHS ethics approval was not required for this study due to non-disclosive nature of data analysed, use of safe-haven for analysis, and robust national information governance procedures.

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Transparency

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Data sharing

The datasets used in this project are national datasets that are held by the Scottish Government and NHS. Researchers wishing to use the national datasets for research purposes should contact the NHS National Services Scotland research support team – electronic Data Research and Innovation Service (eDRIS) in the first instance, see: <http://www.isdscotland.org/Products-and-Services/eDRIS/Becoming-an-eDRIS-User/>

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Dataset Descriptions

- ScotXed School Pupil Census – the annual census of children in local authority primary and secondary schools, which provided the identifiers for indexing, and also provided the denominator for the cohort. The characteristics of the available children included: local authority of residence, child's age, sex, ethnicity, and socioeconomic circumstances. The date of the census was 20th September 2011. Note that the Scottish Exchange of Data, ScotXed, is a department of the Scottish Government that facilitates data projects for children and young people.

<http://www.gov.scot/Topics/Statistics/ScotXed>

- ScotXed Looked After Children (LAC) dataset – this identified looked after children and their characteristics including: local authority, accommodation, legal reason, and full looked-after episodes dating from 1st August 2007 – 31st July 2012.

- Management Information and Dental Accounting system (MIDAS) – this provided individual level data on patient registration with a primary care NHS dentist and treatment details to indicate levels of dental service access, dating from the years 2008/9 to 2012/13 ending in March 2013. This dataset includes both salaried and non-salaried General Dental Services (GDS).

- Scottish Morbidity Records (SMR01) hospital discharge dataset – this provided dental specialty continuous inpatient stays by diagnosis and procedure codes to specify dental extractions to assess the level of failure of dental preventive care, dating from the years 2008/9 to 2012/13 year ending on the 31st July 2013.

- National Dental Inspection Programme (NDIP) – this provided individual-level data on the dental treatment needs of children in the Primary 1 school year (P1) aged approximately 5-years-old and

in Primary 7 (P7) aged approximately 11-years-old. NDIP is collected annually and we accessed the years 2008/9 to 2012/13 ending in the 31st July 2013. The Basic Inspection involves a simple assessment of the mouth of each child using a light, mirror and ball-ended probe. Each child is placed into one of three categories depending on the level of dental health and a letter sent to their parents. Letter A (Urgent dental needs) – severe dental decay and/or abscess and should seek immediate dental care; or Letter B (Non-urgent dental needs) – some decay experience and should seek dental care in the near future; or Letter C (Low dental needs) – no obvious decay but should continue to see the family dentist on a regular basis. If a child refuses an inspection or is absent on the day of inspection the data is recorded with an 'X'.

Record Linkage Details

As part of the wider project leading to the results reported in this paper, our team linked looked after child, education, and health records for the first time in Scotland. In short the linkage process was as follows. Scottish Candidate Numbers (SCN, a unique personal identifier used on all education and relevant social care records in Scotland) which are recorded on looked after child records, were deterministically matched to SCNs recorded on the pupil census (annual census of all children in state funded education in Scotland) to categorise children included in the census as looked after or not.

Personal identifiers contained within the pupil census for all children (pupil date of birth, gender, and home postcode) were then probabilistically matched to the Community Health Index database (master index of all patients receiving NHS care in Scotland, including the NHS unique patient identifier, the CHI number) to generate a SCN-CHI number key. CHI numbers are recorded on all routine health records in Scotland hence the linked CHI numbers were then used to identify relevant health records (dental health, dentist attendance, in-patient dental extractions) for looked after and not looked after children.

Our full study cohort comprises children included in the pupil census (census of children in state funded education) in academic year 2011/12. Children were classified as currently looked after if their Scottish Candidate Number was recorded on a looked after child record during academic year 2011/12. Children were classified as previously looked after if their Scottish Candidate Number had been recorded on a looked after child record during the academic years 2007/08-2010/11 (but not 2011/12). Children were classified as not looked after if their Scottish Candidate Number was not recorded on any looked after child records for academic years 2007/08-2011/12.

Detailed assessment of the quality of data linkage achieved showed that there is a degree of under-recording of the SCN on looked after child records, hence a small number of looked after children in the pupil census will erroneously be classified as not looked after. This would tend to conservatively bias results comparing looked after and not looked after children to the null.

Linkage to the CHI database for children within the pupil census classified as looked after and not looked after is very high (around 95%), with minimal potential for bias due to non-linkage.

Furthermore, previous work by our team has shown that links made are highly likely (>99%) to be correct (see Wood R, Clark D, King A, Mackay D, Pell J. Novel cross-sectoral linkage of routine health and education data at an all-Scotland level: a feasibility study. *Lancet* 2013; 382: S10). As CHI numbers are universally required on all routine NHS records, once a link to a child's CHI number is made, it is assumed that relevant health records will be identified if present.

We are therefore confident that our results provide a robust, population based view of the dental health of looked after children compared to their non-looked after peers.

Appendix 2 Ethics and governance

- NHS West of Scotland Ethics Service – confirmed NHS ethics approval was not required for this study due to non-disclosive nature of data analysed, use of safe-haven for analysis, and robust national information governance procedures.

- University of Glasgow College of Medicine Veterinary and Life Sciences Ethics Committee – approval was received for the purposes of research ethics approval.

- Data Sharing Application and Agreement – approval to use ScotXed data and agreement signed between the Scottish Government Education Analytical Services Division ScotXed Unit and the University of Glasgow to enable the pupil identifiers from ScotXed for linkage purposes, and to release data on looked after children status and placements.

- Data Processing Agreement – signed between University of Glasgow and NHS National Services Scotland Information Services Division (ISD) to enable ISD to conduct the data linkage on behalf of the University of Glasgow.

- NHS National Services Scotland Privacy Advisory Committee (PAC), now the Public Benefit And Privacy Panel (PBPP) including completion of a privacy impact assessment – approval to undertake the data linkage and allow University of Glasgow to access linked dataset within the National Safe Haven platform for the purposes of analyses.