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Dental procedures in children with or without intellectual disability and autism spectrum disorder in a hospital setting

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ABSTRACT

Background: This population-based cohort study investigated dental procedures in the hospital setting in Western Australian children with or without intellectual disability (ID) and/or autism spectrum disorder (ASD) aged up to 18 years. Considering previously reported disparities in dental disease between Indigenous and non-Indigenous Australian children, this study also investigated the effect of Indigenous status on dental procedures.
Methods: Data on Western Australian live births from 1983 to 2010 from the Midwives Notification System were linked to the Intellectual Disability Exploring Answers database and the Hospital Morbidity Data collection. Primary admissions for relevant dental diagnoses were identified, and treatment procedures for dental hospitalization were investigated. Descriptive statistics and Pearson's chi-squared test of independence were used for analysis.
Results: Overall, 76 065 episodes of dental hospitalization were recorded. Amongst children with ID and/or ASD, Indigenous children experienced more extractions and fewer restorations (68.7% and 16.2%) compared to non-Indigenous children (51.5% and 25.9%). After 6 years, extraction occurred less often in children with ID and/or ASD than in those without, where most surgical dental extractions were in the age group of 13–18 years.
Conclusions: This study indicates a need for further improvements in access to dental services and the quality of care provided in hospitals for children with ID/ASD. There is also concern that more vulnerable Indigenous and all disadvantaged children are receiving an inadequate level of dental services resulting in more emergency dental hospitalization and invasive treatment.

Keywords: Autism spectrum disorder, child health, data linkage, dental disease, intellectual disability.

Abbreviations and acronyms: AAPD = American Academy of Paediatric Dentistry; ABS = Australian Bureau of Statistics; ACHI = Australian Classification of Health Interventions; ACS = Australian Coding Standards; ASD = autism spectrum disorder; DSC = Disability Services Commission; GA = general anaesthesia; HMDC = Hospital Morbidity Data Collection; ID = intellectual disability; IDEA = Intellectual Disability Exploring Answers; LA = local anaesthesia; SEIFA = Socio-Economic Indexes for Areas; SES = socioeconomic status; SHCN = Special Health Care Needs; WA = Western Australia.

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INTRODUCTION

Intellectual disability (ID) is characterized by impaired cognitive functioning and limitations in adaptive behaviour that manifest before 18 years of age[1] and autism spectrum disorder (ASD) by qualitative impairments in social interaction and communication and restricted, repetitive behaviour.[2] Previous research has suggested that children with ID and ASD might have an increased lifetime risk for dental diseases.[3–6] A higher risk of unmet dental needs has also been reported for the broader category of children with special health care needs (SHCN).[7,8] Such increased risk might be due to issues relating to the characteristics of children with ID and ASD, such as behavioural challenges, lack of effective oral hygiene practices, dietary behaviour or frequent exposure to medications.[6,9,10] It can also be related to issues in the health care system delivery, such as the lack of appropriate facilities or the limited number of dental professionals

with adequate expertise to work with these populations.[8,11] Hospitalization for dental treatment under general anaesthesia (GA) is one pathway commonly employed to manage children who cannot obtain adequate care in traditional clinical settings.[12,13]

'Paediatric dentistry is an age-defined specialty that provides both primary and comprehensive preventive and therapeutic oral health care for infants and children through adolescence, including those with special health care needs'.[14] Guidelines of the American Academy of Paediatric Dentistry (AAPD) state that 'children and adolescents who cannot cooperate due to lack of psychological or emotional maturity and/or mental, physical, or medical disability; the extremely uncooperative, fearful, anxious, child or adolescent; patients for whom the use of GA may protect the developing psyche and/or reduce medical risk are indicated for dental GA'.[15] Higher quality dental care outcomes can often be provided under GA for children with complex dental treatment needs.[16] The Clinical Guidelines for the Oral Health Care of People with Learning Disabilities of the Royal College of Surgeons of England state that the use of GA should be a last resort and only be undertaken when all other avenues for accepting routine dental care have been explored.[17] However, dental hospitalization can play an important role in comprehensive dental management in children with ID and ASD.[18] Dental treatment in a hospital in Australia can be done either under GA or in the conventional outpatient clinical environment using local anaesthesia (LA) or other behavioural management techniques, and in children, dental treatment under GA comprises a large proportion of preventable hospitalizations in Australia.[19] Dental treatment using pharmacological techniques such as relative analgesia and intravenous sedation is also available and might be appropriate in selected children with ID or ASD. In Australia, treatment under conscious sedation and relative analgesia tends to be underutilized in adults with special needs.[20]

Previous studies have described differences in dental treatments performed under GA between children with SHCN and healthy children and argued that the pattern of dental treatment is considerably influenced by underlying medical disorders in these children.[21–23] Most studies report a higher frequency of extractions in patients with SHCN than in healthy children.[21–23] Guidelines for the use of GA in paediatric dentistry recommend that if a GA is indicated for paediatric patients, unrestorable teeth with excessive caries should be extracted in addition to those currently causing pain or odontogenic infection in order to reduce the need for further GAs.[24] Difficulties in accessing dental care services, delayed presentation in accessing services[25,26] and long waiting lists for dental care under GA after clinical assessment also contribute to the high disease burden[27,28] and presumably the larger number of dental extractions in these populations. In Western Australia (WA), there was a publicly funded Disability Services Commission (DSC) dental clinic operating until the early 2000s. This was a major source of referral for hospital treatment for both children and adults until it closed down. However, in its absence, there still exists another public clinic with a broader scope which continues to act as a referral source.

Most previous studies[21,23,29,30] have examined dental procedures on children with diverse SHCN. SCHN are defined as 'any physical, developmental, mental, sensory, behavioural, cognitive, or emotional impairment or limiting condition that requires medical management, health care intervention, and/or use of specialised services or programs', according to the AAPD.[15] However, in many of these studies, children with ID were not able to be distinguished from those with physical disabilities or medical comorbidities.[21–23,30] One comparative study on 170 children with ID and 64 healthy children receiving dental treatment under GA in Turkey showed that restorative treatment and dental extraction were higher in children with ID than in healthy children.[29]

Children aged <5 years with ID in WA were found to have a higher prevalence of dental hospitalizations compared to the total population,[31] as did similarly aged Indigenous children with ID compared with those without ID.[32] The previous population-based study on factors related to dental hospitalizations in children with ID and/or ASD showed that children with severe ID were much more likely to be hospitalized than those with mild/moderate ID.[18] However, in this study, Indigenous children with ID and/or ASD were less likely to be hospitalized for dental conditions, although the effect was weaker after adjustment for all relevant covariates in the regression model (cause/type/level of ID, sex, birth weight, major birth defect, maternal age, remoteness and socioeconomic status (SES)) in those under 13 years.[18]

A previous study on hospital dental treatment of Indigenous Australians (children aged 2–14 years) indicated that they experienced higher rates of extractions than non-Indigenous children when undergoing care in a hospital setting.[33] However, there is limited research on the dental hospitalization of Indigenous Australian children, specifically with ID/ASD.[32]

In the past, little emphasis has been placed on differences in dental treatment performed in hospital settings between children with and without ID/ASD in Australia. Although subsidized emergency and general dental care are provided for eligible patients with SHCN in Australia, understanding dental treatment modalities in hospital settings for these children provides information for planning the future use of

hospitalization in these populations. The purposes of this retrospective cohort study were first, to evaluate the characteristics of and dental treatment modalities used in paediatric patients with and without ID/ASD in a hospital setting, and second, to compare the different treatment patterns between children with and without ID /ASD taking into account their Indigenous background.

METHODS

Study population and data source

This retrospective cohort study has used linked administrative data for all live births in WA from 1983 to 2010. Data from the WA Hospital Morbidity Data Collection (HMDC), Intellectual Disability Exploring Answers (IDEA) database and the WA Midwives Notification System were linked by the Western Australian Data Linkage System and provided to researchers in a de-identified format. The IDEA database is a WA population-based register of individuals diagnosed with ID and children diagnosed with ASD both with and without ID. Data sources for the register are the DSC and the WA Department of Education.[34]

Dental hospitalizations

HMDC data were used to identify inpatient dental hospitalization (including records of all day and overnight admissions) to public, private and free-standing day hospitals in WA. Principal diagnoses for dental hospitalizations were coded using the International Statistical Classification of Diseases and Related Health Problems (ICD-9 CM and ICD-10-AM) diagnosis codes. Dental hospitalizations before 1 July 1999, originally coded in ICD-9 CM, were recoded using ICD-10-AM for the analyses as was done in a previous study.[35] All diagnostic codes related to diseases of 'oral cavity, salivary glands, and jaws' were retrieved. Dental hospitalizations were classified into 14 diagnostic groups using ICD codes (Table S1). Children (≤18 years) were flagged as having a dental hospitalization if they had one or more such hospitalizations from 1986 to 2010. Dental hospitalizations from 1986 onwards were included due to the limited number of recorded procedures prior to this time. Type of admission (elective or emergency), length of hospital stay and frequency of hospitalization have also been extracted from HMDC data.

Dental treatment procedures

Australian Classification of Health Interventions (ACHI)[36] is used in public and private hospitals in Australia to classify procedures and interventions of the admitted patient. The Australian Coding Standards (ACS) have been developed to support sound coding conventions for use with ICD-10-AM and ACHI. They apply to all public and private hospitals in Australia. ICD-10-AM/ACHI/ACS and the mapping table (from ACHI to ICD-9-CM) were used to identify treatment procedures. Prior to 1988, the procedures were coded using the International Classification of Procedures in Medicine which was used to identify treatment procedures in this period. The ACHI Dental Services chapter (chapter 6, dental services, blocks 450–490) is based on the Australian Dental Association's publication 'The Australian Schedule of Dental Services and Glossary, 9th Edition (2009)'. It includes diagnostic, preventive, periodontic, oral surgery, endodontic, restorative, prosthodontics, orthodontics, general dental and miscellaneous dental services. Then, dental procedures were categorized as dental extraction (non-surgical and surgical), restorative services, endodontics and other procedures, similar to a previous study.[33] The data were grouped into three age groups at the admission time, similar to a previous study[37] 0–6, 7–12 and 13–18 years, due to the possibility of different treatment patterns for children of different ages and to approximate timings for the presence of primary, mixed and permanent dentition, respectively.

Demographic information

Information on children's date of birth, gender and Indigenous status (children with mothers who identify as Indigenous at the birth of the child or identified as Indigenous at the time of hospitalizations) was used. Socioeconomic disadvantage related to the geographic location was determined using the Socio-Economic Indexes for Areas (SEIFA) codes developed by the Australian Bureau of Statistics (ABS); The Index of Relative Socio-Economic Disadvantage from SEIFA was used.[38] It was allocated according to the Collection District of the mother's residence at the time of birth and grouped into quintiles based on ABS data, with the most disadvantaged group being in quintile 1.

Statistical analysis

Descriptive statistics were used to describe the characteristics, dental hospitalizations and treatment procedures of the study population. Pearson's chi-squared test of independence was used to examine the relationship between categorical variables. All analyses were undertaken using Stata/SE statistical software (Release 14.0) (StataCorp LP, College Station, TX, USA).

Ethical approval

Ethical approval for this study, which conforms to the Declaration of Helsinki, was received from the Human Research Ethics Committee of the Health Department of WA (reference no. 2011/64) and the WA Aboriginal Health Ethics Committee (reference no. 613).

RESULTS

A total of 65 131 children (≤18 years) born in 1983–2010 were hospitalized for dental conditions in WA between 1986 and 2010. Characteristics of children with any dental hospitalization according to the presence or otherwise of ID/ASD are provided in Table 1. This table also shows the underlying differences in characteristics in children with ID and no ASD, ASD and ID and ASD without ID. Children with ID/ASD were more likely to be male (63.2% vs. 48.0%), Indigenous (8.6% vs. 4.0%) and in the most disadvantaged quintile of SES (25.4% vs. 17.9%) than the comparison group. Children with ID/ASD were more likely to have their first dental hospitalizations under 13 years (86.6% vs. 64.0%).

Overall, there were 76 065 episodes of dental hospitalization recorded for these children, including 3971 (5.2%) for children with ID/ASD and 72 094 (94.8%) for children without ID/ASD. A summary of diagnosis by recorded ICD-9 and ICD-10 categories is provided in Fig. 1. The most common diagnosis for both groups was dental caries (44%). A large proportion of diagnoses (12%) was also found to be for diseases of the pulp and periapical tissues in the ID/ASD group; disorders of tooth development and eruption were the second most prevalent diagnoses (37%) after dental caries in the comparison group (Fig. 1).

Temporal changes in the proportion of dental hospitalizations for children with ID/ASD (overall and by age group) are shown in Fig. 2. Children aged 7–12 years with ID/ASD had the highest proportion of hospitalizations. However, overall, the proportion attributed to children with ID/ASD tapered off slightly over time from the peak of approximately 8% in the early 1990s to approximately 4% at the end of the study period.

The most common procedure for both groups was dental extraction, 52.7% in ID/ASD children vs. 65.3% in the comparison group (Table 2) and the proportion of treatment procedures differed between the groups (chi-squared test, χ^2 (3, n = 73 634) = 327.2, $P<0.001$). Amongst children with ID/ASD, such difference was also affected by Indigenous status (chi-squared test χ^2 (3, N = 3807) = 29.84, $P<0.001$), with Indigenous children experiencing more dental extraction (68.7%) and fewer restorations (16.2%) compared to non-Indigenous children (51.5% and 25.9%, respectively). The majority of dental hospitalizations in both children with and without ID/ASD were non-emergency (90.8% and 93.6%, respectively). Indigenous children experienced more emergency dental hospitalizations compared to non-Indigenous children in those with ID/ASD (27.7% vs. 7.6%, respectively) and

Table 1. Descriptive characteristics of children (≤18) with dental hospitalizations born in Western Australia (1986–2010)

Sociodemographic characteristics	Children with ID/ASD (n = 2548)						Comparison group (n = 62 583)
	Total	ASD + ID	ASD not ID	Biomedical	Unknown mild	Unknown severe	Total
	n (col %)						n (col %)
Gender							
Male	1609 (63.2)	363 (80.5)	145 (83.3)	372 (55.1)	632 (57.8)	97 (63)	30 019 (48.0)
Female	939 (36.8)	88 (19.5)	29 (16.7)	303 (44.9)	462 (42.2)	57 (37)	32 564 (52.0)
Indigenous status							
Indigenous	220 (8.6)	12 (2.7)	0 (0)	60 (8.9)	134 (12.3)	14 (9.1)	2510 (4.0)
Non-indigenous	2328 (91.4)	439 (97.3)	174 (100)	615 (91.1)	960 (87.8)	140 (90.9)	60 073 (96.0)
IRSD quintiles at birth							
Q1 (≤20%)	647 (25.4)	92 (20.4)	29 (16.7)	159 (23.6)	334 (30.5)	33 (21.4)	11 216 (17.9)
Q2 (20–39%)	532 (20.9)	92 (20.4)	44 (25.3)	135 (20)	221 (20.2)	40 (26)	12 187 (19.5)
Q3 (40–59%)	424 (16.6)	82 (18.2)	28 (16.1)	115 (17)	177 (16.2)	22 (14.3)	11 162 (17.8)
Q4 (60–79%)	343 (13.5)	77 (17.1)	27 (15.5)	96 (14.2)	123 (11.2)	20 (13)	10 300 (16.5)
Q5 (≥80%)	307 (12.0)	67 (14.9)	25 (14.4)	101 (15)	100 (9.1)	14 (9.1)	10 614 (17.0)
Missing	295 (11.6)	41 (9.1)	21 (12.1)	69 (10.2)	139 (12.7)	25 (16.2)	7104 (11.3)
Dental hospitalization							
Age at first dental hospitalizations (years)							
0–6	1268 (49.8)	240 (53.2)	65 (37.4)	311 (46.1)	597 (54.6)	55 (35.7)	29 306 (46.8)
7–12	939 (36.8)	180 (39.9)	77 (44.3)	286 (42.4)	323 (29.5)	73 (47.4)	10 786 (17.2)
13–18	341 (13.4)	31 (6.9)	32 (18.4)	78 (11.6)	174 (15.9)	26 (16.9)	22 491 (35.9)

ID = intellectual disability; ASD = autism spectrum disorder; n = number of children; col = column; IRSD = Index of relative socioeconomic disadvantage.

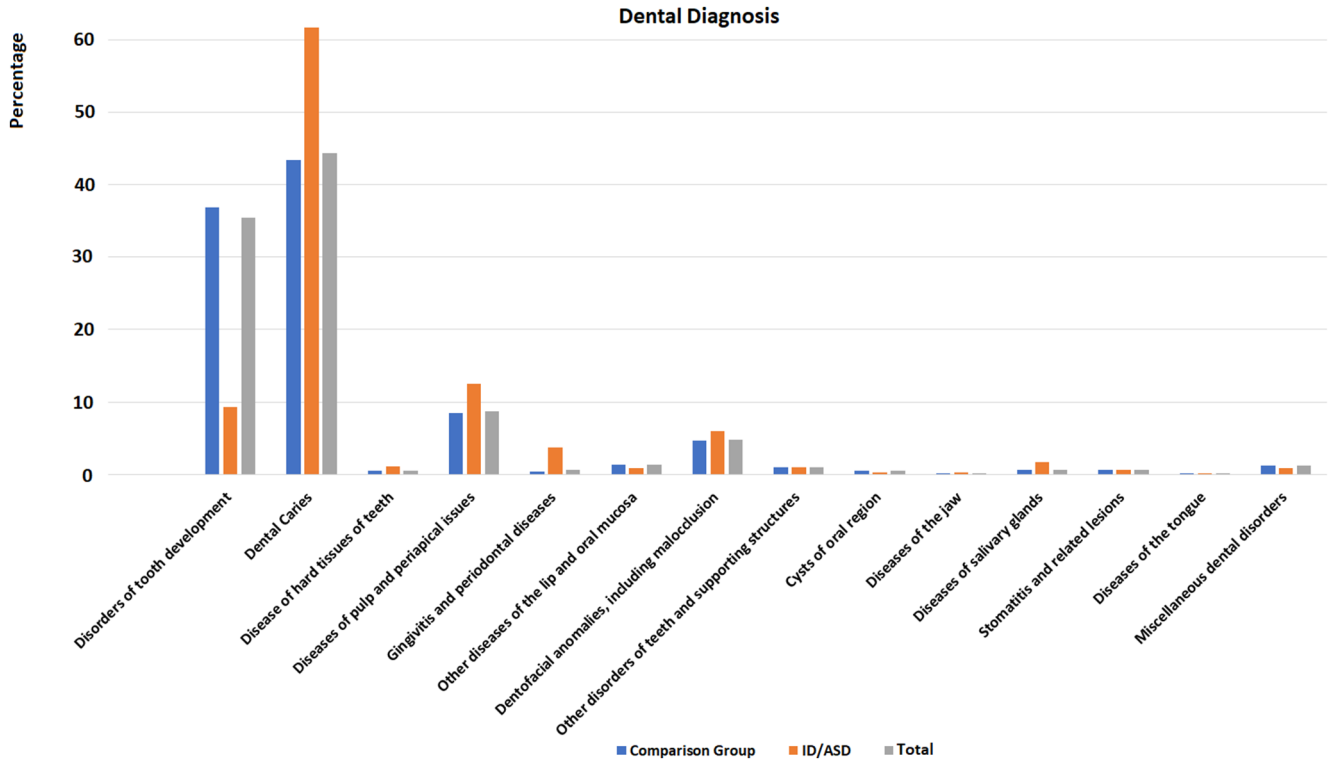

Fig. 1 Dental hospitalization episodes for various dental diagnoses for children with intellectual disability (ID) and/or autism spectrum disorder (ASD) and comparison group born in Western Australia. ASD, autism spectrum; ID, intellectual disability.

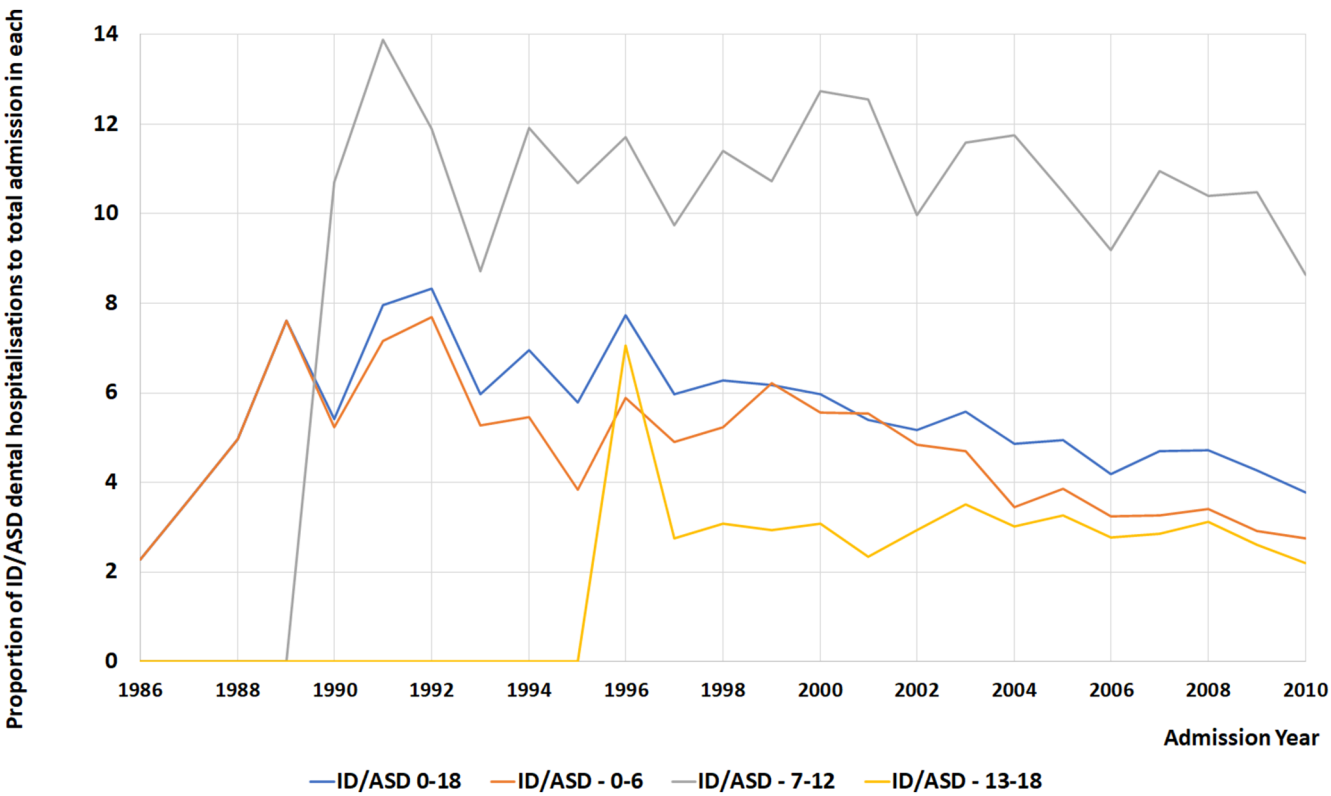

Fig. 2 Temporal changes in the proportion of dental hospitalizations in children with ID/ASD to total hospitalizations in each age group. ASD, autism spectrum; ID, intellectual disability.

Table 2. Frequency distribution of features of dental hospitalization in children with ID/ASD and children in the comparison group

Features of dental hospitalization	Children with ID/ASD Total (n = 3971) n (col %)	Comparison group Total (n = 72 094) n (col %)	*P*-value*	Children with ID/ASD		*P*-value*	Comparison group		*P*-value*
				Indigenous (n = 314) n (col %)	Non-indigenous (n = 3657) n (col %)		Indigenous (n = 2862) n (col %)	Non-indigenous (n = 69 232) n (col %)	
Treatment procedure									
Dental extraction	2005 (52.7)	45 580 (65.3)	<0.001	182 (68.7)	1823 (51.5)	<0.001	1893 (80.3)	43 687 (64.7))	<0.001
Surgical	390 (10.2)	27 153 (38.9)		26 (9.8)	364 (10.3)		199 (8.4)	26 594 (39.9)	
Non-surgical	1615 (42.4)	18 427 (26.4)		156 (58.9)	1459 (41.2)		1694 (71.9)	16 733 (24.8)	
Restorative treatment	962 (25.3)	14 675 (21.0)		43 (16.2)	919 (25.9)		244 (10.4)	14 431 (21.4)	
Endodontic treatment	146 (3.8)	2307 (3.3)		5 (1.9)	141 (4.0)		37 (1.6)	2270 (3.4)	
Other treatment	694 (18.2)	7265 (10.4)		35 (13.2)	659 (18.6)		181 (7.7)	7084 (10.5)	
Missing information	164	2267		49	115		507	1760	
Type of admission									
Elective dental treatment	3606 (90.8)	67 498 (93.6)	<0.001	227 (72.3)	3379 (92.4)	<0.001	1926 (67.3)	65 572 (94.7)	<0.001
Emergency dental treatment	365 (9.2)	4596 (6.4)		87 (27.7)	278 (7.6)		936 (32.7)	3660 (5.3)	
Frequency of hospitalization									
1	2548 (64.2)	62 583 (86.8)	<0.001	220 (70.1)	2328 (63.7)	0.023	2510 (87.7)	60 073 (86.8)	0.150
>1	1423 (35.8)	9511 (13.2)		94 (29.9)	1329 (36.3)		352 (12.3)	9159 (13.2)	
Length of stay (days)									
1	3755 (94.6)	70 396 (97.6)	<0.001	255 (81.2)	3500 (95.7)	<0.001	2336 (81.6)	68 060 (98.3)	<0.001
>1	216 (5.4)	1698 (2.4)		59 (18.8)	157 (4.3)		206 (18.4)	1172 (1.7)	

ID = intellectual disability; ASD = autism spectrum disorder; n = number of hospitalizations; col = column.
*Pearson's chi-squared test of independence.

Table 3. Frequency distribution of treatment procedures by age groups

Treatment procedure	Children with ID/ASD			Comparison group		
	0–6 years (n = 1454) n (col %)	7–12 years (n = 1611) n (col %)	13–18 years (n = 742) n (col %)	0–6 years (n = 31 397) n (col %)	7–12 years (n = 13 250) n (col %)	13–18 years (n = 25 190) n (col %)
Dental extraction	667 (45.9)	919 (57.0)	419 (56.5)	13 228 (42.1)	8951 (67.5)	23 401 (92.9)
Surgical	45 (3.1)	123 (7.6)	222 (29.9)	954 (3.0)	3882 (29.3)	22 317 (88.6)
Non-surgical	622 (42.8)	796 (49.4)	197 (26.5)	12 274 (39.1)	5069 (38.2)	1084 (4.3)
Restorative treatment	433 (29.8)	391 (24.3)	138 (18.6)	12 094 (38.5)	2400 (18.1)	181 (0.7)
Endodontic treatment	85 (5.8)	37 (2.3)	24 (3.2)	2066 (6.6)	227 (1.7)	14 (0.1)
Other treatment	269 (18.5)	264 (16.4)	161 (21.7)	3.999 (12.7)	1672 (12.6)	1594 (6.3)

ID = intellectual disability; ASD = autism spectrum disorder; n = number of hospitalizations; col = column.

without ID/ASD (32.7% vs. 5.3%). Over a third (35.8%) of children with ID/ASD were hospitalized more than once for dental conditions compared with 13.2% of children without ID. Almost one in five Indigenous children (18.8% with ID/ASD and 18.4% without ID/ASD) were hospitalized overnight, whereas more than 95% of non-Indigenous children were discharged the same day in both groups (95.7% with ID/ASD and 98.3% without ID/ASD).

Table 3 shows the distribution of treatment procedures by age group. Restorative treatments were performed more often in children without ID/ASD than in children with ID/ASD in the under 6 years age group (38.5% vs. 29.8%, respectively). Dental extraction was performed more often in children without ID/ASD than in those with ID/ASD after the age of six (84.2% vs. 56.9% respectively), and most were surgical dental extraction in the age group of 13–18 years.

Fig. 3 illustrates the age trend (represented as proportions over all ages) of surgical and non-surgical dental extraction for ID/ASD children and the

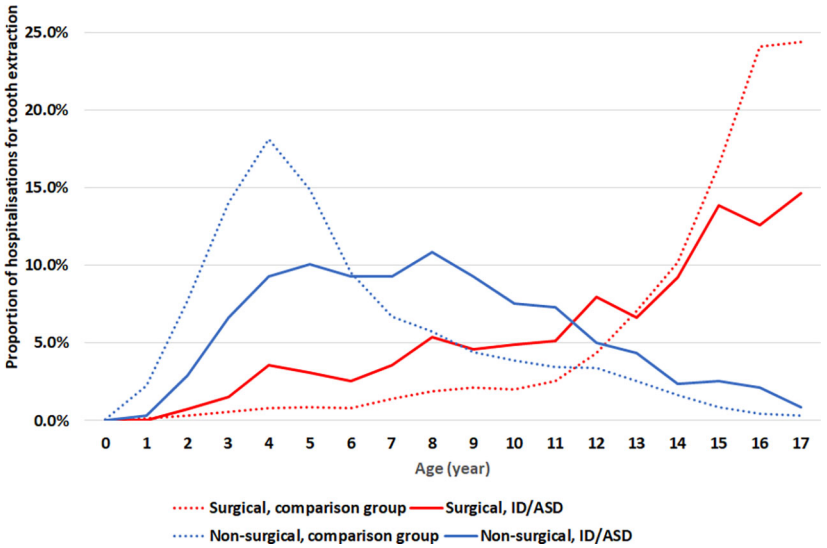

Fig. 3 The proportion of surgical and non-surgical dental extraction for ID/ASD children and the comparison group in each age. ASD, autism spectrum; ID, intellectual disability.

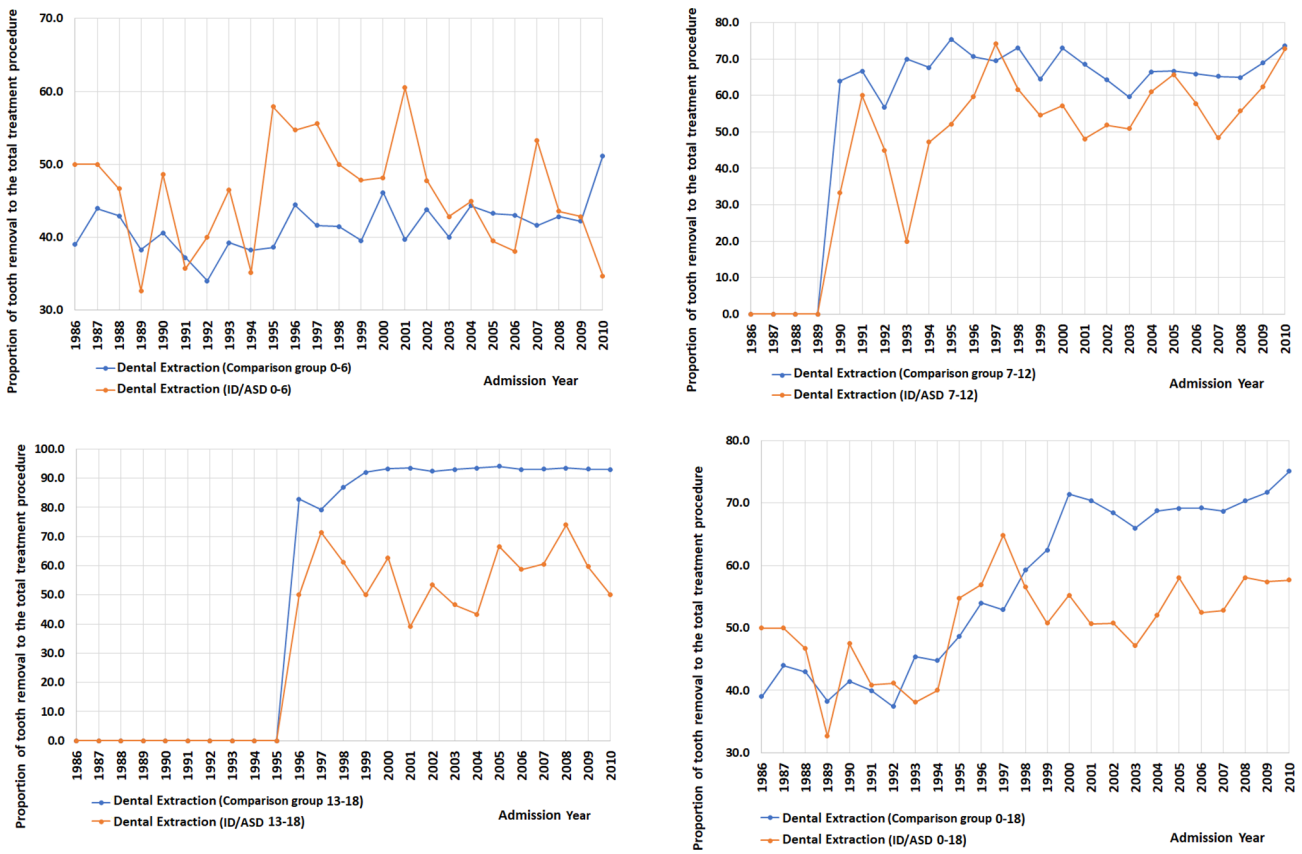

Fig. 4 (a and b) Temporal changes of dental extraction as a percentage of all treatment procedures in each age group, in children with intellectual disability (ID)/ autism spectrum disorder (ASD) and comparison group. ASD, autism spectrum; ID, intellectual disability.

comparison group. In the comparison group, most of the surgical dental extraction was performed in the adolescent populations with a peak at the age of 17 years, whereas non-surgical dental extraction was prevalent in early childhood with a peak at 4 years of age. The patterns were similar for children with ID/ASD but with a more even age distribution.

Fig. 4 depicts dental extraction as a percentage of all treatment procedures per admission year in different age groups. By age group, the percentages of

treatment procedures due to dental extraction over time were generally similar for children with ASD/ID and the comparison group except for the age group of 13–18 years, where there was a higher proportion in the comparison group. The disparity was reflected in the overall trend where the trends of dental extraction of the two groups diverged since the end of the 1990s.

DISCUSSION

Principal findings

It was found that the proportion of all childhood dental hospitalizations attributed to children with ID/ASD decreased slightly over time. Children aged 7–12 years with ID/ASD had the highest proportion of hospitalizations. In younger age groups, dental hospitalization might often occur for the treatment of oral diseases that are difficult to treat in the clinic. In contrast, in older age groups, surgery might often be related to growth and development issues such as orthodontic extractions and removal of wisdom teeth.[18] The lower proportion of extractions attributed to children with ID/ASD in the oldest age group might be due to an increase in the number of orthodontic treatments being undertaken in the comparison group. The closing in the early 2000s of the publicly funded DSC Dental clinic, previously a major source of referrals for hospital treatment, could also have affected the results.

One in three children with ID/ASD who had a dental hospitalization had a subsequent dental hospitalization. As would be expected, dental extractions and restorations were the most common treatment procedures,[21,29] although extractions were more common than restorations. Compared with the rest of the population, extractions were less frequent in children with ID/ASD, where, after the age of 11 years and in contrast to early childhood, surgical extractions became more common and non-surgical less common. By the age of 17 years, the proportion of children with ID/ASD having surgical extractions was still considerably lower than in the comparison group. The percentages (~40–70%) of treatment procedures due to dental extraction by age group over time were generally similar between the ID/ASD and the comparison populations except for the 13–18-year age group, where there was a much higher percentage of dental extraction in the comparison group.

The pattern of dental hospitalization procedures appeared to be different in Indigenous children, who experienced more extractions and fewer restorations in children with ID/ASD and the comparison group. At least one in four Indigenous children had an emergency dental hospitalization compared to <1 in 10 non-Indigenous children. Indigenous children with ID/ASD were also more likely to be hospitalized overnight compared to non-Indigenous children. A previous WA study also found that Indigenous children were more likely to have longer admissions than non-Indigenous children.[32]

Strengths and limitations of the study

The main strength of our retrospective study was the use of large population data to ascertain children with ID/ ASD and link to their hospitalization records. The linkage between administrative hospital data sets and a population-representative database on ID allows the identification of all children with ID/ASD rather than relying on ascertainment from coded hospital records. It provides a comprehensive picture and detailed description of the patterns of dental hospitalization procedures in the ID/ASD population over the years.

This is also the first study to have examined the dental hospital treatment procedures in an all-age cohort of Indigenous Australian children with ID/ASD. However, a previous population-based study reported on dental hospitalizations in Indigenous children under 5 years.[32] There are, however, some limitations associated with administrative data. The criteria for the hospitalization of children for dental conditions in Western Australia need to be acknowledged.[39] The comparison group might not necessarily be healthy children but might have included children with SHCN other than ID/ASD, such as medically compromised children who cannot receive dental treatment elsewhere. Despite the benefits provided by data linkage, the use of administrative data is always dependent on the quality of that data. The administrative coding process is reliant on the hospital coding system and the recording of the appropriate diagnoses by the treating clinician. More detailed information available in clinical studies, such as the duration of treatment, intraoperative procedures and the severity of the dental disease, was not available in our linked data set. In addition, determining whether procedures were undertaken in the private or public system was not possible. Because only information on inpatient hospital encounters and not on treatments in other locations was available, it was also not possible to examine dental hospitalizations as a proportion of overall dental visits. In a previous study, we investigated how the level and type of ID affected the likelihood of dental hospitalization.[18] In this current study, however, we did not include information about the severity of the disability and treatment procedures.

Strengths and limitations in comparison to other studies

In comparison to this population-based study, most previous studies in this area have been small scale, for

example, sourced from one hospital,[21,29,40,41] and/or have included all children with SHCN, and not specifically identified children with ID/ASD.[40,42–44] This study indicated that children with ID/ASD had fewer dental extractions than the comparison group. In contrast, most previous studies found that more of the extractions done under GA were in children with SHCN rather than in healthy children.[21,22,29,45] Previous authors have argued that children with SHCN might present with more caries coupled with more unrestorable teeth compared to healthy children, resulting in a decision for dental extraction for the unrestorable teeth and teeth with extensive caries with pulp damage. They also argued that the treatment decision might be influenced by the child's health status. Dental professionals might prefer a less complex and more radical dental procedure for a child with SHCN to minimize further complications, re-treatment or follow-ups.

The higher proportion of dental extractions in the comparison group in this study might be because, for those without disability, less invasive treatments like restorative treatments are done in the clinic, whereas more invasive treatments, including some extractions, are more likely to occur in hospital. The pattern might also be influenced by changing dental schemes for dental care for children from 1986 to 2010. Moreover, whilst WA children with SHCN can access free comprehensive care through the public system at the main children's hospital, children without disabilities can only access free extractions in the public system in an emergency situation to relieve pain and odontogenic infection. This is often the only alternative for disadvantaged families who cannot afford comprehensive treatment through the private system or the subsidized public system, as was highlighted in a recent WA study that identified a higher rate of unplanned dental presentations, particularly involving infections, in children residing in low socioeconomic areas.[46]

The higher number of surgical extractions in the comparison group aged over 13 years is most likely related to the extraction of impacted teeth (e.g. wisdom teeth) or unerupted teeth requiring extraction for orthodontic reasons. Children with ID/ASD are probably less likely to have orthodontic treatment, and thus, post-orthodontic referral for third molar extraction could also be less frequent. Whilst most instances of inpatient hospitalizations involve treatment under GA, this might not always be the case. However, a recent Australian study amongst all children aged under 6 years indicated that 96% of all dental hospitalizations for dental caries and associated procedures were performed under GA.[47] Our study would have benefitted from knowing whether any dental procedures were not undertaken under GA, as treatment planning for children under GA is different from dental treatment under LA.[47]

It was not possible in the present study to ascertain if children with ID/ASD who received extractions had similar oral health presentations to others who received more conservative care. Teeth with extensive caries are more likely to be extracted, especially if the treatment is provided under GA. The treatment plan for extraction can be affected by whether the teeth are primary or permanent. Some previous studies have separated the treatment according to dentition stage,[21,22,45,48] whereas in this study, we could only infer this from the age of the children. Other studies have used (DMF) coding[29,45,48,49] as a classification system to assess the extent of oral health problems. As not done previously, this study uniquely described surgical vs. non-surgical extraction by age group. These findings point to the gap in care for WA preschool-aged children both with and without ID/ASD, with the peak of non-surgical extractions in the comparison group at 4 years and a high proportion for children with ID/ASD at 4–8 years.

This study found that children with ID/ASD were especially likely to be hospitalized more than once for dental conditions, possibly due to inadequate oral hygiene, inappropriate diet and recurring dental needs. An Australian population study on hospitalizations for dental caries amongst all children aged under 6 years showed that 15% of the children admitted at 2 years of age had a re-admission before they were 8 years old. The authors stressed the importance of follow-up preventive oral health care in community dental clinic settings.[47]

Our results showed that Indigenous children with and without ID/ASD experienced more dental extractions than non-Indigenous children. A previous Australian survey on dental hospitalization concluded that non-Indigenous children generally received more conservative care than Indigenous children in hospitals.[33] The authors noted that the extent of extractions, as opposed to less-invasive treatment in Indigenous children, was striking. A further study showed that the rate of dental extractions for <5-year-old Indigenous children was more than twice that of their non-Indigenous counterparts.[50] Treatment decisions might be due to clinical presentation (e.g. severe untreated tooth dental caries), access to dental service or financial issues and the child's limited compliance with oral hygiene.[33,50,51] In a very recent qualitative study on Indigenous oral health in WA, a recurring perception was that visiting the dentist was associated with dental extraction.[52] Other studies worldwide also indicated that children from socially deprived backgrounds received more extractions and fewer restorations or preventive care than their affluent counterparts, even with the equivalent dental disease.[53,54] In Australia, a population-based study on children under 6 years also indicated disparities in

extraction procedures across the sociodemographic divide.[47] Consistent with the findings from WA,[52] this New South Wales study also found that children from more disadvantaged backgrounds were more likely to be treated in public hospitals where more than 90% received extractions. Less disadvantaged children were more likely to be treated in private hospitals, with as many as 43% receiving only restorations.[47]

This study also found that Indigenous children with or without ID/ASD had higher rates of emergency attendances. These might be due to untreated advanced dental caries resulting in extensive toothache that, under emergency attendance conditions, would be treated by extractions. Another explanation could be a lack of education around dental health and a lack of access to preventative measures and dental care.[51,52] These findings also showed that the total proportion of emergency hospitalizations in the ID/ASD group was higher than in the comparison group. A previous Australian population-based study using The Household, Income and Labour Dynamics in Australia found that those with a disability had 1.20 times higher adjusted odds of irregular dental attendance than those without.[55] This can potentially suggest a higher likelihood of dental emergency presentations as a result of irregular dental attendance. A retrospective audit of dental treatment provided under GA in Hong Kong reported that almost 40% of the SHCN patients were treated on an emergency basis, with pain and facial swelling arising from dental caries, being the most common reasons for emergency management.[44]

Meaning of the study: possible mechanisms and implications for clinicians or policymakers

According to the Australian National Oral Health Plan, 2015–2024, it is necessary to reduce potentially preventable dental hospitalization.[56] Our study might suggest that the evaluated dental system in WA is not catering adequately for pre-school age children with and without a disability, resulting in more potentially preventable dental hospitalization in this age group. Additionally, capacity building of oral health professionals in the management of children with ID/ASD and developing and strengthening the skills of non-dental health professionals regarding the importance of oral health management of children with ID/ASD could be appropriate strategies in the early identification of dental caries and the addressing of oral health risk behaviours in these children and their families.

Identifying early carious lesions when they could be reversed rather than restored would significantly reduce potentially preventable dental hospitalizations and avert the need for ongoing GA for less invasive treatments. When hospitalization is needed, early access to appropriate quality care and appropriately planned GA could lead to better treatment planning and a reversal of the extraction to restoration ratio. The development of clinical indicators to measure the quality of care provided is a priority area of need. Improving the quality of training for oral health professionals for treating patients in a hospital could potentially enhance the standard of care. Uniform Australian policy guidelines for the decision to perform dental treatment under GA in hospitals for children with ID/ASD to reduce the rate of dental hospitalization and retreatment in this group of children would be helpful.

To improve oral health for Indigenous children, models of oral health should reflect biological, developmental and environmental factors, including the family's health, financial status and access to health services.[51] A previous qualitative study amongst the Indigenous community in WA showed that school is perceived in remote communities as a facilitating site for efficient screening and oral health promotion for all children and not just those taken to health services by their parents.[52] Other studies also advocated for embedding of oral health promotion activities within the school framework.[57] The WA study also suggested that community-driven strategies to reduce consumption of sugary food and drinks and encourage healthy nutritional choices could be beneficial in oral health promotion in Indigenous communities.[52] Future research to develop and implement teledentistry to prioritize children at higher risk of dental problems in remote communities could be beneficial in reducing emergency dental hospitalizations for Indigenous children with ID/ASD.

CONCLUSION

To the best of the authors' knowledge, this is the first time that dental hospital treatment procedures in children with and without ID/ASD have been examined in WA. These total population data have provided an important opportunity to examine trends in dental hospitalization in this total population of children with ID/ASD, determine coded diagnoses and identify and compare dental procedures with the rest of the hospitalized population.

Best practice in dentistry supports moving towards prevention by targeting high-risk groups rather than more expensive and invasive care in hospitals. The importance of early identification of dental disease and proper dental care is especially important for vulnerable children such as those with ID/ASD. This could be further facilitated by the capacity building of oral health professionals in the management of children with ID/ASD and capacity building of non-dental health professionals in the importance of oral health for the overall health and well-being of these

children. As well as this, early access to appropriate quality care and appropriately planned hospitalization will, however, continue to be an important component of dental management in this population.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Diagnostic codes ICD-9 and ICD-10 relevant for dental hospitalizations[18]

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