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Assessment of oral and dental health status in children with cerebral palsy: An exploratory study

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ABSTRACT

Objectives: Evaluating oral and dental health status in Egyptian children with cerebral palsy (CP) in relation to gross motor skills and types of CP.

Methods: A Cross-sectional study was conducted at el-Shatby Hospital for Children, Alexandria-Egypt. Oral examination for 62 children with CP between the age ranges 3–12 years was performed and decay missing filling-tooth/decay filling-tooth (DMFT/dft), simplified oral hygiene index (OHI-S), and modified gingival index (MGI) indices were charted. Maxillofacial defects, dental problems and drooling of saliva were assessed. Children's CP type, motor milestone, and gross motor skills were determined. All statistical analyses were performed at $P < 0.05$ and 0.01.

Results: About 84.0% of children had spastic quadriplegia, 41.9% were sit supported, 32.3% had Level IV gross motor function classification system (GMFCS), and 29.0% had Level V. No maxillofacial defects, 14.5% had dentine exposure >1/3 of the surface, and 22.6% had frequent/severe drooling saliva. Caries prevalence comprised 54.8%, 53.2% had poor oral hygiene (OHI-S index), and 43.6% had severe gingival inflammation (MGI index). The first best predictor variable for dft was "Motor Milestone." GMFCS (Level IV and V) was the first best predictor variable for DMFT, OHI-S, and MGI indices.

Conclusion: The majority of children had dental caries, poor oral hygiene, and severe gingival inflammation. Children who were sit supported had no neck support and stand supported were suffering from dental caries (dft) more than children who were sitting and walking alone. Children with Levels IV/V GMFCS were prone to have dental caries (DMFT), susceptible to suffer from bad oral hygiene, and older children experiencing severe gingivitis more than younger ones.

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Key words: Cerebral palsy, gross motor function classification system, decay missing filling-tooth, decay filling-tooth, simplified oral hygiene index, modified gingival index

Introduction

Cerebral palsy (CP) is presently viewed as the principle crippling condition in childhood and is one of the chief neurological disorders.[1]

Population-based evaluations of CP prevalence range from 1.5 to more than 4 per 1000 live births or per children of a distinct age category.[2-7] CP is a disorder caused by injury to the brain, commonly happening before, during, or shortly after birth. "Cerebral" represents the brain and "palsy" implies a disturbance of movement or posture. CP is a central nervous system disorder of movement, coordination, and posture, revealing a non-progressive deformity or insult to the immature brain.[8] CP is neither progressive nor transmissible. Moreover, it is not curable, despite the fact that learning, treatment, and applied technology can assist people with CP run humane and dignified lives.[9]

CP is classified according to the type of body movement and posture problem into spastic (pyramidal), non-spastic (extrapyramidal), and mixed CP. Spastic CP is the most common type. A person with spastic CP develops tight muscles in some parts of the body that are unable to relax. Affected joints become stiff and hard to move. Usually, a person has problems in movements control, poor coordination and balance, as well as talking and eating with difficulty. There are four types of spastic CP, categorized according to how many limbs are affected. Monoplegia, Hemiplegia, or diplegia, these are the most common types of spastic CP,

Triplegia, and Quadriplegia in which both arms and both legs are affected additionally, commonly the trunk and muscles that control the mouth, tongue, and windpipe are affected too. This leads to difficulty in eating and talking. Babies with spastic quadriplegia may have problems in sucking and swallowing, a weak or shrill cry, a very relaxed and floppy or a very stiff body, when held they may arch their backs and extend their arms and legs, be irritable when awake, sleep a lot or show little interest in what is going on around them. The other type of CP is the non-spastic forms that include dyskinetic CP (subdivided into athetoid and dystonic forms) and ataxic CP. Dyskinetic CP is associated with muscle tone that fluctuates between being loose and tight. Athetoid (hyperkinetic) CP characteristics include relaxed and limp muscles during sleep, with some involuntary jerking (chorea) or writhing (athetosis). If the face and mouth muscles are affected, problems may develop related to unusual facial expressions, drooling, speaking, and choking when sucking, drinking, and eating. Ataxic CP is the rarest type and involves the entire body. Abnormal body movements affect the trunk, hands, arms, and legs. Ataxic CP causes problems with balance, exact movements, coordination and hand control. The third type is mixed CP in which some children have symptoms of more than one type of CP. In addition, total body CP is the type that affects the entire body to some degree. Complications of CP and other medical problems are more likely to develop when the entire body is involved rather than isolated parts. Total body CP may include any of the types of CP, spastic quadriplegic, dyskinetic, or ataxic.[10-12]

Studies have demonstrated that increased severity of the neurological damage in children with CP resulted in higher risk of oral diseases.[13,14] Children with CP regularly have physical, coordinative, sensory, intelligence, communication and cognitive problems in implementing, detecting and retaining self-care performances of activities of daily living (ADLs), such as walking, showering, wearing clothes, teeth brushing, eating, talking, and ambulating.[15,16] These challenges extremely influence their ADLs and lead to a deteriorated oral health condition in the form of high caries rate, decreased number and rate of restored teeth and/or poor quality restorations, as well as intense periodontal inflammation. Consequently, children with CP frequently necessitate intensive dental care.[17-23] A previous study discovered that the decayed, missing, and filled permanent surfaces (DMFS) of children with CP was 12.86 which was significantly higher than that of normal children were 2.87; likewise, the dental plaque index was higher in children with CP.[24] De Camargo and Antunes[25] in their study that was held in a specialized health care unit in São Paulo, Brazil declared that 49.5% of children with CP had at least one untreated carious tooth. They have a poorer oral health condition than other children of similar age and geographic location, for both the primary and permanent dentition. On the other hand, an earlier study conducted in Denmark revealed that children with CP, severe mental retardation (MR), and motor disturbances had a lower DMFS index and a higher caries-free rate than normal children meaning that the dental health condition of children with CP and MR could be superior to that of children with CP but without MR, and even better than normal children, through the influence of preventive strategies as dental health education and fluoride application.[26] In contrast, another survey conducted on CP children attending special schools in Leeds, England disclosed that the caries status of children with CP was similar to that of normal children.[18] However, they had less restoration, more extractions, minimal access to dental care, as well as poor oral hygiene and periodontal health, in addition to more dental plaque, gingivitis, and overjets. In addition, this group of children demonstrated severe attrition of both primary and permanent dentitions.[18]

Moreover, recently in 2015, Sinha *et al*.,[27] demonstrated that Indian children with CP had higher caries, poor oral hygiene and Class 2 malocclusion when compared to controls, this chiefly may be because of their compromised general health condition as well as lack of dental awareness.

The oral health status of children with CP, considering gross motor skills and types of CP has not previously been reported in Egypt. As this group of children is considered as an important segment of the population, so, the aim of this study was to assess the oral and dental health status among a group of Egyptian children with CP attending el-Shatby Hospital for Children in relation to gross motor skills and types of CP. In particular, the current study concerned about decay missing filling-tooth (DMFT) index (decayed, missing, and filled permanent teeth), decay filling-tooth (dft) index (decayed and filled primary teeth), and oral hygiene status of CP children measured by simplified oral hygiene index (OHI-S) as well as modified gingival index (MGI). The outcomes achieved would serve as baseline data for planning oral health preventive programs aimed at enhancing the dental care in the future as well as improving the oral health of this group of children.

Material and Methods

This cross-sectional study was conducted at El-Shatby Hospital for Children, Alexandria Faculty of Medicine – Alexandria University, Egypt. Alexandria University Children's Hospital is the main Pediatric hospital in the North Coast Region. It serves as a tertiary referral center for four governorates: Alexandria, Beheira, Matrouh, and Kafr El Sheikh. It has about 264 inpatient beds with more than 70.800 acute admissions a year. The study sample consisted of 10% of CP children attending the outpatient specialty clinics selected randomly in each visit to the clinics between May and October 2015, after getting a prior permission from the relevant authorities and the approval of the Dental Ethical Committee for the study protocol that was performed in accordance with the World Medical Association Declaration of Helsinki principles for Medical Research involving human subjects to maintain the ethics.[28] The nature of the study was clarified to the parents/caregivers

through an informed consent; in case of the agreement, they were requested to sign the written consent.

Children's medical records were reviewed for demographic and clinical data, including age, gender, CP type, and the gross motor function classification system (GMFCS), a pro forma was filled including these data. The participating children were classified as a spastic, dyskinetic, ataxic, or mixed type of cerebral palsied child according to Swedish classification system.[29] In addition, the children with CP were classified according to the GMFCS.[30] Exclusion criteria were: Associated disorders such as MR, and children below 3 years and above 12 years old.

After the exclusion of nonconformity cases, the sample size consisted of a total of 62 CP children who were subjected to oral examination by one examiner. Children were examined in the outpatient clinic for both hard and soft dental tissues, lying on a bed under the natural light using sterile plane mouth mirror following the criteria recommended by the World Health Organization (WHO) 2013.[31] All examinations were visual, and no probes were used due to the difficult behavior of the CP children, and to ensure the safety of the child and examiner during the examination process.

Dental health status of the participants was measured using decayed, missing, and filling index for caries measurement for mixed dentition (DMFT and dft) according to the WHO, oral health assessment form for children, 2013.[31] Furthermore, clinical measurement of tooth wear was detected using the simplified scoring criteria for tooth wearing index, 2004.[32] According to the index the teeth were assessed as followed: 0, No wear in dentine; 1 - Dentine just visible (including cupping) or dentine exposed for <1/3 of surface; 2 - Dentine exposure > 1/3 of surface; and 3 - exposure of pulp or secondary dentine. In addition, the presence or absence of maxillofacial defects as clefts lip/palate, as well as bruxism was identified, and the eruption status of the contributing children was observed in the form of normal or delayed eruption. The children were checked also for the presence of other oral conditions. Drooling control was assessed by applying the scale developed by Thomas-Stonell and Greenberg, Drooling Severity and Frequency Scale, DFSS.[33] Determination of drooling severity and frequency was based on the method of observation regulated in appointments with the parents/caregivers and concerned physiotherapists. Drooling status of the CP children was specified numerically by applying the DFSS scale.[33] With regard to the scale, drooling severity was evaluated as followed: 1 - dry (no drooling); 2 - mild (humid lips only); 3 - moderate (humid lips and chin); 4 - severe (clothing begins to be affected); and 5 - profuse (clothes, hands, and objects are wet). Drooling frequency was assessed as followed: 1 - no drooling; 2 - occasionally drools (not every day); 3 - frequently drools (part of the day); and 4 - constantly drools.

Oral hygiene status of the participating children was evaluated by means of OHI-S for ages 4–6 and 7–10 (deciduous and mixed dentition),[34] with slight modification in the age range. For oral hygiene assessment, children were divided into two groups: 1) 4–6 years and below as well as and 2) 7–10 years and above. The criteria described by GREEN and VERMILLION, 1964,[35] were selected. Calculus was excluded. For the ages, 4 to 6 years and below, the labial surfaces of the 54, 61, 82 and the lingual surface of 75 were selected, and for the mixed dentition (7–10 years and above) the labial surface of 26 and the lingual surface of 46 was added. For interpretation of the findings, the OHI-S (DI-S) was scored as followed: 0.0–0.6 = Good oral hygiene; 0.7–1.8 = Fair oral hygiene; and 1.9–3.0 = Poor oral hygiene.[34] Finally, the MGI[36] was used to assess the prevalence and severity of gingivitis among the participating children. This index is strictly based on non-invasive approach, i.e., visual examination only without any probing. To achieve MGI, labial and lingual surfaces of the gingival margins and the interdental papilla of all erupted teeth were examined and scored as followed: 0, Normal (absence of inflammation); (1) mild inflammation (slight change in color, little change in texture) of any portion of the gingival unit; (2) mild inflammation of the entire gingival unit; (3) moderate inflammation (moderate glazing, redness, edema, and/or hypertrophy) of the gingival unit; and (4) severe inflammation (marked redness and edema/hypertrophy, spontaneous bleeding, or ulceration) of the gingival unit. For interpretation of the outcomes, a modification was applied to the method of interpretation of GI[37] and the MGI was scored as followed: 0.1–1.0 = Mild inflammation of any portion of the gingiva; 1.1–2.0 = Mild inflammation of the entire gingiva; 2.1–3.0 = Moderate inflammation; and 3.1–4.0 severe inflammation.

To make sure that intra-examiner reliability is achieved, a blind re-examination of 6 CP children was performed (10% of the sample) and the Cohen's Kappa score[38] was found to be 0.91.

Statistical analysis

Statistical analysis was conducted using the SPSS program (SPSS 19.0 for Windows, SPSS Inc., Chicago, USA). All statistical analyses were performed at a significance level <0.05 and 0.01. The data were analyzed for frequency distributions. Data were subjected to descriptive statistics such as frequencies, percentages, and cross-tabulation. Pearson's correlation coefficient was used to investigate associations between the studied variables. Finally, linear regression analysis was conducted to figure out which factors that have the main effect on the studied condition.

Results

The study included 62 children suffering from CP, 61.3% boys and 38.7% girls, with an average age of 6.5 years (standard deviation [SD] ± 2.6 years) and the age range was 3–12 years old, with 45.2% of the participants in the age category

"<6 years old," 29.0% in the age group "6 to <9 years-old," and 28.8% "9 years and more."

Table 1 summarizes the types of CP, Motor Milestone, and the GMFCS among the studied group. It was found that the majority of the children (83.9%) were suffering from spastic quadriplegia CP, while 6.5% of the studied children were suffering from ataxic CP and the same percentage of children were suffering from spastic diplegia. Finally, only 3.2% of the studied children had right hemiplegia. About 42.0% of the studied subjects were sit supported, followed by 16.0% were stand supported. On the other hand, more than 5th (22.6%) of the studied subjects had no neck support and <10% were sitting alone as well as walking alone. Concerning the GMFCS for CP it was found that 32.3% of the studied group had Self-Mobility with Limitations or May Use Powered Mobility (Level IV), followed by 29.0% were Transported in a Manual Wheelchair (Level V), and 19.4% of the children Walks with Limitations (Level II).

Regarding the maxillofacial defects as well as oral and dental problems of the participants, all the studied subjects had no maxillofacial defects, whereas only 19.4% of the children had bruxism. Concerning the tooth wearing index, the majority of children (71.0%) had normal teeth, whereas just 14.5% had dentine exposure >1/3 of the surface. With regard to the other oral conditions, 6.5% of the children had an open bite and developing Class II, while 8.1% had heavy food accumulation, 4.8% showed the history of oral ulcers and 6.5% were experiencing malocclusion. Furthermore, only 32.3% of the participating children were suffering from the delayed eruption. Moreover, merely 33.9% of the studied group had no drooling of saliva, with 22.6% had frequent and severe drooling and 19.4% were suffering from constant profuse drooling of saliva, Table 2.

Table 3 summarizes the distribution of dental and oral hygiene status of the studied subjects. It was found that caries prevalence constituted 54.8% among the participating children with dft index Mean ± SD = 2.77 ± 4.59) and DMFT index mean ± SD) = 1.43 ± 3.12). The most affected teeth by caries were the lower posteriors (85.3%) followed by the upper posterior teeth (73.5%), then the upper anterior

Table 1: Types of CP, motor milestone, and GMFCS among the studied group (*n*=62)

Variable	Frequency (%)
Diagnosis	
Ataxic	4 (6.5)
Spastic quadriplegia	52 (83.9)
Spastic diplegia	4 (6.5)
Spastic hemiplegia (Rt)	2 (3.2)
Motor milestone	
Sit supported	26 (41.9)
Stand supported	10 (16.1%)
No neck support	14 (22.6)
Sit alone	6 (9.7)
Walk alone	6 (9.7)
GMFCS	
Level I	2 (3.2)
Level II	12 (19.4)
Level III	10 (16.1)
Level IV	20 (32.3)
Level V	18 (29.0)

CP: Cerebral palsy, GMFCS: Gross motor function classification system

Table 2: Maxillofacial defects as well as oral and dental problems of the studied group (*n*=62)

Variable	Frequency (%)
Maxillofacial defects	
Yes	0 (0.0)
No	62 (100.0)
Bruxism	
Yes	12 (19.4)
No	50 (80.6)
Wearing index	
Normal tooth	44 (71.0)
No wear into dentine	3 (4.8)
Dentine just visible (including cupping) or dentine exposed for<1/3 of surface	4 (6.5)
Dentine exposure>1/3 of surface	9 (14.5)
Exposure of pulp or secondary dentine	2 (3.2)
Other oral conditions	
Open bite and developing Class II	4 (6.5)
Heavy food accumulation	5 (8.1)
History of oral ulcers	3 (4.8)
Malocclusion	4 (6.5)
Eruption status	
Normal eruption	42 (67.7)
Delayed eruption	20 (32.3)
Drooling of saliva	
Drooling severity	
Dry, no drooling	21 (33.9)
Drooling frequency	4 (6.5)
Moderate: Humid lips and chin	11 (17.7)
Severe: Clothing begins to be affected	14 (22.6)
Profuse: Clothes, hands, and objects are wet	12 (19.4)
Drooling frequency	
No drooling	21 (33.9)
Occasionally drools	15 (24.2)
Frequently drools	14 (22.6)
Constantly drools	12 (19.4)

*Percent of affected teeth

Table 3: Dental and oral hygiene status of the studied group (*n*=62)

Variable		Frequency (%)		
DMFT index	Caries prevalence	Children who are caries free	28 (45.2)	
		Children with carious teeth	34 (54.8)	
	Caries distribution*	Upper anterior carious teeth	18 (29.0)	
		Upper posterior carious teeth	25 (40.3)	
		Lower anterior carious teeth	8 (12.9)	
		Lower posterior carious teeth	29 (46.8)	
	Mean±SD		4.18±5.60	
	Minimum		0	
	Maximum		22	
OHI-S index	Score	Age Frequency (%)		Total Frequency (%) within age
		4–6 years and below	7–10 years and above	
	Good	19 (52.8)	5 (19.2)	24 (38.7)
	Fair	2 (5.6)	3 (11.5)	5 (8.1)
	Poor	15 (41.7)	18 (69.2)	33 (53.2)
	Mean±SD		1.60±1.10	
	Minimum		0	
	Maximum		3	
MGI index	Score	Age Frequency (%)		Total Frequency (%) within age
		4-6 years and below	7-10 years and above	
	Normal	6 (16.7)	3 (11.5)	9 (14.5)
	Mild inflammation	4 (11.1)	0 (0.0)	4 (6.5)
	Mild inflammation of the entire gingival unit	9 (25.0)	2 (7.7)	11 (17.7)
	Moderate inflammation	5 (13.9)	6 (23.1)	11 (17.7)
	Severe inflammation	12 (33.3)	15 (57.7)	27 (43.6)
	Mean±SD		1.64±1.05	
	Minimum		0	
	Maximum		3	

DMFT: Decay missing filling-tooth, OHI-S: Simplified oral hygiene index, MGI: Modified gingival index

teeth (52.9%) and the least affected teeth were the lower anterior (23.5%). With regard to the oral hygiene status of the participants, the majority of children (53.2%) had poor oral hygiene represented through the OHI-S index with a Mean index ± SD) =1.60 ± 1.10) in which 69.2% of older children in the age of 7–10 years and above had poor oral hygiene, and severe gingival inflammation (43.6%) represented by the MGI index with a mean index ± SD) =1.64 ± 1.05), where 57.7% of 7–10 years and above had severe gingivitis.

Table 4 summarizes Pearson's correlation coefficient between different studied variables. A strong correlation was detected between the diagnosis of CP and the other oral conditions, eruption status, dft and oral hygiene status OHI-S. Moreover, a correlation was found between the motor milestone and the other oral conditions that affect this group of children as well as dft index. Finally, a strong correlation was registered between the GMFCS) for CP and drooling of saliva, tooth wearing index, DMFT index and the OHI-S in the form of OHI-S as well as the MGI indices.

Table 5 summarizes the effect of each independent variable in relation to CP assessed by caries index for deciduous teeth (dft). Out of the 10 variables studied, only one variable was statistically associated with caries index for deciduous teeth (dft). The first best predictor variable for dft Index was "Motor Milestone," where those children who were sit supported, had no neck support and those who were stand supported were suffering from dental caries (dft) 21.6 times more than those children who were sitting and walking alone.

In addition, Table 6 summarizes the effect of each independent variable in relation to CP assessed by Caries Index for permanent teeth (DMFT). It was detected that out of 10 variables studied, again only one variable was statistically associated with the occurrence of dental caries. "GMFCS" was found to be the first

Table 4: Pearson's correlation coefficient between different studied variables (n = 62)

	Diagnosis	Motor milestone	GMFCS	Age	Gender	Drooling of saliva	Tooth wearing index	Bruxism	Other oral conditions	Eruption status	DMFT	dft	OHI-S score	MGI score
Diagnosis														
r														
P														
Motor milestone														
r	0.26*													
P	0.044													
GMFCS														
r	0.27*	0.10												
P	0.032	0.446												
Age														
r	−0.14	0.17	0.22											
P	0.294	0.196	0.080											
Gender														
r	−0.23	0.12	−0.15	0.10										
P	0.068	0.339	0.248	0.442										
Drooling of saliva														
r	0.09	−0.02	0.35**	−0.04	−0.13									
P	0.479	0.860	0.005	0.780	0.311									
Tooth wearing index														
r	−0.08	0.19	0.36**	0.23	−0.05	0.34**								
P	0.559	0.146	0.004	0.078	0.713	0.007								
Bruxism														
r	−0.06	0.14	0.05	−0.11	−0.22	0.18	0.62**							
P	0.628	0.289	0.707	0.411	0.083	0.166	0.000							
Other oral conditions														
r	0.31*	0.28*	0.20	0.34**	−0.12	0.08	0.19	0.13						
P	0.015	0.029	0.121	0.007	0.365	0.547	0.142	0.332						
Eruption status														
r	0.26*	−0.08	−0.03	−0.02	−0.18	0.23	−0.01	−0.28*	0.00					
P	0.037	0.547	0.794	0.859	0.162	0.073	0.918	0.027	0.984					
DMFT														
r	−0.02	−0.13	0.51**	−0.16	0.07	−0.12	−0.14	−0.23	0.01	−0.14				
P	0.890	0.305	0.000	0.213	0.611	0.348	0.301	0.075	0.945	0.297				
dft														
r	0.63**	0.47**	0.05	−0.06	−0.32*	0.32*	−0.03	−0.01	0.10	0.22	0.02			
P	0.000	0.000	0.699	0.641	0.010	0.010	0.801	0.929	0.437	0.093	0.858			
OHI-S score														
r	0.26*	−0.09	0.38**	0.31*	0.10	0.19	0.27*	0.03	0.23	−0.02	0.31*	0.35**		
P	0.043	0.502	0.002	0.014	0.459	0.130	0.032	0.822	0.078	0.855	0.016	0.006		

(Contd...)

Table 4: (*Continued*)

	Diagnosis	Motor milestone	GMFCS	Age	Gender	Drooling of saliva	Tooth wearing index	Bruxism	Other oral conditions	Eruption status	DMFT	dft	OHI-S score	MGI score
MGI score														
r	0.24	−0.09	0.41**	0.34**	0.03	0.23	0.34**	0.04	0.22	0.02	0.30*	0.37**	0.97**	
P	0.060	0.481	0.001	0.006	0.846	0.075	0.007	0.741	0.088	0.887	0.018	0.003	0.000	

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed). GMFCS: Gross motor function classification system, OHI-S: Simplified oral hygiene index, DMFT: Decay missing filling-tooth, MGI: Modified gingival index, dft: Decay filling-tooth

Table 5: Significant variables related to CP assessed by dft index based on linear regression analysis

Model	Variables	Unstandardized coefficients	Standardized coefficients	R^2	R^2 change	t	*P*
		B	Beta				
1	(Constant)	3.037		0.216	0.216	4.005	0.000
	Motor milestone	−0.828	−0.465			−2.676	0.013

Dependent variable: Dft. CP: Cerebral palsy, dft: Decay filling-tooth

Table 6: Significant variables related to CP assessed by DMFT index based on linear regression analysis

Model	Variables	Unstandardized Coefficients	Standardized coefficients	R^2	R^2 change	t	*P*
		B	Beta				
1	(Constant)	7.517		0.263	0.263	4.724	0.000
	GMFCS	−0.192	−0.513			−3.275	0.003

Dependent variable: DMFT. CP: Cerebral palsy, GMFCS: Gross motor function classification system, DMFT: Decay missing filling-tooth

best predictor variable for DMFT index, where those children who had self-mobility with limitations or may use powered mobility (Level IV), in addition to those who were transported in a Manual Wheelchair (Level V) were 26.3 times prone to have dental caries (DMFT) than the rest of children.

Furthermore, the effect of each independent variable in relation to CP was assessed by Simplified OHI-S. Out of the 10 variables studied, only one variable was statistically associated with OHI-S. The first best predictor variable for oral hygiene was "GMFCS" as once again those children with Level IV and Level V were 14.7 times prone to suffer from bad oral hygiene more than children who had other levels of GMFCS, Table 7.

Finally, in Table 8, out of the 10 variables studied to detect the effect of each independent variable in relation to CP assessed by MGI, two variables were statistically associated with the manifestation of gingivitis. Again "GMFCS" was found to be the first best predictor variable for MGI index as children with Levels IV and V GMFCS were experiencing severe gingivitis 17.0 times more than children with Levels I, II, and III GMFCS. "Age" constituted the second predictor variable, where older children with Levels IV and V GMFCS were 6.6 times at higher risk of having severe gingivitis than younger children with I, II, and III GMFCS Levels.

Discussion

Several studies associated with dental disease in CP have been done in the west, but till now no studies have been done to evaluate dental problems in CP children in Egypt. The purpose of this study was to assess the oral and dental health status in a group of Egyptian children with CP to explore the oral health status and dental problems of this group of children.

In this study, the percentage of boys with CP was greater than that of girls, which is in accord with the findings of earlier studies.[24,25,39-41] In addition, the present study found a high percentage of children with a high degree of impairment (83.9% spastic quadriplegia), which is comparable to the results of a study carried out in Brazil by Guerreiro and Garcias.[41] This profile of significant motor impairment potentially influenced the poor oral hygiene and severe gingival inflammation of the study sample as well as the presence of dental caries and drooling of saliva. The findings of this study are consistent with the outcome of an epidemiological survey carried out in 14 European countries, in which CP is more prevalent among males, with a superiority of the spastic form of the disease over the other types.[42]

Results of the current study revealed that no maxillofacial defects were found in the participating children; however, a low percentage of the children (19.4%) were suffering from bruxism which is the habitual grinding of teeth that is a common occurrence in people with CP. These results are not in agreement with previous findings in which a high prevalence of bruxism was reported in persons who have CP.[43,44] Moreover, only 14.5% of children had tooth wear

Table 7: Significant variables related to CP assessed by OHI-S index based on linear regression analysis

Model	Variables	Unstandardized Coefficients	Standardized Coefficients	R^2	R^2 change	t	*P*
		B	Beta				
1	(Constant)	0.665		0.147	0.147	2.088	0.041
	GMFCS	0.045	0.382			3.221	0.002

Dependent variable: OHI-S index. CP: Cerebral palsy, GMFCS: Gross motor function classification system, OHI-S: Simplified oral hygiene index

Table 8: Significant variables related to CP assessed by MGI based on linear regression analysis

Model	Variables	Unstandardized coefficients	Standardized coefficients	R^2	R^2 change	t	*P*
		B	Beta				
1	(Constant)	0.680		0.170	0.170	2.267	0.027
	GMFCS	0.046	0.413			3.510	0.001
2	(Constant)	0.132		0.237	0.066	0.351	0.727
	GMFCS	0.040	0.354			3.029	0.004
	Age	0.106	0.264			2.265	0.027

Dependent variable: MGI score, CP: Cerebral palsy, GMFCS: Gross motor function classification system, MGI: Modified gingival index

in the form of dentine exposure >1/3 of the surface. This finding is lower than the findings of previous studies,[45-50] and is higher than that was reported by Alhammad,[51] where only 9.3% of the examined CP Saudi children living in Riyadh had tooth wear. However, the comparison between studies should be explained with concern due to the lack of consistency in diagnostic criteria and age groups. Numerous studies have been performed to detect the prevalence of malocclusion in CP children but with different results. Findings of the current study revealed that only 6.5% of the sharing CP children had malocclusion. These results are lower than the outcomes of Chandna *et al*.,[52] where they found that 70.58% of spastic cerebral palsied children attending the outpatient clinic of the Department of Pedodontics and Preventive Dentistry, Christian Dental College, Ludhiana, India, had Class II malocclusion. In addition, Strodel, 1987,[53] discovered that spastic cerebral palsied children had a greater propensity concerning Class II malocclusion. The most important risk factors related with the severity of malocclusion in CP patients have been ascertained to be mouth breathing, lip incompetence, and long face.[54] In this study, merely 6.5% of the children had anterior open bite, this result is lower than the findings of previous studies conducted by Giménez *et al*.,[55] and Morales-Chávez *et al*.,[56] in which they reported that 62% as well as 30%, respectively, of the studied samples, had anterior open bite. In addition, this outcome is inconsistent with the findings of Carmagnani *et al*.,[48] where they pointed that spastic patients presented with an increased incidence of open bite. The existence of malocclusion, anterior open bite, lip hypotonicity and lingual incompetence complicate lip sealing and transport of the food bolus toward the posterior zone of the oral cavity; as a result, the commencement of swallowing is complicated.[24,57,58] Tahmassebi and Luther[58] have indicated a possible association between lip sealing and the presence of drooling in children with CP attending special schools in the county of Yorkshire. In this work, two-thirds of the contributing CP children were suffering from drooling of saliva, with 22.6% had frequent and severe drooling and 19.4% experienced constant profuse drooling of saliva. Moreover, 32.3% of the participating children had delayed eruption which is coincident with the observations published by Rodrigues dos Santos *et al*.,[24] where they concluded that there was a strong tendency toward delayed eruption of the permanent molars in CP patients in the metropolitan area of Sao Paulo in Brazil.

In this study, caries prevalence comprised 54.8% among the participating children, which is higher than the findings of Chu and Lo,[59] where they noted that a high proportion of decayed teeth (43%) had been left untreated, indicating high caries involvement among Chinese students. In addition, the caries experience in terms of mean dft/DMFT in this study was 2.77 and 1.43, respectively, which is higher than the findings of Chandna *et al*.,[52] where they found that dft/DMFT mean scores were 1.68 and 1.32, respectively. The current results are also higher than that of Chu and Lo,[59] where they reported that the DMFT score in their study was 1.2. The prevalence of high dft/DMFT investigated in cerebral palsied children was referred to the lack of oral hygiene maintenance. Guare Rde and Ciampioni,[13] registered that children Brazilian children with CP had greater prevalence of dental caries in the primary dentition than normal children. On the contrary, Du *et al*.,[50] in their study that conducted in Special Child Care Centers in Hong Kong revealed that children with and without CP had similar caries experiences. Moreover, previous studies declared that CP would lead to abnormal movements of the tongue and facial muscles[25] together with the low salivary flow, pH, as well as buffering capacity,[60] which might intensify the risk for dental caries. Results of the present study revealed that for younger participants "Motor Milestone" affects the

dft score, where those children who were sit supported, had no neck support and those who were stand supported had dental caries 21.6 times more than those children who were sitting and walking alone. Whereas, DMFT score for older children was influenced by "GMFCS," where those children who had Self-Mobility with Limitations or May Use Powered Mobility (Level IV), in addition to those who were transported in a Manual Wheelchair (Level V) were 26.3 times prone to have dental caries than the rest of children. Poor oral hygiene is frequently mentioned as a problem influencing the oral health status of people with CP.[14,16,61] Santos *et al*.,[14] revealed that the more severe the neurological damage is, the more frequent is the incidence of the biting reflex and consequently, the higher is the risk of oral diseases in Brazilian children with spastic CP due to the difficulty to implement adequate oral hygiene. When oral hygiene was assessed, poor oral hygiene, as well as severe gingival inflammation, was a predominant finding in this study, where 53.2% of the contributing children had poor oral hygiene represented through the OHI-S index with an average of 1.60, and 43.6% of them had severe gingival inflammation represented by the MGI index (mean = 1.64). These results are in accord with the findings of a previous study where 40% of the participants had poor oral hygiene.[52] Furthermore, Guare Rde and Ciampioni,[61] registered higher values of GI scores for Brazilian CP children with primary dentition in comparison to normal children. The oral hygiene status of the contributing children in the current study was affected by "GMFCS" as those children with Level IV and Level V were 14.7 times liable to have bad oral hygiene more than children who had other levels of GMFCS. In addition, the gingival condition was influenced by "GMFCS" and "Age" of the participants, as children with levels IV and V GMFCS were suffering from severe gingivitis 17.0 times more than children with Levels I, II, and III GMFCS and older children with Levels IV and V GMFCS were 6.6 times at higher risk of experiencing severe gingivitis than younger children with I, II, and III GMFCS Levels. A possible explanation for this may be that increased severity of the neurological damage in children with CP resulted in higher risk of oral diseases[13,14] and these individuals need to obtain efficient oral hygiene, but they are subjected to restricted oral care.

Conclusion

Based on the findings of the current study, the mainstream of participating children had spastic quadriplegia, less than half of them were sit supported and more than the fifth of the participants had no neck support, with about one-third of the investigated group, had Self-Mobility with Limitations or May Use Powered Mobility (Level IV of GMFCS), followed by those who were Transported in a Manual Wheelchair (Level V). No maxillofacial defects were detected among children, and less than fifth of them were suffering from bruxism, while a small number of children had tooth erosion in the form of dentine exposure >1/3 of the surface. Regarding the other oral conditions, a minority of children had an open bite and developing Class II, heavy food accumulation, history of oral ulcers, and malocclusion. In addition, less than one-third of the contributors were experiencing delayed eruption, and just about one-third of them had no drooling of saliva. On the other hand, more than half of the participants had dental caries with the most affected teeth were the posteriors, lower followed by upper teeth, then the upper anterior teeth and the least affected teeth were the lower anterior. The majority of children possessed poor oral hygiene and severe gingival inflammation. Moreover, children who were sit supported had no neck support and those who were stand supported were suffering from dental caries (dft) more than those children who were sitting and walking alone. Furthermore, those children with Levels IV and V GMFCS were prone to have dental caries (DMFT), susceptible to suffer from bad oral hygiene, and older children experiencing severe gingivitis more than younger ones with I, II, and III GMFCS Levels.

Limitations

- Only children of El-Shatby Hospital were included in the study.
- Only children between 3 and 12 years old were enrolled in the study.

Recommendations

- Increase the awareness of dental professionals concerning this group of children specifically, starting by dental students. This could be achieved through the enrollment of dental students in programs that permit them to visit those children in hospitals, schools, as well as the centers for Children with Special Health Care Needs, so they can be acquainted with their environments, oral and dental health status and treatment needs.
- In addition, advanced training and long-term continuing education programs are recommended for dental professionals and ancillary staff to enhance their dental health awareness for this group of patients.
- Earlier preventive strategies in addition to professional and regular dental care should be incorporated within the framework of dedicated prophylactic and therapeutic programs for patients with CP, as they are a high-risk group for dental caries and periodontal diseases.
- Oral health preventive and therapeutic programs should be offered specifically for preschool children to have an early intervention before the deterioration of their oral and dental health.
- Health education program for the caregivers and parents of these children regarding proper oral hygiene practice and nutrition to take care of their children.
- Further studies should be conducted incorporating children with CP who were not covered in the current work. Children could be recruited from schools, centers for Children with Special Health Care Needs, clinics, as well as from their homes.

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