Access to dental care and caries experience among children with cerebral palsy: a Singapore experience

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Abstract

Introduction: Cerebral palsy (CP) is one of the most severe childhood neurodevelopmental disabilities resulting from non-progressive insult to the developing brain. We aimed to report our experience regarding dental visit attendance, caries prevalence and factors affecting dental access in children with CP in Singapore.

Methods: Patients diagnosed with CP who were born in or after 1994 were included in this study. We reviewed the data of all 151 patients recruited under the CP Registry in Singapore (SingCPR) from September 2017 to May 2020. The SingCPR was launched in September 2017 to assist in future planning of services and resources for CP in Singapore.

Results: The mean age of the patients was 7.8 years, with the interquartile range being 3 years and 8 months–10 years and 10 months. Only 41.7% reported a visit to the dentist ever, with 25.4% reporting presence of dental caries. Age was the only statistically significant factor influencing access to dental care. None of the children less than 2 years old ever received any dental care, and 20% of the children with CP aged 2–6 years had received dental care before. Age range with the highest percentage of dental visits was 7–12 years, with up to 44.0% having ever received dental care. We believe the prevalence of dental caries was underreported as many children did not receive any dental care and therefore may have undetected dental caries.

Conclusion: Dental care in children with CP should be advocated early for prevention and detection of caries.

Keywords: Cerebral palsy, children, dental care, dental caries, paediatrics

INTRODUCTION

Cerebral palsy (CP) is a chronic motor disorder resulting from non-progressive insult to the developing brain. It is one of the most severe childhood neurodevelopmental disabilities, with an estimated prevalence of 2.1 per 1000 live births in high-income countries.[1] Children with CP are more vulnerable to dental diseases such as dental caries due to the following reasons: (a) greater difficulty in performing and maintaining effective independent and assisted oral care due to motor incoordination and reduced cooperation; (b) greater intake of soft and carbohydrate-rich food; (c) pseudo-bulbar palsy resulting in chewing and swallowing difficulties with food pouching, as well as excessive drooling and loss of protective saliva; (d) gastro-oesophageal reflux disease causing dental erosions (i.e. chemical loss of tooth surfaces due to acidity from stomach juices); (e) malnutrition; (f) suboptimal awareness to seek and access dental health care;[2,3] and (g) higher prevalence of developmental enamel defect.[4]

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Good dental health is important for eating and nutrition, non-verbal smile and verbal communication, quality of life in terms of pain and sleep, as well as for preventing local and systemic infections such as bacteraemia. The American Academy of Paediatric Dentistry and the Health Promotion Board of Singapore recommend that infants should be shown to a dentist once the first primary tooth erupts and by 12 months of age.[5,6] Overall, there is poor oral health awareness among parents in Singapore. In a 2014 study, only 8% of Singaporean children aged between 3 and 6 years and 3% of children aged 18–48 months have regular dental care visits, with only 1% of parents being aware of the recommendations of regular dental visit for infants from 1 year of age.[7,8] The 2009 study of Singaporean children by Gao, *et al*.[8] noted that 40% of preschool children under 6 years of age had early childhood caries. Malay ethnic origin and lower socioeconomic status were risk factors, and 90% of these lesions were untreated. Another study in 2010 reported a higher incidence of dental caries in Singapore children from lower socioeconomic status, who had increased frequency of between-meal sweet snacks, increased levels of dental plaque, presence of bedtime feeding or decreased fluoride exposure.[9]

Worldwide, several studies have shown higher caries rate among children with CP as compared to the general population. A 2018 cross-sectional study of oral and dental health in 62 children with CP in Egypt found that the majority had dental caries, poor dental hygiene and severe gingival inflammation.[10] Another 2016 Bangladeshi study on the risk factors for dental caries among 90 children with CP reported that 35% of children aged 2–6 years and 70% of children aged 7–11 years have experienced dental caries.[11] Dental caries can result in painful teeth and gums, discomfort while eating or drinking hot, cold or sweet food due to sensitive teeth, dental abscess and negative cosmetic effects such as teeth discolouration. Considering the impact of untreated dental caries on oral health-related quality of life of children and their families[12] and the scarcity of evidence on oral health among children with CP worldwide,[13] we aimed to study dental visit attendance, caries prevalence and factors contributing to dental access in children with CP in Singapore.

METHODS

Patients diagnosed with CP who were born in or after 1994 were included in this study. We reviewed the data of all 151 patients recruited under the CP Registry in Singapore (SingCPR) from September 2017 to May 2020. The SingCPR was launched in September 2017 and aims to assist in future planning of services and resources for CP in Singapore. It was set up by two tertiary paediatric hospitals in Singapore (KK Women's and Children's Hospital and National University Hospital) and Cerebral Palsy Alliance Singapore, a social service agency that provides services for persons with CP.

All patients and their parents registered with SingCPR were asked to complete a standardised questionnaire upon recruitment. Questions included basic socioeconomic demographics such as ethnic group, household income per capita, parents' marital status, parents' educational level, clinical data such as birth history, comorbidities and associated impairments, and service utilisation such as dental visit attendance and dental findings. Functional outcome scales assessed and recorded included Gross Motor Function Classification System (GMFCS),[14] Manual Ability Classification System (MACS)[15] and Eating and Drinking Ability Classification System (EDACS).[16] The GMFCS, MACS and EDACS are three different classification systems that categorise children with CP based on their gross motor ability, ability of their hands to handle objects in daily activities, and ability to eat and drink efficiently and safely, respectively. A higher GMFCS, MACS or EDACS level corresponds to a higher requirement for assistance. Cognitive impairment is defined as intelligence quotient ≤ 70.[17] Presence of gastrostomy with/without fundoplication, failure to thrive and presence of drooling were also studied.

Ethical approval for this study was obtained from the SingHealth Institutional Review Board (CIRB number: 2016/2266). Informed written consent was obtained from all subjects/caregivers in accordance with the Institutional Review Board guidelines.

Primary outcome for this study was access to dental care, and the secondary outcome was proxy-reported dental caries experience in children. Explanatory variables were categorised into three categories: socioeconomic (parents' marital status, maternal highest education, paternal highest education, household income per capita); biological (age, gender, race); and clinical (cognitive function, GMFCS, MACS and EDACS levels, presence of gastrostomy, gastrostomy with fundoplication or drooling, and failure to thrive).

Descriptive analyses were used to report basic demographics of the patients. To measure the correlation of each variable against dental caries prevalence, chi-square test was used for categorical variables and Kruskal–Wallis one-way analysis of variance test was used for continuous variables. Then, a further statistical analysis was conducted via non-hierarchical logistic regression using generalised linear model to investigate how the socioeconomic, biological and clinical factors contribute to the primary outcome, i.e., access to dental care. For this model, 22 patients who had missing data for the explanatory variables were treated with Multivariate Imputation by Chained Equations to conduct a complete case analysis. The variables with missing data were maternal education level (1.99%), paternal education level (5.96%), household income per capita (7.95%) and cognitive function (0.66%). Statistical analysis was conducted using R Studio Version 1.2.5033 (RStudio, PBC, Boston, MA, USA). A P value < 0.05 was deemed to be statistically significant for all analyses.

RESULTS

Basic demographics

All 151 patients in the CP registry recruited during the study period were analysed. Majority were paediatric patients; ten patients were aged > 18 years. The mean age of the patients was 7.8 years (interquartile range: 3 years 8 months to 10 years 10 months). There was a predominance of males (*n* = 106, 70.2%). The racial group distribution was reflective of contemporary multi-racial Singapore census data, with majority being of Chinese ethnicity. More than half of the patients belonged to families with household income per capita of < SGD 1500, which qualifies for full medical subsidy. Among our study population, the majority had spastic CP (*n* = 98, 64.9%), cognitive impairment (*n* = 113, 74.8%) and epilepsy (*n* = 101, 66.9%). Up to 45% (*n* = 68) of our study population belonged to the higher GMFCS level group, suggesting poorer gross motor function, while 25.8% (*n* = 39) had EDACS levels IV–V, indicating higher difficulty in eating and drinking. Close to one-third (*n* = 53, 35.1%) of our study population had MACS level IV–V, reflecting higher difficulty in handling objects or completing tasks with their hands. Only 6.6% (*n* = 10) had gastrostomy and fundoplication, 38.4% (*n* = 58) had issues with drooling and 17.2% (*n* = 26) had failure to thrive. Table 1 summarises the baseline demographics of the subjects.

Primary outcome: access to dental care

Among the 151 patients with CP, only 41.7% (*n* = 63) had ever visited a dentist. None of the children aged < 2 years had ever received any dental care, and 20% of the children aged 2–6 years had ever received dental care. The age group with the highest number of children who had dental visits were those aged 7–12 years (44.0%). As shown in Table 1, the only factor found to affect access to dental care was age. Gender, race, marital status, maternal or paternal educational level, household income per capita, cognitive function, GMFCS, EDACS and MACS scores, cognitive function, presence of drooling, gastrostomy or fundoplication did not influence access to dental care. Figure 1 shows the odds ratios of each variable studied for access to dental care. Even though the results were statistically insignificant, the overall trend suggests that children in the older age group, of Chinese ethnicity, belonging to families with income level of SGD 1500 and with more or good weight gain were more likely to have received dental care. Children from the ethnic group 'Others' (not Chinese/Malay/Indian) or with high GMFCS (level IV–V) and MACS (level IV–V) were less likely to have received dental care.

Secondary outcome: proxy-reported dental caries experience

Among the 151 patients, only 41.7% (*n* = 63) who had ever visited a dentist were able to respond to the question about dental findings. Among those who responded, 74.6% (*n* = 47) reported normal dental findings while 25.4% (*n* = 16) reported dental caries. The incidence of dental caries among children aged 2–6 years was 18.8%, and the incidence was the highest among children aged 7–12 years (62.5%). There was no data on dental caries among children with CP aged < 2 years, as none had access to dental care.

DISCUSSION

Children with CP are at a higher risk of dental caries compared to the general population due to multiple predisposing factors, such as physical and/or intellectual disability requiring assistance for oral hygiene, pseudo-bulbar palsy causing chewing and swallowing difficulties, gastro-oesophageal reflux disease causing chemical erosion of the dental surfaces due to acidity of the gastric contents, and malnutrition and immobility resulting in poor calcium and vitamin D intake.[2,3] Bringing children with CP for routine dental checks can also

Variable		N	Odds ratio	p
Age		151	0.83 (0.76, 0.90)	<0.001
Gender	Male	106	Reference	
	Female	45	1.23 (0.53, 2.93)	0.6
Race	Chinese	91	Reference	
	Malay	31	0.99 (0.36, 2.76)	1.0
	Indian	17	1.10 (0.34, 3.88)	0.9
	Others	12	2.53 (0.53, 16.30)	0.3
Maternal Education Level	College/diploma and below	87	Reference	
	University and above	64	1.21 (0.42, 3.51)	0.7
Paternal Education Level	College/diploma and below	82	Reference	
	University and above	69	1.07 (0.35, 3.28)	0.9
Household Income	SDG $1500 or below	93	Reference	
	More than SDG $1500	58	0.74 (0.28, 1.88)	0.5
Cognitive Function	No	112	Reference	
	Yes	39	1.20 (0.44, 3.35)	0.7
GMFCS Level	Low (I-III)	83	Reference	
	High (IV-V)	68	1.16 (0.34, 3.97)	0.8
MACS Level	Low (I-III)	98	Reference	
	High (IV-V)	53	1.61 (0.43, 6.19)	0.5
Failure to Thrive	Yes	26	Reference	
	No	125	1.07 (0.35, 3.21)	0.9

Figure 1: Chart shows the odds ratios of variables studied for access to dental care. GMFCS: Gross Motor Function Classification System, MACS: Manual Ability Classification System

Table 1. Descriptive analysis of factors associated with access to dental care.[a]

Factor	*n* (%)		*P*
	Access to dental care (*n*=63)	No access to dental care (*n*=88)	
Age (yr)			<0.001
<2	0 (0.0)	13 (14.8)	
2–6	20 (31.7)	59 (67.0)	
7–12	28 (44.4)	7 (8.0)	
>13	15 (23.8)	9 (10.2)	
Gender			0.935
Male	44 (69.8)	62 (70.5)	
Female	19 (30.2)	26 (29.5)	
Race			
Chinese	40 (63.5)	51 (58.0)	0.571
Malay	14 (22.2)	17 (19.3)	
Indian	6 (9.5)	11 (12.5)	
Others	3 (4.8)	9 (10.2)	
Marital status			0.534
Married	56 (88.9)	78 (90.7)	
Divorced/separated	6 (9.5)	7 (8.1)	
Common law	0 (0.0)	1 (1.2)	
Single	1 (1.6)	0 (0.0)	
Maternal education level			0.253
College or diploma and below	40 (63.5)	46 (54.1)	
University and above	23 (36.5)	39 (45.9)	
Paternal education level			0.874
College or diploma and below	33 (55.0)	44 (53.7)	
University and above	27 (45.0)	38 (46.3)	
Per capita household income (SGD)			0.653
≤ 1500	34 (59.6)	52 (63.4)	
> 1500	23 (40.4)	30 (36.6)	
Cognitive function			0.911
No	46 (74.2)	66 (75.0)	
Yes	16 (25.8)	22 (25.0)	
GMFCS level			0.147
Low (I–III)	39 (61.9)	44 (50.0)	
High (IV–V)	24 (38.1)	44 (50.0)	
EDACS level			0.107
Low (I–III)	51 (81.0)	61 (69.3)	
High (IV–V)	12 (19.0)	27 (30.7)	
MACS level			0.077
Low (I–III)	46 (73.0)	52 (59.1)	
High (IV–V)	17 (27.0)	36 (40.9)	
Failure to thrive			0.419
Yes	9 (14.3)	17 (19.3)	
No	54 (85.7)	71 (80.7)	
Drooling			0.946
Yes	24 (38.1)	34 (38.6)	
No	39 (61.9)	54 (61.4)	
Gastrostomy			0.583
Yes	5 (7.9)	5 (5.7)	
No	58 (92.1)	83 (94.3)	

[a]The only factor found to affect access to dental care was age. EDACS: Eating and Drinking Ability Classification System, GMFCS: Gross Motor Function Classification System, MACS: Manual Ability Classification System

be challenging due to their limited mobility. They may also be non-verbal or have behavioural issues, making them fretful and less cooperative for dental check, possibly requiring general anaesthesia to complete the dental examination. All these factors may further contribute to reduced caregiver compliance, thus making dental health assessment difficult. There is also a need for increased awareness and better understanding of the need for routine dental screen in such a population among primary healthcare providers, so that they can provide prompt education and appropriate advice. Our study showed that there is poor access to dental care among children with CP who are at high risk of dental caries. Only 41.7% of our study population reported having ever visited a dentist, with 25.4% reporting the presence of dental caries.

Our data analysis showed that age was the only statistically significant factor influencing access to dental care. These findings correlate with the study findings from the general population and suggest that overall, there is poor oral health awareness among parents in Singapore.[7] Other factors found to have positive associations with dental care include Chinese ethnicity, families with higher household income and patients with good weight gain. Our study findings concur with those of a study conducted on healthy preschoolers in Singapore, which reported higher dental caries rate and treatment need among those of Malay ethnicity and those of lower socioeconomic background.[8,9] The differences in access to dental care among racial and socioeconomic groups may be attributed to their lack of dental knowledge and awareness, cultural characteristics and barriers to dental care services. Other factors found to have negative association with access to dental care included functional status such as higher GMFCS and MACS levels. Caregivers or children with higher GMFCS and MACS levels, who are in need of more functional assistance, are more likely to have greater difficulty in accessing dental care.

Studies from various parts of the world, mostly done in low-resource countries, reported that up to 50%–60% of children with CP were affected by dental caries.[10,11,18] In comparison, the rate of dental caries in our study was found to be lower. Compared to the general population,[8] the incidence of dental caries among children aged less than 6 years was also found to be lower at 18.8%. However, we opined that the prevalence of dental caries was severely underreported in our study population, as many children, especially the younger age group, did not receive any dental care and may have undetected dental caries. In fact, a study conducted in England in 1991 reported that children with CP had more untreated decay than children without disability.[19]

Based on our findings, we recommend that children with CP should have early access to dental care. Dental visits can be challenging for children and family with CP due to multiple medical appointments and limited mobility. Delay in seeking dental care may result in increased severity of disease, leading to more extensive and costly treatment. In addition, general anaesthesia may be required to provide quality dental care for children, especially children with CP, due to behavioural and cognitive deficits. The School Dental Service, an initiative of the Health Promotion Board in Singapore, provides free dental services such as dental examination, as well as basic and preventive dental treatment for primary and secondary school students from mainstream schools and some special education schools. However, 61% of our study population were aged 6 years or below and were thus too young to benefit from this service. A study by Sinha *et al*.[20] reported that preventive dental visits for routine check-up and topical fluoride application clearly resulted in comparatively lower caries experience. Similarly, Lai *et al*.[21] reported that Singaporean children who had attended early preventive dental visits had a lower proportion and lower severity of dental caries compared to their peers who had not accessed dental care. In that study, 31.3% of children in the control group had severe early childhood caries compared to 7.8% in the intervention group (difference of 23.5%, 95% confidence interval 11%–36%), regardless of age. This finding can be extrapolated to our children with CP. Periodic dental visits based on dental risk level should be incorporated in the routine medical care for these patients. Early dental visit will offer an opportunity to provide anticipatory guidance to both parents and children, allowing for early detection of dental caries.

Furthermore, we recommend greater oral health awareness among medical professionals. Children with CP usually have more frequent encounters with medical and early childhood professionals, compared to their peers. Instead of being a potential rate-limiting factor to dental visits, these frequent medical visits can be used opportunistically for oral health assessment and early dental referrals. Stearns *et al*.[22] reported that physician-delivered preventive oral health services reduced 32% of treatment cost of caries-related hospital episodes in children aged up to 3 years. There should be increased oral health awareness among medical professionals, such as paediatricians and nurses in polyclinics who provide routine vaccination, to enable timely referrals to paediatric dentists. Paediatricians with regular encounters with these children should be equipped with knowledge to provide dental care recommendations. Future directions may include incorporation of a section on oral health in medical school and paediatric residency training, or an oral health assessment checklist in the health booklet.[21]

This study has some strengths and limitations. First, the dental findings were reported by parents and patients, and this may be prone to recall bias and underreporting. As it was a secondary analysis, it was not possible to trace back the dental records for a more accurate picture of the oral health status. Presence of dental caries was the only dental finding that was surveyed as it was believed that parents would have more difficulty recalling other dental problems like gum diseases or

bruxism. Nonetheless, this study has yielded useful information regarding dental care, caries experience and risk factors in children with CP, where literature is scarce, to allow better design of future studies.

Second, some of the variables contained missing data, but no variables contained more than 8% of missing values. This missingness was assessed as Missing-Not-At-Random, as most missingness only appeared in socioeconomic determinant variables. Since the amount of missingness was not critical, they were treated using multiple imputations, with five imputations of 50 iterations per imputation.[23] Density plot of observed and imputed data was used to check if the values generated from imputation were plausible. This process decreased the potential selection bias from missing values.

Lastly, despite the 3-year study period, the study population was relatively small. Majority of the younger children (aged < 6 years) with CP had never had access to dental care. Considering the above limitations, this study could be repeated on a scale in the near future, with more patients recruited. Future studies should also be prospective to reduce recall bias. This should also include dental examinations by calibrated dental examiners to record oral health status, including dental caries, DMFT (Decayed, Missing and Filled Teeth) in the permanent teeth, and gingival health.

In conclusion, dental caries is a preventable chronic disease, even among children with CP who are at higher risk of dental caries. Our study revealed suboptimal access to dental care among this vulnerable patient group, especially in those younger than 6 years and families with complex or lower socioeconomic background. We hope our findings can raise awareness on the importance of early dental access and care for prevention, early detection and treatment of dental caries in children with CP.

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Conflicts of interest

There are no conflicts of interest.

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