


Child oral health and preventive dental service access among children with intellectual disabilities, autism and other educational additional support needs: A population-based record linkage cohort study

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Abstract

Objective: Inequalities in child oral health are a global challenge and the intersection of socioeconomic factors with educational additional support needs (ASN), including children with intellectual disabilities or autism, have thus far received limited attention in relatively small clinical studies. We aimed to address this evidence gap by investigating oral health and access to preventive dental services among children with ASN compared to the general child population.

Methods: Cohort study linking data from six Scotland-wide health and education databases compared: dental caries experience and tooth extraction via general anaesthetic; receipt of school-based dental inspection; access to primary care and hospital dental services; and access to the Childsmile national oral health improvement programme between children with a range of ASN (intellectual disabilities, autism, social and other) and their peers for the school years 2016/17–2018/19 ($n = 166\,781$).

Results: Children with any ASN had higher rates of caries experience than those with no ASN, however, after adjustment for socioeconomic deprivation, sex, year, and school type only those with a social or other ASN remained at increased risk. Rates of tooth extraction under general anaesthesia in hospital were higher among children with intellectual disabilities (aRR = 1.67; 95% CI = [1.16–2.37]). School-based dental inspection access improved for children with intellectual disability and/or autism from 2016/17 onwards, although higher rates of child refusal on the day were observed in these groups (no ASN refusal: 5.4%; intellectual disability: 35.8%; autism: 40.3%). Children with any ASN were less likely to attend primary dental-care regularly, and in those who attended, children with intellectual disability or autism were less likely than their peers to receive prevention (fluoride varnish, oral-hygiene instruction, or dietary advice). Childsmile nursery-supervised toothbrushing programme access among children with any ASN was similar to children with no ASN and children with intellectual disability (aRR = 1.27; 95% CI = [1.12–1.45]) or autism (aRR = 1.32; 95% CI = [1.19–1.45]) were more likely to receive support from Childsmile dental health support worker.

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Conclusions: We have identified inequalities in oral health and dental care for children with different ASN in Scotland with both a greater burden of disease among some groups and higher complexity of care; compounded by reduced and variable access to preventive dental services. Further efforts are needed to develop and improve preventive care pathways for children with ASN and integrate oral health to wider healthcare systems for these children to mitigate against oral health inequalities.

KEYWORDS

additional educational support needs, autism, children, dental caries, dental services, intellectual disabilities, oral health

1 | INTRODUCTION

Inequalities in child oral health are a global public health challenge.¹⁻³ In the UK caries prevalence is 2-3 times higher among children from the most deprived compared to those in the least deprived communities.⁴ Relatedly, poor access to preventive dental services is a global issue for children living in poverty or those in marginalized groups.¹ These marginalized groups include children with special or additional education needs and disabilities, including intellectual disabilities, Autism Spectrum Disorders, and other educational support needs.

Educational additional support needs (ASN) for children in relation to education and learning have long been internationally recognized⁵ and are defined in Scottish legislation to cover physical and intellectual disabilities, learning difficulties, health conditions, family circumstances, and social/emotional factors.⁶ The World Health Organization (WHO) defines intellectual disabilities as impairments in adaptive functioning, social functioning, and intellectual functioning (IQ < 70), requiring a need for daily support, with the onset in the developmental phase (<18 years)⁷. Autism Spectrum Disorders (henceforth autism) is defined as a diverse group of conditions that are characterized by some degree of difficulty with social interaction and communication and atypical patterns of activities and behaviours, such as difficulty from one transition to another.⁸ Poorer life expectancy and general health are increasingly recognized among people with intellectual disabilities and autism.⁹

Recent systematic reviews on oral health of children with intellectual disabilities and/or autism identified a high number of relatively small and limited quality studies, which were equivocal on whether those children had a greater burden of dental disease than children with neither intellectual disabilities or autism.¹⁰⁻¹² Further systematic reviews have identified reduced access to dental services among disabled children, including those with intellectual disabilities and autism.^{11,13} Oral health among children with more generally defined educational ASNs does not seem to be reported, and the intersection of oral health inequalities associated with socioeconomic and educational ASNs (including children with intellectual disabilities or autism) has thus far received limited attention.

Scotland offers a unique opportunity to examine inequalities in oral health and access to preventive dental services associated with children with educational ASNs at the population level. Child oral health

is monitored annually via the National Dental Inspection Programme (NDIP) which involves dental inspections in school and follow up in primary dental care services.¹⁴ There is a national Childsmile oral health improvement programme involving multiple universal and targeted interventions in education, community, and dental settings.¹⁵ Primary and secondary care dental services for children have population coverage and are free at the point of care via the National Health Service in Scotland (NHS Scotland). Moreover, data on these preventive dental services and educational ASN are held on routine administrative national education and health service databases,^{16,17} and secure NHS Scotland data linkage infrastructure is in place to enable population-wide, individual child-level data linkage with oral health and dental service databases. Here, we aimed to investigate the oral health, and access to preventive dental services among children with educational ASNs including children with intellectual disabilities and children with autism, compared to the general child population, taking into account socioeconomic factors.

2 | METHODS

2.1 | Study design and participants

Three birth cohorts of children who were born between 1 January, 2011, and 1 February, 2014, were tracked from birth until their first year at primary/elementary school (2016/17, 2017/18, 2018/19) using individual child level data securely linked across six national administrative, education and health databases. Ethical approval was obtained from the University of Glasgow Ethics Committee (Project number MVLS200150076). This study received approval from the NHS National Services Scotland Privacy Advisory Committee and Public Benefit and Privacy Panel (PBPP) Approval no.1617-0302 Amendment Approval 2019 09 04.

2.2 | Databases

1. The Education Pupil Census (held by the Scottish Government)¹⁷ provides data on additional support needs (ASN) of each pupil in each school year.

Individual child-level data from the Pupil Census were then linked across five health/administrative databases held by Public Health Scotland:

2. National Dental Inspection Programme (NDIP) database¹⁴ includes an annual survey of oral health outcomes on all Primary 1 school-year (approximately 5 years old) children attending local authority schools. The dental inspection involves a simple assessment of the mouth and teeth of each child undertaken by trained and standardized primary care dental teams within primary schools.
3. Scottish Morbidity Records (SMR01—hospital admission and SMR00—hospital outpatients)¹⁸ specifically for tooth extractions under general anaesthesia.
4. Management Information and Dental Accounting System (MIDAS)¹⁶ collates information on all child primary care dental practice appointments and treatments in Scotland (including Childsmile prevention items-fluoride varnish applications, diet and toothbrushing advice).
5. Childsmile intervention database holds data on (a) timing and frequency of (i) fluoride varnish applications at nursery/school (ii) home-based support visits from Dental Health Support Workers; (b) parent/carer consent/class lists indicating child-level participation in the nursery-supervised toothbrushing programme.¹⁹

2.3 | Data linkage process

The Pupil Census database was linked at the individual level using probabilistic matching (on date of birth, sex and postcode) to the Community Health Index (CHI), Scotland's list of all unique patient identifiers by National Records Scotland (NRS) and provided with a pseudonymised study specific identifier. NRS provided Public Health Scotland this list of CHI numbers alongside a study-and database specific linkage identifier. Public Health Scotland used the CHI numbers to extract corresponding records from each of the five health/administrative databases detailed above. The 'pay-load' health data from each of these extracts along with linkage identifiers were uploaded into the National Safe Haven along with the Pupil census data (with date of birth, sex and postcode removed). A linkage agent then replaced the linkage identifiers from the health databases with the pseudonymised study specific identifier allowing individuals to be linked across the six databases.

2.4 | Definition of ASN status

For this study, ASN categories were (i) Intellectual Disability; (ii) Autistic Spectrum Disorder (autism); (iii) ASN associated with social issues—'Social ASN' (Interrupted learning, English as an additional language, Looked after, More able pupil, Communication

support needs, Young carer, Bereavement, Substance misuse, Family issues, Risk of exclusion, Not disclosed/declared, Other) and (iv) 'Other ASN' (Dyslexia, Other specific learning difficulty, Other moderate learning difficulty, Visual impairment, Hearing impairment, Deafblind, Physical or motor impairment, Language or speech disorder, Social, emotional & behavioural difficulty, Physical health problem, Mental health problem). This study used any ASN recorded in the first school year 'primary 1' (~5-year-olds) as this was when the primary outcome measure of caries experience was reported. The control group was the children with no recorded ASN on the Pupil Census.

2.5 | Outcome measures

2.5.1 | Primary outcomes (oral health)

1. Dental caries experience (yes/no) in primary 1 (~5 years) as measured by the presence or absence of obvious caries experience which was determined clinically by the presence of decay (caries into dentine), missing (extracted due to decay) or filled deciduous teeth following recognized criteria. National Dental Inspection Programme database (1 in list above).
2. Hospital admission for tooth extraction under general anaesthetic (from birth to 5 years) (ever/never). SMR01 and SMR00 database (2 in list above).

2.5.2 | Secondary outcomes (access to preventive dental services)

1. Regular attendance (at least once a year from birth to 5 years) at NHS primary dental care General Dental Service (GDS) and/or Public Dental Service (PDS). GDS are 'high street' dental practices providing routine dental services, and the Public Dental Service (PDS) are community health centre based dental services providing dental care to communities where there is no GDS provision, for example rural and remote areas or to patient groups with complex special care needs. MIDAS database (3 in list above).
2. Participation in the National Dental Inspection Programme in the first year of primary school (P 1 aged ~5 years) (child participation in participating schools; child non-participation in participating schools; child attended a non-participating school). National Dental Inspection Programme database (1 in list above).
3. Access to Childsmile oral health improvement programme interventions (from birth to 5 years) (ever/never): Childsmile prevention at primary dental care (fluoride varnish, toothbrushing support and dietary advice); nursery supervised toothbrushing; fluoride varnish application in nursery/school; home/community oral health support by trained dental health support workers. Childsmile intervention database (4 in list above).

2.6 | Covariates and confounders

Age of child / cohort year (2016, 2017, 2018), sex (Male/Female), area-based socioeconomic status (derived from the Scottish Index of Multiple Deprivation SIMD [2012,2016]) which is based on home postcode and uses 38 indicators to rank areas across Scotland—categorized into fifths from SIMD-1 the 20% most deprived to SIMD-5 the 20% least deprived²⁰; and school provision (mainstream, special school or mixed provision) were considered possible confounding variables and were considered in the multivariable models.

2.7 | Statistical methods

Analyses of outcome measures used data from the school years 2016/17–2018/19 due to (a) incomplete coverage of the NDIP in special schools prior to 2016 and (b) the need for five full years of data from birth for access to services and Childsmile interventions (Childsmile programme started in 2011). The four ASN groups (Intellectual disability, Autism, Social, Other) were categorized and univariable and multivariable models were produced for each outcome measure according to ASN category. Multinomial logistic regression models were used for the three-category response NDIP outcome (child participated in participating school; child did not participate in participating school; child attended a non-participating school). For all other binary outcomes including the primary outcomes of caries experience at ~5 years (yes/no) and hospital admission for tooth extraction under general anaesthetic (ever/never from birth to 5 years), and secondary outcomes regarding access to prevention, Modified Poisson regression models with a log link function and robust standard errors were used. All models were presented unadjusted and then adjusted for sex, cohort year, school provision and SIMD fifth (based on quintile cut points). We reran all the models stratified for cohort year and found negligible differences between the individual cohort year results and the results from the pooled cohorts for all outcomes. All linked data were pseudonymised and

analysed using RStudio v1.2.1335 within the National Safe Haven hosted by Public Health Scotland.

3 | RESULTS

There were 56848 children in the school year cohort of 2016/17, 55914 in the year 2017/18 and 54019 in the year 2018/19 resulting in a total of 166781 children. All primary and secondary outcome variables were then linked to these children's baseline data.

3.1 | Oral health outcomes

For the school years 2016/17–2018/19, caries experience in children aged ~5 years was higher in all four ASN groups compared to the group who had no ASN (Table 1), however after adjustment, only those children recorded as having a social ASN had a substantive increased risk of caries experience (aRR = 1.42; 95% CI = [1.38–1.46]) with those categorized as 'other' ASN slightly less so (aRR = 1.17; 95% CI = [1.13–1.21]). Children with intellectual disability had much higher rates of hospital admission for tooth extraction under general anaesthetic than those with no ASN, and this association remained after adjustment in the multivariable model (aRR = 1.67; 95% CI = [1.16–2.37]).

3.2 | Access to preventive dental services

3.2.1 | Regular attendance at NHS primary dental care

Children in all ASN groups, in particular those children with a social ASN, intellectual disability and autism were less likely to attend primary dental care (both general and public dental service) regularly than those with no ASN. (Table 2).

TABLE 1 Primary outcomes: Caries experience at ~5 years and hospital admission for tooth extractions under general anaesthetic (birth to 5 years) according to ASN status.

| | Caries experience by ~5 years | | | Tooth extraction under GA | | |
|------------|-------------------------------|------------------|------------------|---------------------------|------------------|------------------|
| | % (n/N) | RR [95% CI] | aRR [95% CI] | % (n/N) | RR [95% CI] | aRR [95% CI] |
| ASN status | | | | | | |
| No ASN | 27.9 (33863/121362) | 1 (ref) | 1 (ref) | 1.7 (2393/144885) | 1 (ref) | 1 (ref) |
| ID | 30.9 (278/898) | 1.11 [1.01–1.22] | 1.02 [0.91–1.13] | 4.1 (57/1392) | 2.48 [1.88–3.19] | 1.67 [1.16–2.37] |
| Autism | 30.2 (356/1178) | 1.08 [0.99–1.18] | 0.94 [0.86–1.03] | 2.4 (42/1738) | 1.46 [1.06–1.96] | 1.12 [0.79–1.53] |
| Social | 46.5 (3056/6571) | 1.67 [1.62–1.71] | 1.42 [1.38–1.46] | 2.6 (222/8491) | 1.58 [1.38–1.81] | 1.24 [1.08–1.42] |
| Other | 35.5 (2503/7054) | 1.27 [1.23–1.31] | 1.17 [1.13–1.21] | 2.3 (195/8426) | 1.40 [1.21–1.62] | 1.24 [1.07–1.44] |
| Total | 29.2 (40056/137063) | | | 1.8 (2909/164932) | | |

Note: Unadjusted and adjusted risk ratios and 95% confidence intervals.

Abbreviations: 95% CI, 95% confidence intervals; aRR, adjusted risk ratio—adjusted for sex, SIMD fifth, school provision, cohort year; GA, general anaesthetic; ID, intellectual disability; RR, risk ratio.

TABLE 2 Secondary outcomes: Regular attendance and prevention at NHS primary care according to ASN status.

| ASN status | Regular attendance at GDS/PDS | | | Diet, toothbrushing advice, FVA at GDS/PDS ^a | | |
|------------|-------------------------------|------------------|------------------|---|------------------|------------------|
| | % (n/N) | RR [95% CI] | aRR [95% CI] | % (n/N) | RR [95% CI] | aRR [95% CI] |
| No ASN | 42.3 (61263/144885) | 1 (ref) | 1 (ref) | 83.9 (107843/128498) | | |
| ID | 28.6 (398/1392) | 0.68 [0.57–0.70] | 0.76 [0.67–0.86] | 76.5 (900/1177) | 0.91 [0.85–0.97] | 0.94 [0.87–1.02] |
| Autism | 28.2 (490/1738) | 0.67[0.58–0.70] | 0.71 [0.64–0.78] | 77.2 (1128/1461) | 0.92 [0.87–0.97] | 0.93 [0.87–0.99] |
| Social | 20.4 (1731/8491) | 0.48[0.45–0.49] | 0.51 [0.49–0.54] | 82.9 (5427/6545) | 0.99 [0.96–1.02] | 0.98 [0.96–1.01] |
| Other | 34.0 (2867/8426) | 0.80 [0.76–0.82] | 0.82 [0.79–0.85] | 81.5 (5943/7293) | 0.97 [0.95–1.00] | 0.97 [0.95–1.00] |
| Total | 40.5 (66749/164932) | | | 83.6 (121241/144974) | | |

Note: Unadjusted and adjusted risk ratios and 95% confidence intervals.

Abbreviations: 95% CI: 95% confidence intervals; aRR, adjusted risk ratio—adjusted for sex, SIMD fifth, school provision, cohort year; FVA, fluoride varnish application; GDS/PDS, general/public dental service; ID, intellectual disability; RR, risk ratio.

^aOnly in those ever attending GDS/PDS.

TABLE 3 Secondary outcomes: Participation in the National Dental Inspection Programme according to ASN status.

| ASN status | Child nonparticipation in NDIP | | | School nonparticipation in NDIP | | |
|------------|--------------------------------|------------------|------------------|---------------------------------|------------------|------------------|
| | % (n/N) | OR [95% CI] | aOR [95% CI] | % (n/N) | OR [95% CI] | aOR [95% CI] |
| No ASN | 6.7 (9748/146106) | 1 (ref) | 1 (ref) | 5.5 (8081/146106) | 1 (ref) | 1 (ref) |
| ID | 27.1 (397/1466) | 5.56 [4.93–6.26] | 3.92 [3.36–4.57] | 8.8 (129/1466) | 2.18 [1.81–2.62] | 1.54 [1.21–1.95] |
| Autism | 24.7 (447/1811) | 4.69 [4.20–5.23] | 3.90 [3.46–4.40] | 6.0 (109/1811) | 1.38 [1.13–1.68] | 1.16 [0.94–1.43] |
| Social | 9.6 (839/8729) | 1.58 [1.46–1.70] | 1.44 [1.34–1.56] | 10.3 (895/8729) | 2.03 [1.89–2.19] | 2.00 [1.86–2.15] |
| Other | 10.6 (918/8669) | 1.66 [1.54–1.78] | 1.57 [1.46–1.69] | 5.3 (461/8669) | 1.00 [0.91–1.11] | 0.97 [0.88–1.07] |
| Total | 7.4 (12349/166781) | | | 5.8 (9675/166781) | | |

Note: Unadjusted and adjusted odds ratios and 95% confidence intervals.

Abbreviations: 95% CI: 95% confidence intervals; aOR, adjusted odds ratio—adjusted for sex, SIMD fifth, school provision, cohort year; ID, intellectual disability; NDIP, national dental inspection programme; OR, odds ratio.

3.2.2 | Participation in the National dental inspection programme (NDIP)

Children with intellectual disability (aOR = 3.92; 95% CI = [3.36–4.57]) or autism (aOR = 3.90; 95% CI = [3.46–4.40]) attending schools participating in the NDIP were much less likely to receive a dental inspection than their peers with no ASN, and children with a social or other ASN attending participating schools were slightly less likely to receive a dental inspection (Table 3). Post hoc analysis of these data indicated that the main reason for this in children with intellectual disability and autism was 'child refusal' on the day of the dental inspection whereas in those with no ASN it was 'being absent' on the day of the dental inspection (No ASN 'child absent': 74.2% vs. Intellectual disability 'child absent' 46.2% vs. autism 'child absent': 39.3%) (No ASN 'child refusal': 5.4% vs. intellectual disability 'child refusal': 35.8% vs. autism 'child refusal': 40.3%).

3.2.3 | Access to Childsmile interventions

Among children who had ever attended primary dental care in their first 5 years, those children with intellectual disability (aRR = 0.94;

95% CI = [0.87–1.02]) or autism (aRR = 0.93; 95% CI = [0.87–0.99]) were less likely to receive prevention (dietary advice or toothbrushing support or fluoride varnish application) at these visits than children with no ASN (Table 2).

Children with a social ASN were less likely to receive nursery supervised toothbrushing than those with no ASN (aRR = 0.89; 95% CI = [0.86–0.92]) whereas those children with intellectual disability or autism had similar access to the nursery supervised toothbrushing programme than those with no ASN (Table 4).

Home/community-based oral health support from Childsmile's Dental Health Support Workers was more targeted towards children with intellectual disability (aRR = 1.27; 95% CI = [1.12–1.45]) and autism (aRR = 1.32; 95% CI = [1.19–1.45]) than children with social or other ASN, or those with no ASN (Table 4).

4 | DISCUSSION

To the best of our knowledge, we have collated and analysed the largest population cohort investigating oral health and dental care among children with educational ASNs including intellectual disabilities and autism.

TABLE 4 Secondary outcomes: Access to Childsmile interventions according to ASN status.

| | NSTB | | | FVA nursery/school | | | DHSW | | |
|------------|---------------------|------------------|------------------|---------------------|------------------|------------------|---------------------|------------------|------------------|
| | % (n/N) | RR [95% CI] | aRR [95% CI] | % (n/N) | RR [95% CI] | aRR [95% CI] | % (n/N) | RR [95% CI] | aRR [95% CI] |
| ASN status | | | | | | | | | |
| No ASN | 76.1 (74426/97759) | 1 (ref) | 1 (ref) | 41.1 (59479/144558) | 1 (ref) | 1 (ref) | 18.8 (26683/142207) | | |
| ID | 69.6 (647/930) | 0.91 [0.84–0.99] | 0.96 [0.87–1.06] | 33.2 (460/1387) | 0.81 [0.73–0.88] | 0.91 [0.82–1.02] | 26.1 (354/1358) | 1.39 [1.25–1.54] | 1.27 [1.12–1.45] |
| Autism | 76.6 (791/1032) | 1.01 [0.94–1.08] | 1.02 [0.95–1.10] | 38.2 (662/1734) | 0.93 [0.86–1.00] | 0.94 [0.87–1.01] | 26.3 (447/1702) | 1.41 [1.28–1.54] | 1.32 [1.19–1.45] |
| Social | 69.1 (3616/5233) | 0.91 [0.88–0.94] | 0.89 [0.86–0.92] | 44.3 (3757/8475) | 1.08 [1.04–1.11] | 0.95 [0.92–0.98] | 22.3 (1849/8297) | 1.19 [1.14–1.25] | 1.04 [0.99–1.09] |
| Other | 83.3 (4622/5550) | 1.09 [1.06–1.13] | 1.09 [1.06–1.12] | 51.0 (4283/8402) | 1.24 [1.20–1.28] | 1.20 [1.16–1.23] | 19.9 (1647/8285) | 1.07 [1.02–1.12] | 1.02 [0.97–1.07] |
| Total | 76.1 (84102/110504) | | | 41.7 (68641/164556) | | | 19.1 (30980/161849) | | |

Note: Unadjusted and adjusted risk ratios and 95% confidence intervals.

Abbreviations: 95% CI, 95% confidence intervals; aRR, adjusted risk ratio—adjusted for sex, Scottish Index of Multiple Deprivation (SIMD) fifth, school provision, cohort year; DHSW, dental health support worker home based oral health support; FVA, fluoride varnish application; ID, intellectual disability; NSTB, nursery supervised toothbrushing; RR, risk ratio.

We found dental caries experience prevalence to be considerably higher among children with other and social ASN compared to their peers with no ASN. Children with intellectual disabilities or autism had slightly higher levels of caries experience than those with no ASN. After adjustment for area-based socioeconomic deprivation, children with intellectual disabilities or autism were no more likely than children with no ASN to have caries experience, while caries experience among those with other ASN or social ASN remained higher. Our findings in part contrast with previous systematic reviews, which were equivocal on whether caries prevalence in children with intellectual disabilities and/or autism differs from their peers with neither diagnosis;^{12,13} as we show that differences exist but that these are explained by socioeconomic circumstances. The social ASN group in our study includes children looked after by the state, a group previously shown to have substantially higher caries prevalence relative to the general child population.²¹ Our finding that even after adjusting for socioeconomic deprivation children within the social ASN group had higher rates of caries than other children further supports this.

Children with ASN had greater levels of dental hospital admissions for tooth extractions under general anaesthesia, which is often the treatment provided for gross dental caries or dental abscesses and indicates a failure of preventive dental care and high level of treatment need.²² Even in our young (up to 5-year-olds) cohort we observed much greater risks for these hospital admissions among children with ASN – particularly among those with intellectual disabilities, ahead of all other ASN groups. Children with intellectual disabilities are also more likely to be directed to dental treatment under general anaesthesia, which may be due to concerns (from both parents/carers and dental professionals) that they would not tolerate routine dental treatments, however, it is also recognized that more anaesthetic complications can occur in people with intellectual disabilities.²³

When examining overall access to primary care dental services we observed that, children with any type of ASN were between around 20% and 50% less likely than their peers to regularly attend dental services. While the literature indicates there are numerous barriers in access to dental services hindering the treatment of children with disabilities¹³ and data showing un-met treatment needs in children with intellectual disabilities,¹¹ access to routine and regular dental services (where preventive care can be delivered) among children ASN has not been quantified at the population level until now. The lowest levels of regular dental service access were observed in children with social ASN, which is again in keeping with previous analyses in looked after children.²¹ Barriers to accessing dental services are likely to be complex and multidimensional reflecting home circumstances, behaviour and service-side factors.¹³

National Dental Inspection Programme dental inspections undertaken in schools are a statutory right for all children in public schools in Scotland; they are an important preventive dental service—assessing children's oral health and ensuring primary dental care follow-up dependent on need.^{24,25} Prior to 2016/17, NDIP had not routinely included special schools. While there has been an

improvement in NDIP coverage of special schools since 2016/17, we found that relative to children with no ASN, children with intellectual disabilities and social ASN were less likely to be offered a dental inspection and that children with intellectual disabilities or autism were much less likely to receive a dental inspection within participating schools. The main reasons for these differences were child absence on the day of inspection, and for children with intellectual disabilities or autism also child refusal on the day. School absence and dental related anxiety are recognized issues in these groups^{26–28}; and there is interesting work ongoing to improve school participation²⁹ although work in relation to dental care acceptance seems more limited, sporadic, or at early stages of development.^{30,31}

The Childsmile programme evaluation has shown positive findings with substantial reductions in population dental caries particularly related to the supervised toothbrushing in nursery (kindergarten) settings.³² However, our findings show that the reach of the supervised toothbrushing component among children was lower among children with social ASN compared to children with no ASN, but for the other ASN groups was broadly similar to children with no ASN, which reflects its near universal coverage with most nurseries across the country participating under opt-out parent/carer consent. In terms of receiving oral health preventive care (fluoride varnish, oral hygiene instruction and diet advice) in dental practice, those children with intellectual disabilities or autism who had attended practice were less likely to receive prevention than their peers with no ASN, while those with social or other educational ASN were no more or less likely than children with no ASN. This could reflect the particular challenges of delivering dental care, even relatively simple prevention to children with intellectual disabilities or autism which have been widely identified particularly for dental treatment.¹³

Our study has some strengths and limitations. The recording of educational ASNs data at school in Scotland is considered to be high quality, although there may be some under-ascertainment of children with complex health needs unable to attend school. Children attending private schools (estimated at 5% of school-children) are also not included. These data are also lacking details on the severity of these ASNs.³³ Our health data sources were routine administrative health service data, which also have some limitations in the detail of data, although this is offset by high population coverage, quality and completeness. The NDIP dental caries outcome data (at the level of presence vs absence of obvious caries experience) employed in this study from the 'basic' inspections produce very similar findings with data those from the obvious caries experience (d3mft) detailed epidemiological information, which is collected on a 20% subsample of the population by trained and calibrated examiners using the British Association of Community Dentistry (BASCED) criteria.^{14,34} The population-levels of obvious decay experience in 5-year-olds from the basic inspections were 30.6% (2016) and 28.9% (2018) and from the detailed epidemiological inspections were 30.1% (2016) and 29.6% (2018).¹⁴ The methods of linkage of education and health records

via probabilistic matching is considered robust and previously validated as 99% accurate.³⁵ We performed a thorough analysis, and for caries outcome adjusted for key confounders including socioeconomic circumstances and age.

5 | CONCLUSIONS

We have found inequalities in the oral health and dental care for children with different ASN in Scotland—with a greater burden of disease, particularly among children with social ASN, and higher levels of hospital admissions for dental extractions under general anaesthesia among those with intellectual disability observe. These inequalities are compounded by reduced and variable access to preventive dental services, which could mitigate these challenges.

Our hope is that a greater understanding of the child oral health, dental care access and oral health improvement programme reach among children with educational ASNs will lead to further development of prevention pathways for children most at risk of poor oral health—ultimately leading to reduction in these health inequalities.

AUTHOR CONTRIBUTIONS

DIC, AS, and LM conceived the idea of this study. DIC, AS, LM, DC, and AH designed the study. JK and DIC prepared data requests and study approvals and data sharing agreements. JK and RS undertook data management. RS with AS performed analysis and prepared figures and tables. DIC and AS prepared first draft of the manuscript. All authors critically reviewed and approved final version of the manuscript.

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CONFLICT OF INTEREST

All authors declare no competing interests.

DATA AVAILABILITY STATEMENT

We applied for approval to access, link and analyse the study data within the NHS national safe haven environment and undertook information governance training. The data generated, linked and analysed during the study are not publicly available. The data controllers for all health data is Public Health Scotland, and for education data is the Scottish Government and researchers can apply to access [via respective emails: phs.edris@phs.scot]. The data controller for

all education data is the Scottish Government and researchers can apply to access data [via email: asu_schools_data_access@gov.scot].

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