Salivary pH Levels and Caries among Siblings and Parents within Families

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Background: *High level of caries activity is related to organisms in the dental plaque with high acidogenesis capacity.* ***Aim:*** *To test salivary pH in children of the same family and compare it with their caries status. To compare pH levels between children and their parents. To examine the relationship between pH and caries status among children of the same family and their parents.* ***Study design:*** *We examined 123 children and adolescents aged 3-18, (73 boys and 50 girls) and 33 adults, (12 men and 21 women), parents of these children. Caries status was examined clinically, using DMF index. Salivary pH measurements were made by a digital pH meter.* ***Results:*** *Among adults, increase in patient age led to increased DMF (p = 0.005). The higher the pH, the lower the DMF (p = 0.037). Among men, DMF was lower by 3 compared to women (p = 0.049). Children's pH correlated with the parents' (p = 0.004). Children's DMF correlated to their pH (p = 0.001). Children's pH was the best predictor of their DMF (R2 = 0.309, p = 0.001).* ***Conclusions:*** *Among children, the higher the pH, the lower the DMFT. Children's pH was the best predictor of their DMF.*
Keywords: Caries, children, salivary pH

INTRODUCTION

Dental caries is the most common dental disease. The etiology and the pathogenesis are multifactorial.[1] The progress of the cariogenic lesion depends on several factors related to each other, including a diet rich in fermentable carbohydrate, microbial content of the dental plaque, pH level of the plaque and saliva activity. High level of caries activity is related to organisms in the dental plaque which have high acidogenesis capacity and high tolerance to acid. These organisms include: *Mutans Streptococci* (MS), Lactobacilli, and "low pH" non *Mutans Streptococci*.[2] Sucrose metabolism produces acid and in addition the MS uses it in the production of Glucan polysaccharide, by which the MS clings to tooth surfaces and contributes to dental plaque.[3] Acid can cause demineralization of tooth surfaces, as a function of the absolute decline in pH level. The absolute critical value of the pH for enamel demineralization ranged from 5.2 to 5.5.[3] Demineralization can cause development of initial caries decay – white spot lesion, which later can develop into cavitation.[3] Quality and rate of secretion of saliva play an important role in protecting the dental tissues in the mouth.[1] Saliva acts as a buffer to balance the pH via neutralization of acids produced by microorganisms in the dental plaque. The saliva pH changes with age. In infants, the pH was found to be lower than in adults.[4] Another study concluded that a decrease in the salivary secretion rate was a high risk factor for dental caries.[5]

Normal salivary secretion rate is 0.1 to 0.2 ml/min. It was found that salivary flow rate is greater in men than in women, probably due to the difference in the size of their salivary glands. Women have smaller salivary glands. This may be one reason they are more likely to demonstrate dry mouth,[6] a common situation found in aged adults (30% aged 65 and over) due to systemic diseases and medications decrease in salivary secretion rate. There is a connection between dry mouth and caries lesions.[7] The buffer system consists of salivary bicarbonate, phosphate and protein which keep the pH in a non-harmful range – 6 to 7.5. Low pH levels can cause enamel erosion like in bulimia and anorexia accompanied by vomiting, and in the consumption of fruit juices and carbonated beverages.[8]

It was suggested that genetic factors explain more than 50% of dental caries in the population.[5] A study conducted on monozygotic and dizygotic twins grown separately, found similar levels of incidence of tooth decay, salivary pH and amylase activity among twins.[9] Other studies revealed similar patterns of decay, salivary flow rate, and pH and amylase activity in saliva among twins, but no connection to specific genes associated with dental caries.[10, 11] It was suggested that there was a gene influencing cariogenic diet preferences containing carbohydrates, and increased saliva amylase activity, and that there was a genetic regulatory element related to the caries frequency.[11] As to the pH level of saliva, research showed that children with active caries had a slight decrease of pH compared to caries-free children.[12]

The assessment of salivary pH levels can identify patients at risk for tooth decay and help to focus the patient's treatment according to their individual needs.[1] Because there are signs of family connections regarding caries development, siblings in the family can be compared for familial tendency to develop tooth decay as expressed in their salivary pH.

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Table 1. Means, standard deviation (SD) and range of the DMFT scores and pH levels of the subjects.

	Number	Mean	SD	Minimum	Maximum
DMFT Child	123	4.44	3.37	0	13
DMF Parent	33	14.33	4.65	2	21
PH Child	123	7.01	0.37	5.4	8
PH Parent	33	6.86	0.56	5.3	8

The aims of the present study were the following:

a. To test salivary pH in children of the same family and compare it with the level of their caries status.

b. To compare the pH levels between children and their parents.

c. To examine the relationship between the level of the pH to the caries status among children of the same family and their parents.

MATERIALS AND METHOD

The research examined 123 healthy children and adolescents aged 3-18, (73 boys and 50 girls) and 33 healthy adults, (12 men and 21 women), who are parents of the children (one parent per family was tested). The study took place in a clinic which provides dental treatment to children and to adults, during routine checkups. In each family we examined a parent and several children. We examined families with more than three children, aged 3-18, usually with household income below the national average and high birthrate (low-medium socioeconomic status). These families live in a defined geographic area, with only partial fluoridated water (the sources of the drinking water is from non-fluoridated local wells and also fluoridated water from the national carrier).

The caries status of the subjects was examined clinically, using the dmft/DMFT (Decayed, Missing and Filled per tooth, for primary and permanent teeth respectively) index, reflected in the number of decayed teeth (D), the number of missing teeth (M) and number of teeth with restorations (F). For the present study there was no separation between primary and permanent teeth. We had data about teeth extractions. Examinations were made with a probe and mirror using a dental unit lamp, without taking radiographs.

In addition, subjects were asked to give a saliva sample (2.5-3 cc). The subjects refrained from eating, brushing their teeth or rinsing with mouthwash for at least 1 h before spitting. They were asked to collect saliva in their mouth and to spit it into a wide test tube. They were asked to collect saliva in their mouth and to spit it into a wide test tube for 5 min.[13]

pH measurements of the saliva samples were made by a digital pH meter (Model: PH-230SD Lutron, Taiwan) immediately after the sample was collected. The saliva that was collected was unstimulated.

All dental examinations and pH measurements were carried out by one of the authors (YB).

The study has been approved by the Helsinki Committee of Tel Aviv University. Parents of patients signed informed consent forms for themselves and for their children. The children gave their consent to participate in the study.

Statistical analysis

The results were analyzed by SPSS statistical software (Statistical package for the social sciences) 15.0 software (SPSS Inc., Chicago. IL., USA) using a number of statistical tests. Tests performed were: Regression analysis to examine the relationship between the level of the pH to DMFT among adults, Mixed Model Analysis (taking into account family structure) containing both fixed effects (non-random) and random effects to examine the relationship between the level of the pH to DMFT among children in the family, and Pearson correlations between the averages of the pH and the DMFT scores of parents and children.

RESULTS

The mean age of the children and adolescents who were examined was 9.21 ± 3.31 years. The mean age of the parents was 36.91 ± 4.49 years with age range of 26 to 49 years.

Table 1 illustrates the means and standard deviations (SD) of the DMFT scores and pH levels of participants. The mean scores of pH among the children and the parents were 7.01 and 6.86 respectively, while the mean DMFT of the children and parents were 4.44 and 14.33 respectively. No significant difference was noted between pH levels of the children and the parents.

Figure 1 illustrates the age distribution of children and parents. The mode children age was 11 years old, and the mode parents' age was 34.

Table 2 illustrates the effect of fixed variables among parents (age, pH, gender) on the DMFT. Linear regression analysis was carried out. The results show that an increase in the patient's age can significantly result in a higher DMFT ($p = 0.005$). The higher the pH values, the lower the DMFT ($p = 0.037$). Among men the DMFT values were lower by 3, compared to women ($p = 0.049$).

Table 3 shows the results of a mixed model regression. The effect of the fixed variables (age, pH, gender) on the DMFT among the children can be noted. Mixed model analysis was carried out among children, taking into account the family structure: one adult and a few children.

The effect of age, pH, and gender on the DMFT was examined. No significant correlation was found between the variables. Because no significance was found in the children's tests, the means

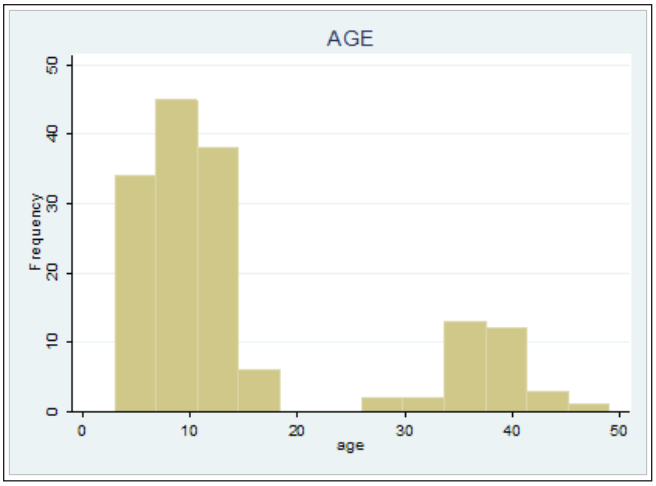

Figure 1. Age distribution of children (left) and parents (right).

Table 2. Effect of fixed variables * (age, pH, gender) on the DMFT among parents **.

P	S.E ***	Coefficient*	Constant variable
0.005	0.162	0.488	age
0.037	1.279	-2.792	pH
0.049	1.457	-2.999	Gender (male)****

** Linear regression

*** SE = standard error

**** Males were chosen as reference

Table 3. Effect of fixed variables age, pH, gender (among children), on the level of their dental caries experience*.

P	S.E**	Estimate of effect	Constant variable
0.193	0.091	-0.119	age
0.681	0.790	-0.325	pH
0.091	0.590	-1.005	Gender (male)***

*Mixed Model analysis

** SE – Standard error

*** Males were chosen as reference

of DMFT and pH were calculated and the correlations between the means of adults and children in the family were examined.

Table 4 shows the correlations between the mean DMFT scores and pH levels of children and adults. The mean DMFT of children was significantly correlated to their mean pH ($p = 0.001$, $R=-0.539$). Non-significant correlation was found between means of pH and DMFT in adults. As the level of the pH decreased the DMFT slightly increased. Significant correlation was noted between the mean pH of the children and the mean pH of the parents ($p = 0.004$, $R=0.497$).

In order to predict the DMFT within the family's children, as a function of the pH of the children, the pH of the parents and children's age, multiple linear regression was performed (Table 5).

The pH of the children was best predictor for the DMF of the children ($R^2 = 0.309$, $p = 0.001$). Standardized Coefficients Beta - Values of coefficient estimates for the average pH of Children (normalized). Normalized factor analysis is the result of normalized variables, so that their variation is equal to 1. Therefore, the normalized coefficient refers to the number of standard deviations of the dependent variable (mean DMFT for children), that will change, for a single unit increase of the standard deviation of the independent variable (the values of the average pH for children).

DISCUSSION

This study involved 123 children and 33 adults (parents) with the goal of examining the relationship between the salivary pH levels of the children within the same family and the level of their DMFT. In addition we investigated the relationship between the pH levels and DMF of children and the pH levels and DMFT of the parents.

Among the children, girls had higher DMFT values than boys. This finding is in accordance with a previous study which demonstrated a higher incidence of permanent dentition caries than boys, regardless of place of residence and socioeconomic status. This might be explained due to the early development of girls and eruption of permanent teeth at an earlier age.[14]

Among adults, the strongest influence on the DMFT was the age of the patient, then the pH, and gender of the subject ($p = 0.005$, $p = 0.037$, $p = 0.049$ respectively). The older the patient – the higher the DMFT. The lower the pH level - the higher the DMFT.

Interestingly, the men's DMFT values were lower by three than the women's DMFT values.

Vehkalahti *et al* found that women and men had similar root caries incidences, depending on correct dental habits and not on patient gender.[15] One possible explanation to the findings in our study can be that the rate of salivary secretions in women is smaller,[6] resulting in less "self cleaning" by saliva, leading to more caries lesions.

In our study, the mean DMFT of children was significantly correlated to their mean pH, while non-significant correlation was found between means of pH and DMFT in adults. It may suggest that the influence of pH on the caries status reflected by DMFT is more pronounced among children. The mean pH scores among the children and the parents in our study were close (7.01 and 6.86 respectively). Among children, relationship between pH and DMF

Table 4. Correlations between the mean DMFT scores and pH levels of children and adults.

		Mean DMFT Children	Mean DMFT Parent	Mean pH Children	Mean pH Parent
Mean DMFT Children	Pearson Correlation (R)	1	0.156	-0.539**	-0.93
	Sig. (2-tailed)		0.401	0.001	0.620
	N	33	31	33	31
Mean DMFT Parent	Pearson Correlation (R)	0.156	1	-0.267	-0.237
	Sig. (2-tailed)	0.401		0.146	0.199
	N	31	31	31	31
Mean pH Children	Pearson Correlation (R)	-0.539**	-0.267	1	0.497**
	Sig. (2-tailed)	0.001	0.146		0.004
	N	33	31	33	31
Mean pH Parent	Pearson Correlation (R)	0.093	-0.237	0.497**	1
	Sig. (2-tailed)	0.620	0.199	0.004	
	N	31	31	31	31

**p=0.01

Table 5. Multiple linear regression to predict the mean DMFT within the family children*.

	Unstandardized Coefficients B	Unstandardized S.E.	R	R Square	Standardized Coefficients Beta	p
Mean pH children	-6.736	1.869	0.556	0.309	-0.56	0.001

* Dependent Variable: DMFT mean children, Predictors (constant), pH mean children. B – The value of the coefficient estimate for the average pH of children. SE - standard error values of this coefficient estimate. R - Correlation between the dependent variable (average DMFT for children) and the independent variable (the values of the average pH for children). R Square - The percent of variance explained out of the total variance of the average DMF in children.

was also investigated by Gopinath *et al*, who found low pH values (5.2 to 6.2) in patients with DMF levels greater than 5.[1] In contrast, others examined the values of DMF and saliva pH in children with Down syndrome, and found that pH values of these children were low, but also their DMF was low.[4, 16] This finding is contrary to the results obtained in our study. The researchers hypothesized that this may be related to the effects of the trisomy on the salivary glands, which creates a different environment of the electrolyte, which interferes with the process of dental caries.[4]

The mean DMFT in our population was 6.53 ± 5.46. The mean DMFT among children was 4.44 ±3.37, and the mean DMFT among adults was 14.33 ± 4.65. These values are higher values of the national mean DMFT according to a study by Zadik et al. from 1992.[17] In their study, the mean dmft for ages 5-6 years was 2.77, and the percentage of caries free at this age were 41.3%, while the DMFT value for age 12 years was 2.99, and the percentage of caries-free at this age was 21.2%. There may be some explanations for the different results: a. Our study used a more strict examination, which was carried out a pediatric dentist; b. Our study population did not benefit from regular supply of fluoridated drinking water (the sources of the drinking water is from non-fluoridated local wells and also fluoridated water from the national carrier); c. The socioeconomic status of the families participating in our study was medium-low, with high birthrate, inadequate dietary habits and hygiene.

We found that within the families, there was a correlation between the pH, and the DMFT. Among the children there was a correlation between low DMFT and the high pH ($p = 0.01$). Also there was a relationship between the values of the pH of the children and those of the parents. That is, it is possible to estimate what level of acidity in the mouth of children may be, when the pH level of the parents is known. In addition, according to results obtained in our study, the factor that best predicts the values of the DMFT of children in the family, is the pH of the children in the family ($R^2 = 0.309$, $p = 0.001$).

This result is clinically significant. It helps to assess caries risk of children by the pH level and DMFT of their siblings. We can recommend that parents bring these children to be examined more frequently, to guide them in terms of diet, maintaining hygiene habits or applying topical fluoride varnishes more frequently, all to reduce their risk of caries.

Our study faces a limitation, because what can be shown for a group may still have a little predictive value on an individual level.[18] Still, our study sheds some light on this complex issue of predicting caries risk, among children.

CONCLUSIONS

Children's DMF correlated to their pH as follows: the higher the pH, the lower the DMF.

Males' DMF was lower compared to females' both in children and in adults.

Within the families, children's pH correlated with the parents' pH.

Children's pH was the best predictor of their DMF.

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