Association of Nutritional Status on Salivary Flow Rate, Dental Caries Status and Eruption Pattern in Pediatric Population in India

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Abstract

Aims: The purpose of the study was to assess the effect of nutrition on salivary flow rate (SFR) (unstimulated and stimulated), dental caries status, and eruption pattern in healthy and malnourished children. Materials and Methods: The study participants were categorized into healthy (Group I, n = 37) and malnourished groups (Group II: Maltfnourished height-for-age [n = 30] and Group III: Maltfnourished weight-for-age [n = 30]) as per classification of chronic malnutrition. SFR, dental caries status, and eruption pattern were noted for all groups. Statistical Analysis: Analysis of variance (ANOVA) was used to analyze the differences in unstimulated and stimulated SFR and dental caries among three groups. The lowest square difference was used for post hoc comparison and Pearson’s correlation to investigate the association between SFR and dental caries. The statistical significance was set at P < 0.05. Results: The unstimulated SFR values were found to be 0.53 ± 0.15 ml/min (Group I), 0.14 ± 0.04 ml/min (Group II), and 0.21 ± 0.20 ml/min (Group III). For stimulated SFR, the values were 1.94 ± 0.44 ml/min (Group I), 1.17 ± 0.48 ml/min (Group II), and 1.07 ± 0.52 ml/min (Group III). Dental caries status was recorded to be 2.43 (Group I), 6.4 (Group II), and 4.66 (Group III). The participants with delayed eruption pattern were 8.10%, 23.30%, and 16.60% for Group I, Group II, and Group III, respectively. Conclusion: The values for unstimulated and stimulated SFR were significantly less, but dental caries status and delayed eruption were found to be more in malnourished groups as compared to the normal group.

Keywords: Dental caries, eruption pattern, malnutrition, salivary flow rate

INTRODUCTION

Marginal nutritional status during infancy and early childhood adversely affects various aspects of growth and development. Malnutrition is a general term for a medical condition caused by an improper or insufficient diet. It is most often referred to as undernutrition resulting from inadequate consumption, poor absorption, or excessive loss of nutrients, but the term can also encompass overnutrition due to overeating or excessive intake of specific nutrients. It continues to be a major health burden in developing countries and globally the most important risk factor for illness and death, with hundreds of millions of pregnant women and young children particularly affected. Stunting has been diagnosed as the most common cause of malnutrition. The national family health survey in India reported the prevalence of underweight in children younger than 3 years in 2005–2006 to be nearly 46%, a figure representing a marginal decline from the rates recorded in 1992–1993 (51%) and 1998–1999 (47%). Malnutrition can be diagnosed by anthropometric (height and weight) measurements and physical examination, with weight-for-age being the most widely used index for assessment of undernutrition in clinical practice and the only one used by integrated child development services program in India.

Although a number of studies have been done to evaluate the effect of various parameters such as socioeconomic status, malocclusion, brushing frequency, and fluoride exposure on caries status, literature search has revealed very few studies

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that quote the relationship between height, weight, salivary flow rates (SFR), eruption status, and dental caries. Hence, in the present study, we have evaluated the association of height and weight with SFR (unstimulated and stimulated), dental caries, and eruption pattern in children residing in rural Gurgaon, Haryana, India.

**Materials and Methods**

Permission to undertake the study was obtained from the Institution’s Ethical Committee. School children from various government and private schools in the rural area around the dental college premises were included in the sample. Consent forms were signed by parents or legal guardians, before the patient enrolment in the study.

**Subjects**

Three hundred and sixty-three participants within the age range of 5–12 years, comprising of 192 boys and 171 girls attending the government and private schools, were included in the study. All children were randomly screened for dental caries and height and weight measurements. Teeth erupted in the oral cavity were also noted down. Inclusion criteria included children of both sexes between the age group of 5 and 12 years, with defined date of birth and attending private and government schools around the college premises. Children with any systemic or nervous illness or under any medication or having symptoms of dry eyes or mouth were excluded from the study.

**Study design**

The study was conducted in two phases; in the first phase, all 363 children were evaluated for the caries status, eruption status, and height–weight measurements. Out of these, parents of only 97 children consented for salivary sample collection. These children were further classified into two groups – nutritionally healthy and malnourished children – depending on the comparison of their anthropometric measures (height-for-age and weight-for-age) with average values given by the Indian Council of Medical Research (ICMR) for specific age and sex. In the second phase, SFRs (both unstimulated and stimulated) were estimated for the selected children (n = 97).

**Data collection**

The dental caries status was noted for deciduous decayed, missed and filled teeth (dmft) and permanent teeth using the WHO criteria (revised 2003). Dental explorer was used for detecting the cavities on proximal surfaces. Proximal surface decay was recorded if marginal ridge showed darkening/shadowing as evidence of caries of dentine, or if caries in dentine was visual as a loss of translucency producing a shadow in a calculus-free and stain-free proximal surface. The decayed component also included the arrested caries of dentine with hard, smooth, and “nonsticky” surface. Tooth filled due to decay was recorded when a tooth had one or more permanent restorations placed to treat cavies. Fissure sealants were not included in the F component of the DMFT index unless there were signs of cavity preparation. If the same tooth had both a filling and a fissure sealant, the filling was counted. The missing component was recorded when a tooth had been extracted due to pathology.[3] Dental caries status was recorded by two calibrated examiners. During the calibration process, repeated examination of 38 participants was carried out. The interexaminer and intraexaminer repeatability for the DMFT scores exceeded 80% agreement.

For the estimation of dental age, all teeth clinically present in the oral cavity were noted and compared to the dental eruption charts.[4] The last erupted tooth was noted and compared to the chronological charts. Weight and height measurements were taken for each child dressed in light clothes and no shoes.[3]

Height was measured using nonstretch inch tape and weight was measured using the standard weighing machine after calibration. All measurements were taken at least twice and the average was computed.[6] Nutritional status of the participant was evaluated using ICMR charts on average height and weight for girls and boys.

Three hundred and sixty-three children were classified into various categories as per the following classification for chronic malnutrition [Table 1].[7]

**Categorization of subjects**

All participants were divided into normal, mild, moderate, and severe categories of malnutrition, both for weight-for-age and for height-for-age. The participants falling into a normal-to-mild category, for both weight-for-age and height-for-age, were considered as control/healthy group and those having moderate-to-severe chronic malnutrition were considered as test/malnourished group. Hence, we had two main groups: healthy group and malnourished group. The malnourished group was further categorized as height-for-age and weight-for-age malnutrition. In total, we had three groups.

Group I: Control/normal children – This group consisted of 37 children with weight ranging from 75% to >90% and height ranging from 90% to >95% of the average ICMR weight and height values for their age.

Group II: Malnutrition children (height-for-age) – This group consisted of 30 children who had height ranging from <85% to 90% of the average ICMR height values for their age.

Group III: Malnutrition children (weight-for-age) – This group consisted of 30 children who had weight ranging from <60% to 75% of the average ICMR weight values for their age.

**Table 1: Criteria for chronic malnutrition**

|                  | Severe | Moderate | Mild   | Normal |
|------------------|--------|----------|--------|--------|
| Weight-for-age   | <60%   | 60%<75%  | 75%-90%| >90%   |
| (Gomez et al., 1955) |       |          |        |        |
| Height-for-age   | <85%   | 85%-<90% | 90%-95%| >95%   |
| (Waterlow, 1976)  |       |          |        |        |

All these percentages are in reference to ICMR average values. ICMR: Indian Council of Medical Research.
Thus, there were a total of 97 children, for whom SFR was measured. The parental consent was taken for the same.

**Salivary flow rate estimation**

Both unstimulated and stimulated SFR were measured. For this, two sessions were conducted: orientation and testing sessions. Saliva was collected between 9.00 am and 1.00 pm[7] by spitting method by making the patient sit in coachman position.[8] The stopwatch was set for 5 min and the participant was asked to collect saliva in his/her mouth and then spit into a graduated test tube every 60 s. For measurement of stimulated SFR, the participants were made to chew on 1 g piece of paraffin wax (mechanical stimulation) for 5 min and spit every 30 s. The participant was asked not to eat anything 1 h before saliva sample collection. The SFR was calculated by dividing the volume of saliva collected in the test tube by the time taken for saliva collection.

**Statistical analysis**

Data were collected and entered into Statistical Package for Social Sciences (SPSS for Windows, version 17.0, IBM SPSS) software. Histograms and box plot diagrams were used to show the distribution of DMFT score, unstimulated and stimulated SFR of all three groups in the study sample and pie chart to show the percentage of delayed eruption in the three groups in our study. Descriptive statistics such as mean, standard deviation, and frequency distribution were also calculated in data analysis. Confidence intervals were calculated for DMFT scores and SFR for all the three groups. The percentage of participants having delayed eruption was compared by Chi-square test. One-way ANOVA test was used to test the difference in means of DMFT and unstimulated and stimulated SFR in the three groups. Multiple comparison between the means of DMFT and stimulated and unstimulated SFR was done by Bonferroni test.

**Results**

A total of 363 children aged 5–12 years were screened for dental caries, height, and weight. Of these 192 were males and 171 were females. The percentage distribution of these children into normal, mild, moderate, and severely malnourished children is given in [Table 2]. Results of **post hoc** test (Bonferroni) showed that the mean difference of stimulated SFR between Group I and Group II and Group I and Group III was 0.77 and 0.21 ml/min for Group II (malnourished height-for-age) and Group III (malnourished weight-for-age), respectively. The range is from 0.06 to 1.06 ml/min. Flow rates have been found to be decreased in malnourished groups, that is, 0.14 ml/min and 0.21 ml/min for Group II (malnourished height-for-age) and Group III (malnourished weight-for-age), respectively. The range is from 0.06 to 0.28 ml/min in Group II and 0.06–1.06 ml/min in Group III. However, there can be a variation in between the studies as the children might have difficulty during the sialometry procedures and values of SFR can vary. No author has tried to establish a normal parameter for SFR in the children population as there is for adults.

For unstimulated SFR, mean differences between Group I and Group II and Group I and Group III were 0.39 and 0.32, respectively, which were highly statistically significant with \( P = 0.001 \). Moreover, the mean differences of dental caries between Group II and I and Group III and Group I were 3.97 \( (P = 0.001) \) and 2.23 \( (P = 0.013) \), respectively, which were highly significant. The percentage of participants having delayed eruption in three groups was nonsignificant \( (P > 0.1) \) with Pearson Chi-square value of 2.986. The results are summarized in graphs [Graphs 1–5].

**Discussion**

Saliva is a complex biological fluid composed of enzymes, hormones, antibacterial constituents, and electrolytes as well as the compounds transported from the blood. Thus, it reflects the physiological state of the body including hormonal, nutritional, and metabolic disturbances.[9] Saliva has a very important role to play in the mechanism of dental caries and increasing the SFR potentially increases protection against caries lesion development.[10]

The unstimulated and stimulated SFR vary among different populations,[11,12] age group,[13,14] and different climatic conditions.[14] The average value of unstimulated SFR for the general population is 0.3–0.5 ml/min.[15,16] For children, it ranges from 0.22 to 0.82 ml/min. The values in our study are also similar and in the same range as the above values. Unstimulated SFR is 0.53 ml/min in Group I (Normal) and ranges from 0.24 to 1.0 ml/min. Flow rates have been found to be decreased in malnourished groups, that is, 0.14 ml/min and 0.21 ml/min for Group II (malnourished height-for-age) and Group III (malnourished weight-for-age), respectively. The range is from 0.06 to 0.28 ml/min in Group II and 0.06–1.06 ml/min in Group III. However, there can be a variation in between the studies as the children might have difficulty during the sialometry procedures and values of SFR can vary. No author has tried to establish a normal parameter for SFR in the children population as there is for adults.[17]
The finding of significantly decreased stimulated SFR in malnourished groups has been found to be consistent with studies done by other authors.[12] These authors reported that secretion rate of stimulated and unstimulated saliva was significantly reduced in chronic protein energy malnutrition. In our study, both stimulated and unstimulated SFRs were statistically significantly decreased in malnourished Groups II and III as compared to nutritionally healthy children. Stimulated SFR was least (1.07 ml/min) in Group III, that is, malnourished weight-for-age, followed by Group II (1.17 ml/min), and maximum for Group I (1.94 ml/min). A similar result was quoted in another study in rural Haitian children that measured SFR and pH and found that both stimulated and unstimulated SFR decreased in malnourished children.[13]

Comparing the dmft/DMFT score in various groups, it was found that Group II (6.40 ± 4.2) had the highest mean caries score followed by Group III (4.66 ± 3.38) and least in Group I (2.43 ± 3.18). It can be interpreted that malnourishment during developmental stage has an influence on the salivary gland functioning and hence on flow rates. This finding can be supported by another investigation[12] which documented that chronic malnutrition in growing children enhances the cariogenic potential stemming from fermentable carbohydrates. Chronically malnourished children (stunted) show a delay in tooth development when compared to normal children but also show a significantly higher percentage of carious teeth. Nutritional injury during the 1st year of life, when primary teeth are being formed, could affect tooth mineralization. A recent study in elementary school children in Germany found a positive correlation between weight and caries experience. However, other studies have described an inverse relationship between them.[18] In another study, a negative relationship between nutritional status and dental caries was seen. Thin and normal weight school children had a higher risk of having DMFT of at least 1 compared to overweight and obese children.[19] A similar result was quoted by Oliveira et al.[20] Previous studies found that children with low height-for-age had more caries experience in their primary dentition.[5,21] Under resting conditions, unstimulated salivary flow is what is secreted by the salivary glands majority of time. Unstimulated saliva is essential for the health and well-being of the oral cavity and also bestows a strong protective effect against dental caries.[22] Similar has been proved in our study. The unstimulated SFR was minimum (0.14 ml/min) in Group II as compared to Group I (0.53 ml/min) and group III (0.21 ml/
As far as the influence of nutritional status on the eruption of teeth is concerned, the present study showed that maximum participants with delayed eruption were seen in Group II (23.30%). In another study, it was stated that one malnutrition episode during 1 year of life was sufficient to delay eruption of all primary teeth. Chronic malnutrition (stunting) has a greater impact than acute malnutrition (wasting). Stunted children suffered the nutritional insult soon after birth, that is, before 6 months. At this time, most of the teeth are still being formed. A review article has been put forward by many authors in support of delayed eruption pattern in malnourished children. Another study quoted a negative linear correlation between the time of first deciduous tooth eruption and birth weight, suggesting that delayed tooth eruption may be related to lower birth weight. Another stated that heavier babies at birth have more erupted teeth at all ages than lighter babies at birth.

**Conclusion**

According to the present study, there is an association between nutritional status and SFR and dental caries. Association was also present between nutritional status and eruption pattern though it was nonsignificant. Hence, nutritional status is also one of the factors which influences tooth development as well as salivary gland functioning and any nutritional disturbance during the development of salivary gland decreases SFR, thus increasing caries susceptibility of the child. Furthermore, it is the unstimulated SFR which is essential for the integrity of our oral tissues. Thus, public health programs and dentists should emphasize and counsel parents about the role of proper diet and nutrient supply to a child during the developmental period as it influences not only general health but also the oral health of the individual.

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**Conflicts of interest**

There are no conflicts of interest.

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