

## Association between oral health status and type of motor function in children and adolescents with cerebral palsy

Associação entre estado de saúde bucal e tipo de função motora em crianças e adolescentes com paralisia cerebral

Asociación entre el estado de salud bucal y el tipo de función motora en niños y adolescentes con parálisis cerebral

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### **Abstract**

**Objectives:** The aim of the present study was to evaluate oral health and motor function in children and adolescents with cerebral palsy (CP) and determine the perception of caregivers regarding the oral health status of these individuals. **Study Design:** A cross-sectional study was conducted with 35 children/adolescents with CP and their caregivers. A questionnaire was administered to the caregivers addressing the oral health of the individuals with CP. The dmft/DMFT index, visible plaque index, malocclusion, dental age, pH, buffering capacity and flow salivary were determined. Motor function was evaluated using the GMFCS and GMFM-88 instruments. **Results:** A significant association was found between the GMFCS category and malocclusion. The GMFM-88 index was significantly lower in individuals with malocclusion and an altered dental age. Caregivers of quadriplegic individuals (57.1%), wheelchair users (42.9%) and those with more severe gross motor impairment (GMFM-88) reported more oral problems. **Conclusion:** Malocclusion and dental age were associated with motor function in children/adolescents with cerebral palsy. The caregivers of children and adolescents who are quadriplegic, use a wheelchair and have greater impairment regarding gross motor function reported more oral problems.

**Keywords:** Oral health; Motor activity; Cerebral palsy.

### **Resumo**

**Objetivos:** O objetivo deste estudo foi avaliar a saúde bucal e a função motora de crianças e adolescentes com paralisia cerebral (PC); e, verificar a percepção dos cuidadores quanto ao estado de saúde bucal desses indivíduos. **Metodologia:** Foi realizado um estudo transversal com 35 crianças e adolescentes com PC e seus cuidadores. Um questionário foi aplicado aos cuidadores abordando a saúde bucal dos indivíduos sob seus cuidados. Foram determinados o índice ceo-d/CPOD, índice de placa visível, maloclusão, idade dentária, pH, capacidade tampão e fluxo salivar. A função motora foi avaliada por meio da aplicação dos instrumentos GMFCS e GMFM-88. **Resultados:** Houve associação significativa entre GMFCS e presença de maloclusão. Além disso, o índice GMFM-88 foi significativamente menor nos indivíduos que apresentaram presença de maloclusão e idade dentária alterada. Cuidadores de tetraplégicos (57,1%), cadeirantes (42,9%) e indivíduos com maior comprometimento da função

motora grossa (GMFM-88) observaram mais problemas orais. Conclusão: Maloclusão e idade dentária estiveram associadas à função motora. Os cuidadores de crianças e adolescentes tetraplégicos, cadeirantes e com maior comprometimento da função motora grossa observam mais a presença de problemas bucais.

**Palavras-chave:** Saúde bucal; Atividade motora; Paralisia cerebral.

### Resumen

Objetivos: El objetivo de este estudio fue evaluar la salud bucal y la función motora de niños y adolescentes con parálisis cerebral (PC); y, verificar la percepción de los cuidadores sobre el estado de salud bucal de estos individuos. Metodología: Se realizó un estudio transversal con 35 niños y adolescentes con PC y sus cuidadores. Se aplicó un cuestionario a los cuidadores sobre la salud bucal de las personas a su cargo. Se determinó el índice dmft / CPOD, índice de placa visible, maloclusión, edad dentaria, pH, capacidad tamponante y flujo salival. La función motora se evaluó aplicando los instrumentos GMFCS y GMFM-88. Resultados: Hubo una asociación significativa entre GMFCS y la presencia de maloclusión. Además, el índice GMFM-88 fue significativamente menor en los individuos que presentaron maloclusión y alteración de la edad dentaria. Los cuidadores de tetraplégicos (57,1%), usuarios de silla de ruedas (42,9%) y personas con mayor deterioro de la función motora gruesa (GMFM-88) observaron más problemas bucales. Conclusión: La maloclusión y la edad dentaria se asociaron con la función motora. Los cuidadores de niños y adolescentes tetraplégicos, usuarios de silla de ruedas y aquellos con mayor deterioro de la función motora gruesa, observan más la presencia de problemas bucales.

**Palabras clave:** Salud bucal; Actividad motora; Parálisis cerebral.

## 1. Introduction

Cerebral palsy (CP) is a permanent condition resulting from a non-progressive injury of the immature brain that affects posture and movement. This condition may be accompanied by cognition, perception, sensation and behavioral disorders as well as epilepsy and other conditions (Rosenbaum, et al., 2008). The incidence of CP is variable, affecting between 1.5 to 5.0/1000 live births (Paneth, Hong & Korzeniewski, 2006). The multifactor etiology includes maternal infection, prematurity, neonatal anoxia, umbilical cord prolapse, congenital malformation and trauma, which can affect the brain during prenatal, perinatal or postnatal periods (Dougherty, 2009; Peixoto, et al., 2021).

Sensorimotor impairment in individuals with CP leads to partial or complete dependence on caregivers with regards to activities of daily living, such as communication, feeding, mobility, oral hygiene and general hygiene (Abanto, et al., 2014; Cesa, Mota & Brandão, 2020). Caregivers make an important contribution to the rehabilitation process of these patients and receive guidance from healthcare providers regarding conduct that should be adopted on a daily basis (De Camargo & Antunes, 2008)

The literature indicates that children and adolescents with CP are more likely to develop oral problems, the most prevalent of which are dental caries, periodontal disease, bruxism and malocclusion (Abanto, et al., 2012; Abanto, et al., 2014; Ahmad, et al., 2020; Ashiry, Alaki & Nouri, 2016; Cardona-Soria, et al., 2020; Dougherty, 2009) with more severe neurological damage increasing the risk of such problems (Abanto, et al., 2012). Furthermore, there are indications that individuals with CP visit the dentist less often and that treatment is often inadequate, with most appointments for urgent care rather than prevention (Akhter, et al., 2017; Wyne, Al-Hammad & Splieth, 2017).

There is a lack of studies about oral health of patients with CP, while there is expressive growth in the publications about health in individuals with CP (Gutierrez, et al., 2021). The aims of the present study were to evaluate the oral health status of children/adolescents with CP, investigate the perception of caregivers regarding the oral health of these individuals and determine possible associations between the oral conditions encountered and motor impairment.

## 2. Methodology

This study was performed following a methodology adapted from Santos, et al. (2016) and Sinha, et al. (2015).

### **Study design and participants**

A cross-sectional study was conducted involving 35 male and female children and adolescents with CP between two and 18 years of age and their respective caregivers. To establish the sample, telephone contact was made with the guardians of patients treated at the three main reference centers for children and adolescents with CP in the city of Santa Maria, Brazil. Forty-three individuals were recruited, but two declined to participate in the study, three did not attend the evaluations and three did not complete the evaluations. Thus, the final sample was composed of 35 pairs of children/adolescents and caregivers. Data collection was initiated only after the guardians provided signed a statement of informed consent.

### **Instruments and data collection**

Oral health status was determined by a dentist and data related to motor function were collected by a physiotherapist. Prior to the examination, a questionnaire was administered addressing sociodemographic and economic characteristics. The caregivers also answered questions on their perceptions regarding the oral health of the child or adolescent under their care (Adeniyi, Diaku-Akinwumi & Ola, 2016).

### **Oral health status**

A single dentist who had undergone training and calibration exercises performed the evaluations of the oral health status of the children and adolescents. Training and calibration were performed according to the basic manual for epidemiological studies issued by the World Health Organization (World Health Organization, 1997). For the evaluation, the participant was seated in a dental chair under the light of the reflector and the examination was performed with the aid of a number 5 mouth mirror and exploratory probe.

The Decayed, Missing and Filled Teeth (dmft/DMFT) index was recorded (World Health Organization, 1997). Only cavitated lesions were included in the present study. The participants did not receive any professional teeth cleaning prior to the investigation of caries, which constitutes a limitation of the study, as some carious lesions may not have been detected. The dmft/DMFT index was considered high when  $\geq 2$  and low when  $< 2$ .

The visible dental plaque index was determined after drying the dental surfaces and without the aid of any mechanical or chemical disclosing methods. The index was established as a percentage by summing the number of surfaces with visible biofilm divided by the total number of surfaces examined (five per posterior tooth and four per anterior tooth) multiplied by one hundred (Ainamo & Bay, 1975). The plaque index was categorized as  $> 50\%$  or  $< 50\%$ .

Malocclusion was investigated considering the molar relationship, midline deviation, open bite, crossbite, overbite and overjet. Individuals with some malocclusion and those with a class II or III relationship of the first permanent molars or distal primary molar relationship were recorded as having malocclusion (Angle, 1899; World Health Organization, 1987).

Dental age was categorized as normal, delayed or advanced according to the Dental Growth and Development Chart of the American Academy of Pediatric Dentistry (Logan & Kronfeld, 1933). For the purposes of statistical analysis, the delayed and advanced categories were merged into one category denominated "altered".

Saliva was collected two hours after food intake and oral hygiene to avoid the effects of diet and hygiene products and maintain the uniformity of the salivary composition. Non-stimulated total saliva was collected by the same examiner using a special sterile polypropylene tube coupled to the aspirator of the dental equipment (Serratine & Silva, 2008) for five minutes, traversing the entire oral cavity. Salivary pH and buffer capacity were measured one hour after the collection of the sample using a digital pH meter (Digimed®DM22). Prior to analysis, the pH meter was calibrated with standard solutions (pH 7.0 and 4.0), following the manufacturer's instructions. For the evaluation of buffer capacity, 1 mL of saliva was added to a

polypropylene tube containing 3 mL of 5 mM hydrochloric acid (HCl) (Ericsson, 1959). The tube was then capped, shaken for 1 min, uncapped and allowed to stand for 10 min to remove the carbon dioxide released during mechanical stirring. The pH of the solution (saliva plus HCl) was measured again for the determination of salivary buffer capacity. Salivary flow was considered normal when between 0.1 and 0.3 ml/min and high when greater than 0.3 ml/min.

### **Evaluation of motor function**

Motor function was evaluated in large adequately equipped physiotherapy rooms at the three sites selected for data collection. The Gross Motor Function Classification System (GMFCS) and a Gross Motor Function Measure (GMFM-88) were employed for the assessment.

The GMFCS is used to evaluate the severity of neuromotor impairment in individuals with CP based on observations of motor behavior in children and adolescents from less than two years up to 18 years of age. This instrument is divided into five functional levels differentiated by limitations, such as trunk control and gait, adaptation needs and the need for assistive devices for movement. Level I comprises children and adolescents who are able to walk without restrictions; Level II indicates those who are able to walk without the aid of a device; Level III includes those who walk with assistive devices and have limitations regarding community ambulation; Level IV includes individuals with limited mobility who need a wheelchair to move outside their home and in the community; and Level V encompasses patients with self-mobility but with limitations and the need for an assistive device (Chamlian, 2010). For the purposes of statistical analysis, the GMFCS levels were grouped based on the degree of dependence: Levels I and II were grouped into the “independent” category, whereas Levels III, IV and V were grouped into the “wheelchair user” category.

The GMFM-88 scale has a scoring chart for activities and success (or non-success) in the accomplishment of the tasks. This scale is formed by 88 items divided into five dimensions: Dimension A – lying and rolling; Dimension B – sitting; Dimension C – crawling and kneeling; Dimension D – standing up; Dimension E – walking, running and jumping (Chamlian, 2010; Russell, et al., 2000).

### **Statistical analysis**

Descriptive analysis was performed using IBM® SPSS Statistics®, version 23. The normality of the quantitative data was first investigated. For variables with normal distribution, means were compared using parametric tests: t-test or ANOVA. For variables with non-normal distribution, nonparametric tests were used: Mann-Whitney and Kruskal-Wallis tests. For qualitative data, associations were investigated using the chi-square test and Fisher's exact test. Differences were considered significant when the P-value was < 0.05.

## **3. Results**

Thirty-five individuals (20 children and 15 adolescents) with CP were evaluated in the present study. Mean age of the sample was 10 years (SD 5.2). Mean age of the caregivers was 42 years (SD 10.22; range: 24 to 68 years). Table 1 shows the characteristics of study population, including the GMFCS and GMFM-88 results. The largest portion (45.7%) of the individuals with CP was classified on Level V (self-mobility with limitations and need for an assistive device). The majority was quadriplegic (65.7%) and, in terms of muscle tone, the majority was spastic (88.6%).

**Table 1.** Characteristics of Study Population.

<b>Variable</b>	<b>n</b>	<b>%</b>
<b>Sex</b>		
Female	12	34.3
Male	23	65.7
<b>Feeding</b>		
Oral	28	80.0
Tube	7	20.0
<b>Age at diagnosis</b>		
Birth	6	17.1
< 8 months old	13	37.1
≥ 8 months old	16	45.7
<b>Caregivers</b>		
Mother alone	22	62.8
Father alone	3	8.6
Both parents	6	17.1
Grandparents	4	11.4
<b>Income</b>		
Brazilian monthly minimum wage	13	37.1
2 x monthly minimum wage	17	48.6
3+ x monthly minimum wage	5	14.3
<b>Mother's education</b>		
Incomplete Elementary School	10	28.6
Complete Elementary School	7	20.0
Incomplete High School	15	42.8
Complete High School	3	8.6
<b>Motor condition</b>		
Diplegia	5	14.3
Hemiplegia	7	20.0
Quadriplegia	23	65.7
<b>Muscle tone</b>		
Spastic	31	88.6
Ataxic	1	2.9
Mixed	3	8.6
<b>GMFCS</b>		
I	7	20.0
II	2	5.7
III	1	2.9
IV	9	25.7
V	16	45.7
<b>GMFM-88</b>	<b>Mean</b>	<b>SD</b>
GMFM-A	59.0%	34.29%
GMFM-B	48.1%	36.21%
GMFM-C	28.8%	41.05%
GMFM-D	24.2%	42.0%
GMFM-E	23.0%	40.0%
<b>TOTAL GMFM – 88</b>	<b>36.8%</b>	<b>36.54%</b>

Source: Authors.

Table 2 displays the data related to the oral health status. A total of 40% of the children and adolescents had a class II permanent molar relationship, 40% exhibited overjet and 48.6% exhibited anterior open bite. Individual oral hygiene was mainly the responsibility of the mothers (40%).

**Table 2.** Oral Health Status.

<b>Variable</b>	<b>Mean</b>	<b>SD</b>
<b>VPI</b>	46.17	28.56
<b>dmft/DMFT</b>	2.7	3.2
<b>Salivary flow</b>	0.67	0.64
<b>Salivary pH</b>	7.7	0.53
<b>Salivary buffer capacity</b>	4.4	1.2
<b>Types of malocclusion</b>	<b>n</b>	<b>%</b>
<b>Dental age</b>		
Altered	8	22.9
Normal	27	77.1
<b>Midline</b>		
Normal	29	82.9
Deviated	6	17.1
<b>Molar relationship (permanent)</b>		
Class I	7	20.0
Class II	14	40.0
Class III	2	5.7
<b>Molar relationship (primary)</b>		
Flush terminal plane	1	2.9
Mesial step	8	22.9
Distal step	2	5.7
<b>Overbite</b>		
Yes	4	11.4
No	31	88.6
<b>Overjet</b>		
Yes	14	40.0
No	21	60.0
<b>Anterior crossbite</b>		
Yes	2	5.7
No	33	94.3
<b>Posterior crossbite</b>		
Yes	3	8.6
No	32	91.4
<b>Anterior open bite</b>		
Yes	17	48.6
No	18	51.4
<b>Posterior open bite</b>		
No	35	100
<b>With malocclusion</b>	30	85.7
<b>Without malocclusion</b>	5	14.3
<b>Responsible for oral hygiene</b>		
Mother	14	40.0
Father	4	11.4
Grandmother/Aunt or Brother	8	22.9
The individual himself	7	20.0
<b>No presence of hygiene</b>	2	5.7

**VPI: visible plaque index; DMFT: decayed, missing and filled teeth.**

Source: Authors.

Table 3 displays the associations between oral health status and type of motor condition as well as the GMFCS and GMFM-88 results. A significant association was found between the GMFCS category and malocclusion, as malocclusion was found in 71.4% of children and adolescents who required wheelchairs. Furthermore, the GMFM-88 index was significantly higher in individuals with a high DMFT index and significantly lower in individuals with malocclusion and an altered dental age.

**Table 3.** Associations between oral health status and type of motor function, GMFCS and GMFM-88 index.

	Motor function <sup>a</sup>			GMFCS <sup>b</sup>		GMFM-88 <sup>c</sup> %
	Diplegia	Quadriplegia	Hemiplegia	Independent	Wheelchair user	
<b>dmft/DMFT</b> (mean±SD)	3.00±4.20	2.20±2.80	4.57±3.45	4.11±3.37	2.30±3.06	-
<b>dmft/DMFT</b> (severity)						
LOW	-	-	-	-	-	26.48±31.53
HIGH	-	-	-	-	-	50.63±39.19*
<b>Salivary flow</b> (mean±SD)	0.83±0.93	0.70±0.66	0.48±0.28	0.48±0.25	0.75±0.72	-
<b>Salivary flow</b>						
NORMAL	-	-	-	-	-	34.92±34.52
HIGH	-	-	-	-	-	37.49±37.85
<b>pH of saliva</b>	7.68±0.67	7.78±0.54	7.66±0.44	7.66±0.44	7.77±0.56	-
<b>Buffer capacity</b>	4.04±1.28	4.37±1.19	4.84±1.50	4.80±1.31	4.28±1.23	-
<b>VPI</b> (mean±SD)	31.61±34.64	49.22±28.96	46.53±23.15	44.59±23.73	46.71±30.46	-
<b>VPI</b>						
>50%	-	-	-	-	-	38.80±37.90
<50%	-	-	-	-	-	34.80±36.10
<b>Malocclusion n</b> (%)						
YES	4(11.4%)	21(60.0%)	5(14.3%)	5(14.3%)	25(71.4%) *	28.44±30.27*
NO	1(2.9%)	2(5.7%)	2(5.7%)	4(11.4%)	1(2.9%)	65.16±43.50
<b>Dental age</b> <b>n</b> (%)						
NORMAL	5(14.3%)	15(42.9%)	7(20.0%)	9(25.7%)	18(51.4%)	43,96±38,70
ALTERED	0	8(22.9%)	0	0	8(22.9%)	12,78±8,12*

<sup>a</sup>ANOVA; <sup>b</sup>CHI-SQUARE TEST; <sup>c</sup>MANN-WHITNEY U TEST

\*P<0.05

DMFT – decayed, missing and filled teeth

VPI: visible plaque index

Source: Authors.

Table 4 displays the associations between the caregivers' perceptions regarding the oral health status of the individuals with CP and type of motor function as well as the GMFCS and GMFM-88 results. Caregivers of quadriplegic individuals (57.1%), wheelchair users (42.9%) and those with more severe gross motor impairment (GMFM-88) reported more oral problems.

**Table 4.** Associations between caregivers' perception regarding oral health status of individuals with CP and type of motor function, GMFCS and GMFM-88 index.

	Motor function <sup>a</sup>			GMFCS <sup>a</sup>		GMFM-88 <sup>b</sup> %
	Diplegia	Quadriplegia	Hemiplegia	Independent	Wheelchair user	
<b>Perception of oral health problems n (%)</b>						
Yes	0	20(57.1%) *	3(8.6%)	8(22.9%)	15(42.9%)*	27,18±33,15*
No	5(14.3%)	3(8.6%)	4(11.4%)	11(31.4%)	1(2.9%)	55,32±36,89%
<b>Perception of gingival bleeding n(%)</b>						
Yes	2(5.7%)	15(42.9%)	1(2.9%)	9(25.7%)	9(25.7%)	26,37±28,42%
No	3(8.6%)	8(22.9%)	6(17.1%)	10(28.6%)	7(20.0%)	47,91±41,25%
<b>Perception of dental problems n(%)</b>						
Yes	2(5.7%)	18(51.4%)	5(14.3%)	6(17.1%)	19(54.3%)	34,51±35,59%
No	3(8.6%)	5(14.3%)	2(5.7%)	3(8.6%)	7(20.0%)	42,63±40,18%
<b>Classification of oral health n(%)</b>						
Good	4(11.4%)	10(28.6%)	5(14.3%)	7(20.0%)	12(34.3%)	45,87±41,34%
Bad	1(2.9%)	13(37.1%)	2(5.7%)	2(5.7%)	14(40.0%)	26,1%±27,38%

<sup>a</sup>MANN-WHITNEY U TEST; <sup>b</sup>CHI-SQUARE TEST.  
\*P<0.05

Source: Authors.

#### 4. Discussion

The present study evaluated the oral health status of individuals with CP, the perception of their caregivers regarding the oral health of the children/adolescents and whether oral problems were associated with motor impairment. Most children and adolescents evaluated were male, quadriplegic and, in terms of muscle tone, spastic. These results are similar to findings reported in previous studies (Cardoso, et al., 2014; Lemos & Katz, 2016) evaluating children and adolescents with CP.

The mothers, who were the main caregivers, had a low level of education and a family income of less than two times the Brazilian monthly minimum wage, which reflects a low socioeconomic level. Mothers are often given the responsibility for the health of children and adolescents and feel entrusted to take on a more active role in the lives of their children (Lemos & Katz, 2016; Sun, Wong & McGrath, 2017). Although the caregivers did not answer a specific question regarding knowledge on their children's oral health, as in the study by Wyne, Al-Hammad & Splieth (2017), only 5.7% of the children and adolescents analyzed did not receive oral hygiene. This demonstrates that, despite some limitations and difficulties that caregivers may encounter when performing oral hygiene in children/adolescents with CP, there is an awareness of the importance of doing so. This statement is supported by the fact that the DMFT index was within what is recommended by World Health Organization (1997) and the visible plaque index (VPI) was relatively low. However, the VPI should be interpreted with caution when referring to oral hygiene habits, as the gingival bleeding index would provide a more reliable data in this respect. Indeed, Santos, et al. (2016) found a significant association between salivary flow and gingivitis in children with CP performing a periodontal evaluation based on the recommended gingival bleeding index (Loe & Silness, 1963) The lack of such an examination constitutes one of the limitations of the present study. It was not performed due to the low



acceptance by the patients. At any sign of discomfort on the part of the children/adolescents or negative manifestation on the part of the caregivers, the evaluations were immediately interrupted.

A significant association was found between the GMFCS category and malocclusion, indicating that individuals with more severe neuromotor impairment are at greater risk of oral problems (Abanto, et al., 2012). In previous studies involving the evaluation of malocclusion in children and adolescents with CP, 65 to 68% of the population exhibited severe malocclusion, which was attributed to factors such as mouth breathing, sialorrhea, dysphagia, lip incompetence and long face (Guerreiro & Garcias, 2009; Miamoto, et al., 2010). In another study (Al Hashmi, et al., 2017), Angle class II malocclusion was found in 52% of the children and adolescents evaluated, which is close to the proportion found in the present analysis (40%).

No association was found between the GMFCS category (degree of locomotion dependency) and caries experience. This result differs from the finding described in a previous study, in which 41.8% of the individuals classified on Levels I to III of the GMFCS I-III had caries experience vs. 82.6% of those classified on Levels IV and V (Akhter, et al., 2017). However, the method by which the GMFCS was grouped makes it impossible to compare the studies properly. On the other hand, the present result is in agreement with the findings of another study, in which the GMFCS level of the individuals with CP was not significantly associated with the prevalence of caries (Santos, et al., 2010).

In contrast, an association was found between gross motor function evaluated using the GMFM-88 instrument and the DMFT index, as individuals with high caries experience had a higher GMFM-88 score, indicating better motor function. One may therefore initially conclude that less impaired children and adolescents (GMFM-88 scores above 50%) have a higher DMFT index than more impaired individuals (GMFM-88 scores below 50%). However, this difference disappears if only individuals who received oral feeding are considered, as the children and adolescents in the present study who were fed through tubes had no caries experience (DMFT = 0) due to the fact that there was no availability of carbohydrates in the oral cavity. Dental caries is a multifactor disease caused by an imbalance in the demineralization-reminerization process of the enamel due to the accumulation of biofilm and its metabolism. Carious lesions are formed by cariogenic bacteria in the dental biofilm that metabolize fermentable carbohydrates, the main sources of which is diet (Fejerskov, 2004).

Children and adolescents with a lower mean of GMFM-88 score had a high frequency of malocclusion and altered dental age. A recent study (Sinha, et al., 2015) also found that the mean GMFM-88 index was lower among the individuals with malocclusion than those without malocclusion, but the difference was not statistically significant. Ozerovic (1980) reported that CP alters dental and skeletal development and that this strong correlation is found in children with spastic CP. In other study, however, the dental eruption sequence was similar to that found in a population with typical development, occurring earlier in the girls than the boys evaluated (Moslemi, et al., 2013).

In the present study, no associations were found between salivary variables and the type of motor function or the GMFCS and GMFM-88 results. This may be explained by the lack of an association between these factors and dental caries in individuals with oral feeding. Salivary factors, especially buffering capacity, are related to the measurement of caries activity. Moreover, salivary pH and flow appear to influence the susceptibility to caries (Cogulu, et al., 2006; Thaweboon, et al., 2008).

The caregivers of children and adolescents who are quadriplegic, those who use a wheelchair and those with greater gross motor impairment (GMFM-88) reported more oral problems. In the evaluation of motor function, most children and adolescents were classified on Levels IV and V, which denotes greater dependence on another person or caregiver with regards to activities of daily living, such as performing oral hygiene. This result is in agreement with findings described by Dias, et al. (2010), who evaluated children with CP, most of whom had severe spastic quadriplegia and were classified on GMFCS Levels IV and V, indicating complete dependence with regards to eating and personal hygiene. Another study applied questionnaires addressing parents' perceptions regarding the oral health of individuals with CP, showing that a lack of knowledge about

children's oral health is a cause of insecurity among caregivers, as they do not know how to perform their child's oral hygiene properly or experience difficulty due to the child's non-cooperation (Cardoso, Cavalcanti & Padilha, 2011). A greater severity of cognitive impairment makes it more difficult for individuals with CP to express their feelings and communicate discomfort caused by oral problems, which makes caregivers feel that they are obligated to always be alert to any sign of anguish or discomfort (Abanto, et al., 2012; Ashiry, Alaki & Nouri, 2016). Thus, caregivers of children/adolescents who are quadriplegic, use a wheelchair and have greater gross motor impairment report more oral problems.

Studies indicate the need for specific public oral health policies targeting individuals with CP and their caregivers. Thus, caregiver education with regards to oral health should be expanded, which would facilitate the early detection of oral problems and enable early interventions (Alvarenga, et al., 2019; Nqco, et al., 2019).

## 5. Conclusion

In the present study, malocclusion was associated with dependence with regards to locomotion (GMFCS) and the aspect of gross motor function (GMFM-88) in children and adolescents with CP. Moreover, an altered dental age was associated with more impaired gross motor function. Dental caries, visible plaque index and salivary variables were not associated with either the aspect of gross motor function or locomotion dependence. Caregivers of children and adolescents who are quadriplegic, use a wheelchair and have greater gross motor impairment reported more oral problems. There are still few studies in the literature that address aspects of oral health in patients with cerebral palsy. Thus, more high-impact research involving this population is needed.

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