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# Evaluation of the Salivary Parameters (pH, Buffering Capacity and Flow Rate) and Dental Caries Status in Children with Cerebral Palsy: A Case Control Study

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## Abstract

**Background and objectives:** Children with cerebral palsy suffer from oral and dental problems more than healthy children, this may be due to poor motor control of orofacial muscles and bad oral hygiene. The objectives of this study are to measure the salivary parameters, dental caries status, to find any correlation between them, and to compare these data with that of healthy siblings.

**Methods:** In this study, 30 children with cerebral palsy and 30 healthy children selected in Helena Center in Erbil City in Iraq between April and December 2023. Samples of the saliva were collected from both groups, and then salivary parameters (flow rate, pH and buffering capacity) were measured, and dental caries status were examined, and the data were analyzed using the SPSS version 20.

**Results:** Dental caries were significantly higher in the study group, for the primary teeth P-value = 0.035, and for the permanent teeth P-value = 0.005, salivary flow rate and buffering capacity were significantly lower in the study group, P-value = 0.000 for both of them. pH shows no significant difference, P-value = 0.303, significant correlations noted between both the salivary flow rate and the buffering capacity with dental caries in primary dentition in the study group, P-values = 0.015.

**Conclusion:** Low salivary flow rate and buffering capacity in children with cerebral palsy might be risk factors for dental caries, so, these parameters could be used as screening tools for detecting children who are at risk of dental caries.

**Key Words:** Cerebral Palsy, Children, Dental Caries Status, Salivary Parameters

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## Introduction

Abnormalities of motor control caused by damage to a child's brain called Cerebral Palsy (CP). It's first described in 1962 by Sir William John Little.[1] Cerebral means the brain and "Palsy" means movement or posture disturbance. These brain damages occur early in the development course, either in utero, during birth or in the 1st few months of infancy, it causes permanent brain defects, it is the most common congenital physical handicap, (2-2.5 per 1000 live births), with slightly higher incidence among males, with much higher and wider range, 2–10/1000 live births in the developing areas.[2-4] There are 4 main types of cerebral palsy, spastic, athetoid, ataxic, and mixed, and many sub types.[3] It is caused by trauma, hypoxia, infections, hyperbilirubinemia, or idiopathic. Children with CP suffer from many problems and potential disabilities such as mental retardation, epilepsy, vision and hearing impairments.[1] CP patients suffer from oral and dental problems more than healthy children, especially spastic quadriplegic patients, so, they need extra dental care from simple daily dental care by parents or caregivers, to dental procedures done by professionals under local anesthesia, sedation, or general anaesthesia.[5-9] So, early dental caries screening and preventive measures are needed in this subtype of children.[10] The physical and chemical properties of the saliva may play a significant role in the dental caries status, saliva is a potential source of clinical information because it's an "ultra-filtrate" of blood, so the salivary parameters can mirror the pathological status of the person, salivary parameters (pH, flow rate and buffering capacity) are clinically useful indicators of dental caries.[11, 12] Dental caries is a multi-factorial infectious disease caused by complex interactions between acid-producing bacteria, fermentable carbohydrates and many host factors including saliva.[13] The management of CP patients includes not only the prevention and treatment of dental caries, but also identification and assessment of the associated risk factors.[10, 14] The pH determines the degree of acidity of the saliva in which (7) is regarded as neutral, lower than (7) is regarded as acidic and above (7) is regarded as alkaline. In the oral cavity, the saliva acts by maintaining the pH near neutrality (6.7-7.3) by the buffer contents.[15] Buffering capacity of saliva is the ability to resist changes in pH caused by bacteria. Salivary flow rate is the amount of saliva in ml/min, for unstimulated saliva it's about 0.3-0.6 ml/min.[16] Saliva plays important roles in maintaining oral and dental health, by cleaning teeth, protecting against abrasion and attrition, decreasing demineralization, increasing remineralization, neutralizing acids, and defending from oral infection.[17] The objectives of this study are to measure the salivary parameters, dental caries status, to find any correlation between them, and to compare these data with that of healthy siblings.

## Patients and methods

This case-control study was performed on children with cerebral palsy who had received physical therapy and rehabilitation in Helena Health Center for children with special needs in Erbil City in Iraq between April and December 2023. The research protocol was approved by the ethical committee of the Kurdistan Higher Council of Medical Specialties prior to the study; all patients were provided with and signed informed consent form by their parents or caregivers. Inclusion criteria involved CP children between (6 and 12) years old who had attended the center between April to December 2023, and who have siblings of the same age ranges. Exclusion criteria involved CP children or parents who refused, cases with severe disabilities due to difficulty in taking salivary samples, cases without


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siblings, and those out of this age range. Sixty children were included in this study, thirty non-institutionalized C.P. children between (6 and 12) years old as (study group), and their (30) healthy siblings of the same age range as an ideal (control group). All examinations were done in Helena Center in the same manner by the same examiner on the dental chair by using a mouth mirror, a blunt explorer probe with good illumination under universal infection control. The participants were fasted from food for at least 12 hours to get salivary samples free of food particles that may affect the pH, and from water for 1 hour to get unstimulated pure salivary samples. The participants were sat in a relaxed position in a good ventilated room. The dental caries status was assessed by using the dental caries prevalence index (DMFT) decade, missed, and filled permanent teeth, and (dft) decade and filled deciduous teeth. The salivary samples were collected from 9 to 11 am. Unstimulated whole saliva was collected by using suction method. The samples for the control group were collected in the same manner to decrease bias as much as possible. Graduated sterile glass tubes were used for collection of the samples. The flow rate was calculated by dividing the amount of collected saliva by the time, so the results were in ml/min.[13] The samples were examined in the laboratory of quality control of drugs in Erbil city. In the laboratory calculation of pH was done using (METTLER TOLEDO)" Switzerland" pH meter. The buffering capacity was measured by a quantitative method, which includes addition of 10 microliters of 0.1 N of HCL to the saliva sample, then a stream of pure nitrogen gas (0.5L/min) was passed through the mixture for 10 min for degassing (elimination of Co2), then pH1 is calculated and this step is repeated 6 times to reach pH6, then (delta pH) was calculated by dividing the sum of the changes in pH/5. Buffering capacity was calculated by ((BC=N(HCL)/Delta pH)), BC=Buffering Capacity, N=no. of moles of HCL.[18] Data were analyzed using the SPSS version 20. Independent *t* test was used to compare the means of caries indices (DMFT and dft) and the salivary parameters of both groups. Pearson's correlation was used to determine the relation between caries status and salivary parameters in CP children, p-value was regarded as significant at the ($P<0.05$) level.

## Results

Thirty cases of cerebral palsy aged between (6 and 12) years old (18 males and 12 females), and (30) siblings of the cases as control group (18 males and 12 females) of the same age range were examined. The mean of dft in the cases is 4.63, and in the control is 2.9, P-value = 0.035 which is statistically significant, the mean of DMFT in the cases is 3.13, and in the control is 1.30, P-value = 0.005 which is statistically highly significant, the mean of pH in the cases is 7.05, and in the control is 7.17, the P-value is 0.303, which is statistically not significant. The mean of buffering capacity in the cases is 8.60, and in the control is 11.51, P-value = 0.000 which is statistically highly significant. The mean salivary flow rate in cases is 0.19, and in the control is 0.35, P-value = 0.000 which is statistically significant too, as shown in Table (1). A significant two-tailed correlation are seen between the salivary flow rate and the buffering capacity with the dental caries in the primary teeth (dft) of cases, the P-values are 0.015 in both of them. The pH shows no significant correlations with the dental caries as shown in Table (2).


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**Table (1):** Comparison of dental caries status and salivary parameters between the 2 groups.

| Variables | | Group | N | Mean | Std. Deviation | t | P |
|---|---|---|---|---|---|---|---|
| Dental Caries | dft | Case | 30 | 4.63 | 3.577 | 2.157 | .035* |
| | | Control | 30 | 2.90 | 2.564 | | |
| | DMFT | Case | 30 | 3.13 | 3.126 | 2.942 | .005* |
| | | Control | 30 | 1.30 | 1.368 | | |
| Salivary Parameters | pH | Case | 30 | 7.05 | .435917 | -1.039 | .303 |
| | | Control | 30 | 7.17 | .415282 | | |
| | Buffering capacity | Case | 30 | 8.60 | 1.735447 | -5.756 | .000* |
| | | Control | 30 | 11.51 | 2.153490 | | |
| | Flow rate | Case | 30 | .19 | .10884 | -4.402 | .000* |
| | | Control | 30 | .35 | .16965 | | |

* P-Value. is significant at the 0.05 level.

**Table (2):** Correlation between the dental caries and the salivary parameters in CP children.

| Variables | | Correlation | dft | DMFT | pH | B. Capacity | Flow rate |
|---|---|---|---|---|---|---|---|
| Dental Caries | dft | Pearson Correlation | 1 | -.406 | -.212 | -.439 | -.441 |
| | | Sig. (2-tailed) | | .026 | .262 | .015* | .015* |
| | | N | 30 | 30 | 30 | 30 | 30 |
| | DMFT | Pearson Correlation | -.406 | 1 | .139 | .254 | -.025 |
| | | Sig. (2-tailed) | .026 | | .462 | .175 | .894 |
| | | N | 30 | 30 | 30 | 30 | 30 |
| Salivary Parameters | pH | Pearson Correlation | -.212 | .139 | 1 | .086 | -.212 |
| | | Sig. (2-tailed) | .262 | .462 | | .653 | .261 |
| | | N | 30 | 30 | 30 | 30 | 30 |
| | Buffering capacity | Pearson Correlation | -.439 | .254 | .086 | 1 | -.099 |
| | | Sig. (2-tailed) | .015* | .175 | .653 | | .602 |
| | | N | 30 | 30 | 30 | 30 | 30 |
| | Flowrate | Pearson Correlation | -.441 | -.025 | -.212 | -.099 | 1 |
| | | Sig. (2-tailed) | .015* | .894 | .261 | .602 | |
| | | N | 30 | 30 | 30 | 30 | 30 |

## Discussion

There is a controversy in the previous studies about the dental caries status and the salivary parameters in children with Cerebral Palsy.[2] These controversies may be due to non-standardized selection criteria, lack of suitable control groups and socioeconomic factors.[14, 19] The CP children suffer from dental caries more than healthy children.[7] Many factors affect the dental caries status in children with Cerebral Palsy, poor motor control of orofacial muscles, bad oral hygiene, types of food, habits like mouth breathing, the presence of fluoride in water, the amount and composition of the saliva, types and amount of oral bacteria, and many other factors.[6, 9, 20] This study has focused on some of the salivary parameters (pH, flow rate and buffering capacity) that may affect the dental caries status in CP children.


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Because there are no institutions for patients with Cerebral Palsy in Erbil City, thirty non institutionalized CP children that attend Helina center at the time of data collection were selected according to the criteria that determined for this study (age range, and having healthy siblings) as a study-group, and their 30 normal siblings as an ideal control-group to decrease the factors that may affect the dental caries like diet, socio economic status, life style, and parent's knowledge about the oral and dental health of their children. The dental caries status was assessed by using the dental caries prevalence index which is recommended by the WHO, (DMFT) which represents decayed, missed, and filled permanent teeth, and (dft) representing decayed and filled primary teeth only, which is accepted by the WHO more than (dmft) because of the normal exfoliation time of deciduous teeth in this age range, and there are no documentations that if the teeth were lost due to caries or due to normal physiological exfoliations.[21] Salivary samples were collected by using the suction method, because most of the CP children cannot control their orofacial muscles for passive drool method.[12] This study found a higher dental caries prevalence (both dft and DMFT) in Cerebral Palsy group than in the control group, both are statistically significant, these are similar to Dos Santos et al., Cardoso, et al., Sedki et al., and Dougherty et al., studies.[5, 8, 10, 22] But in Anjugam et al., study, there was only higher dft.[23] Other studies are mentioned that there are no significant differences between the CP children and controls in regard to dental caries status, like in Roberto et al., Alhammad et al., Ruiz et al., Quintella et al., De Carvalho et al., and Al Allaq et al., studies.[20, 24-29] These differences may be due to the age range group, sample size, socioeconomic status, severity of the cases, and the fact that in some countries the CP children were treated in rehabilitation centers or institutions which are providing constant preventive care and healthy diet that could also be a factor in the low dental caries scores obtained by some previous studies.[6] Many earlier studies mentioned that the poor oral hygiene, dental erosion and dental trauma in CP children were common, possibly making their teeth more prone to dental caries in the mixed dentition stage.[18] The present study was focused on the salivary parameters (pH, buffering capacity, and flow rate) that may have greater effects on the dental caries status in this children subgroup. In the present study the mean pH of the study group was slightly lower than that of the control group, which is statistically not significant, it is similar in this point to Shapira et al. study.[30] But it disagrees with Dos santos et al., Anjugam et al., and Radha et al., studies.[5, 23, 31] This may be due to the method by which the pH was calculated, in most of old studies they used pH indicator strips, but in this study a special electronic pH meter was used which is more accurate. This study found a lower salivary flow rate in the study group than in the control group, which is statistically highly significant and this agrees with Quritum et al., Dos santos et al., Anjugam et al., and Deniz et al., studies.[2, 5, 23, 32] But it disagrees with Subramaniam et al., and Erasmus et al., studies.[14, 33] These differences may be due to different saliva collection methods, uncooperative cases, type of the saliva (unstimulated whole saliva is used in this study).[11] Also, in this study the buffering capacity in the study group was lower than that of the control group, which is statistically highly significant, and this agrees with Quritum et al., Dos Santos et al., Leone et al., studies.[2, 5, 11] But not with Subramaniam et al., and Anjugam et al., studies.[14, 23] This may be due to the differences in the method of calculation the buffering capacity, type of saliva (stimulated or unstimulated), and using the electronic pH meter instead of pH


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indicator strips. The buffering capacity is more useful measure than the pH to detect the ability of the saliva to resist teeth demineralization due to its ability to resist change in pH, because the pH of the saliva may be influenced by the type, frequency, and timing of food intake.[34] In table (2) Pearson's correlation between the salivary parameters and dental caries status shows a significant two-tailed correlation between the salivary flow rate and dental caries in primary teeth (dft) of CP children , so it agrees in this point with Quritum et al., and Anjugam et al., studies.[2, 23] Also a significant correlation observed between the buffering capacity and dental caries in primary teeth (dft) of CP children, and agrees in this point with Quritum et al., study, but not with Anjugam et al., study.[2, 23] The pH shows no significant correlation with the dental caries, many factors might affect these differences like no. of cases, age ranges, and severity of the cases.[35]

## Conclusion

Children with cerebral palsy suffer from dental caries more than their healthy siblings. Low salivary flow rate, and buffering capacity might act as risk factors for dental caries in children with cerebral palsy. Both the salivary flow rate and the buffering capacity could serve as tools for caries risk assessment in children with cerebral palsy.

## Conflicts of interest

No conflict of interest to report.

## References

1. Jan MM. Cerebral palsy: comprehensive review and update. Ann Saudi Med. 2006;26(2):123-32.
2. Quritum SM, Ali AM, Raouf MM, Omar TE, Dowidar KM. Evaluation of salivary parameters and Streptococcus' Mutans count in children with cerebral palsy in Egypt: a case control study. BMC Oral Health. 2022;22(1):411.
3. Wasnik M, Chandak S, Kumar S, George M, Gahold N, Bhattad D. Dental management of children with cerebral palsy-a review. J Oral Res Rev. 2020;12(1):52-8.
4. Reid SM, McCutcheon J, Reddihough DS, Johnson H. Prevalence and predictors of drooling in 7-to 14-year-old children with cerebral palsy: a population study. Dev Med Child Neurol. 2012;54(11):1032-6.
5. dos Santos MT, Masiero D, Simionato MR. Risk factors for dental caries in children with cerebral palsy. Spec Care Dentist. 2002;22(3):103-7.
6. da Rocha DM, Andrade PM, Ramos ML, Moreira RN, Oliveira F. Association between executive/attentional functions and caries in children with cerebral palsy. Res Dev Disabil. 2013;34(9):2493-9.
7. Ilhanli M, Ilhanli L, Celenk P. Cerebral palsy and oral health. Int J Clin Exp Med. 2022;39(4):1283-93.
8. Sedky NA. Assessment of oral and dental health status in children with cerebral palsy: An exploratory study. J Contemp Dent. 2017;7(1):1-11.
9. Vandal VB, Noorani H, Shivaprakash P, Walikar BN. Salivary lead concentration in dental caries among normal and children with cerebral palsy. JISPPD. 2018;36(4):381-5.
10. Cardoso AM, Gomes LN, Silva CR, de Soares R, De Abreu MH, Padilha WW. Dental caries and periodontal disease in Brazilian children and adolescents with cerebral palsy. Int J Environ Res Public Health. 2015;12(1):335-53.
11. Leone CW, Oppenheim FG. Physical and chemical aspects of saliva as indicators of risk for dental caries in humans. J Dent Educ. 2001;65(10):1054-62.
12. Bellagambi FG, Lomonaco T, Salvo P, Vivaldi F, Hangouët M, Ghimenti S. Saliva sampling: Methods and devices. An overview. TrAC, Trends Anal Chem. 2020;124:115781.


https://doi.org/10.56056/amj.2025.414

13. Guo L, Wenyuan S. Salivary biomarkers for caries risk assessment. J Calif Dent Assoc. 2013;41(2):107-18.
14. Subramaniam P, Babu KG, Rodriguez A. Relation of salivary risk factors to dental caries in children with cerebral palsy. J Clin Pediatr Dent. 2010;34(4):355-60.
15. Baliga S, Muglikar S, Kale R. Salivary pH: A diagnostic biomarker. J Indian Soc Periodontol. 2013;17(4):461.
16. Heintze U, Birkhed D, Björn H. Secretion rate and buffer effect of resting and stimulated whole saliva as a function of age and sex. Swed Dent J. 1983;7(6):227-38.
17. Bansode PV, Pathak SD, Wavdhane M, Birage PP. Salivary biomarkers of dental caries-A review article. J Dent Med Sci. 2018;17(3):12-8.
18. Ericson D, Bratthall D. Simplified method to estimate salivary buffer capacity. Eur J Oral Sci. 1989;97(5):405-7.
19. Botti RS, Masiero D, Novo NF, Simionato MR. Oral conditions in children with cerebral palsy. J Dent Child. 2003;70(1):40-6.
20. Roberto LL, Machado MG, Resende VL, Castilho LS, Abreu MH. Factors associated with dental caries in the primary dentition of children with cerebral palsy. Braz Oral Res. 2012;26:471-7.
21. Weckwerth SA, Weckwerth GM, Ferrairo B, Chicrala GM, Ambrosio AM, Toyoshima GH. Parents' perception of dental caries in intellectually disabled children. Spec Care Dentist. 2016;36(6):300-6.
22. Dougherty NJ. A review of cerebral palsy for the oral health professional. Dent Clin North Am. 2009;53(2):329-38.
23. Anjugam P, Mathian VM, Gawthaman M, Vinod S, Devi EY. Salivary biomarker levels and oral health status of children with cerebral palsy and their healthy siblings: a comparative study. Rambam Maimonides Med J. 2021;12(2).
24. Du RY, McGrath C, Yiu CK, King NM. Oral health in preschool children with cerebral palsy: a case–control community-based study. Int J Paediatr Dent. 2010;20(5):330-5.
25. Alhammad NS, Wyne AH. Caries experience and oral hygiene status of cerebral palsy children in Riyadh. Odontostomatol Trop. 2010;33(130):5-9.
26. Ruiz LA, Diniz MB, Loyola JP, Habibe CH, Garrubbo CC. A controlled study comparing salivary osmolality, caries experience and caries risk in patients with cerebral palsy. Med Oral Patol Oral Cir Bucal. 2018;23(2):e211.
27. Quintela L, Alfredo L. Experience of caries in patients with cerebral palsy. Rev Gaucha Odontol. 2011;59:387-95.
28. de Carvalho RB, Mendes RF, Prado RR, Neto JM. Oral health and oral motor function in children with cerebral palsy. Spec Care Dentist. 2011;31(2):58-62.
29. Al-Allaq T, DeBord TK, Liu H, Wang Y, Messadi DV. Oral health status of individuals with cerebral palsy at a nationally recognized rehabilitation center. Spec Care Dentist. 2015;35(1):15-21.
30. Shapira J, Stabholz A, Schurr D, Sela MN, Mann J. Caries levels, Streptococcus mutans counts, salivary pH, and periodontal treatment needs of adult Down syndrome patients. Spec Care Dentist. 1991;11(6):248-51.
31. Radha G, Swathi V, Jha A. Assessment of salivary and plaque pH and oral health status among children with and without intellectual disabilities. JISPPD. 2016;34(3):257-61.
32. Diniz MB, Guaré RO, Ferreira MC, Santos MT. Does the classification of cerebral palsy influence caries experience in children and adolescents? Braz J Oral Sci. 2015;14:46-51.
33. Erasmus CE, Van HK, Rotteveel LJ, Jongerius PH, Van Den Hoogen FJ, Roeleveld N. Drooling in cerebral palsy: hypersalivation or dysfunctional oral motor


https://doi.org/10.56056/amj.2025.414


control Dev Med Child Neurol. 2009;51(6):454-9.
34. Dowd FJ. Saliva and dental caries. Dent Clin North Am. 1999;43(4):579-97.
35. Bensi C, Costacurta M, Docimo R. Oral health in children with cerebral palsy: A systematic review and meta-analysis. Spec Care Dentist. 2020;40(5):401-11.


https://doi.org/10.56056/amj.2025.414