

Evaluation of the Relationship between Type, Value, and Frequency of Carbohydrates Consumed and Saliva pH and Dental Decay among Elementary School Students of Ahwaz City in 2015

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Abstract

The current research was conducted to evaluate the relationship between the type, value and frequency of carbohydrates consumed and saliva pH and dental decay in elementary school students of Ahwaz city in 2015. The research method is randomized clinical trial type of descriptive-analytical study. Accordingly, 336 healthy elementary students aged 7 to 13 and had no any mental and physical illness, were selected by informing at Jondishapur University of Medical Sciences in Ahwaz. Questionnaire was used as tool of data collection. A demographic questionnaire to record the anthropometric measurements (weight, height, BMI) and a 3-day food recording questionnaire (two normal days and one holiday) were filled out by parents and students. The guideline on filling out of the food recording questionnaire was explained in detail for subjects. The recorded information included time of consuming, type of food or drink consumed, cooking method and value of food consumed. In addition, one sample of non-stimulating saliva (about 2 cc) was taken and measured immediately by Metrohm digital pH meter. The status of teeth was examined at school and the appropriate environment. Since results of previous studies show that use of oral saliva pH has relationship with dental decay, non-stimulating saliva was used as an appropriate sample to achieve high precision results. Saliva samples were measured by digital pH meters. The collected data were analyzed by using SPSS21 software. Pearson correlation coefficient was used to examine the relationship between the research variables. In addition, $p < 0.05$ was considered as a significant value. The results generally revealed a reverse relationship between saliva pH and dental decay. A direct relationship was also found between lactose, sucrose, and total carbohydrate intake and DMFT. Among Intrinsic, Milk, and Non-milk types of carbohydrates, Intrinsic carbohydrate showed direct relationship with dental decay. A reverse relationship was also found between lactose, sucrose, and total carbohydrate intake and saliva pH.

Keywords: Dental Decay, Carbohydrates Consumed, Saliva pH, DMFT, NMES.

Introduction

Dental decay is considered as one of the most common chronic diseases associated with carbohydrates. This disease is a bacterial disease at calcified surfaces of tooth. It is characterized by demineralization of inorganic parts (enamel) and loss of organic matter of tooth. The factors, which are involved in tooth decay, are classified into three groups of host, environmental factors and microorganisms (Moeini et al., 2013). Dental decay prevalence has decreased in developed countries over the past 20 years, while its prevalence and severity have increased significantly in many developing countries (Ajami et al., 2001). The consumption of sugars and carbonated beverages has also increased dramatically in developing countries. It can be a major cause of increased dental decay in these countries (Feskanich et al, 2004). Children are in the mixed dental stage (permanent and primary) at their elementary school age and many health and nutritional habits are established in this period and will remain until adulthood. Many human diseases are rooted in food diet. One of the common infectious diseases is dental decay. Many factors are involved in dental decay, but the food diet seems to be the most important factor in this regard (Pourhashemi et al., 2013). The rate of people without dental decay in the age group of 6-12 years in Iran has been reported 47.7% (Samadzadeh et al., 2001).

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Based on the Ministry of Health and Medical Education figure in 1998, Iranian children spend their 3 years of old period with five decayed or lost primary teeth and spend their six years of old period with five decayed primary teeth. It suggests that parents do not pay attention to these teeth. It highlights the need for educational, preventive and therapeutic programs for children aged 3 to 6 years. Consuming chocolate and sweets for more than 6 times per day among Iranian children and parents' lack of knowledge on necessary care and oral hygiene and the high tooth filling costs have caused that dental decay to begin since infancy. For this reason, they would suffer from dental decay during their youth period (MohammadNejad et al., 2011). Diet and nutrition affect the dental decay through leaving an impact on type of virulence of dental plaque microorganisms and the resistance of teeth and supporting structures as well as salivary properties (Mahsewson et al., 1995). Carbohydrates are the most important sources of human food. They supply more than 60% of the daily energy required. Despite the major role of carbohydrates in supply of energy and protecting human health, their excessive consumption can lead to dental decay (Adinejad et al., 2006).

Investigating the child's diet can make the parents aware on child's wrong eating habits and eliminate nutritional deficiencies as much as possible. Moreover, the way of using of foods and the frequency of using are also very important. Studies suggest that excessive use of sugary foods plays a major role in dental decays. Knowing this relationship can be helpful in designing preventive programs (Moynihan et al., 2004). In this regard, saliva plays major role in keeping the mouth moist and in controlling four factors involved in dental decay (Bardow et al., 2000). In addition, the mean of DMFT (Decayed, Missed, and Filled Teeth) indices indicates the dental decay. As the frequently use of sugary and starch foods and carbohydrates is an important factor involved in the dental decays, the objective of this research is to evaluate the relationship between the type, value, and frequency of carbohydrates consumed and dental decay of elementary school students of Ahwaz. Thus, examining the factors related to dental decay in Ahwaz city and type of diet and the presence of factors contributes to decay in diet of students, this research helps the health authorities develop children dental decay programs in future and helps the parents of children to implement this programs in order to prevent the dental decay in children of this city.

Review of Literature

Many previous studies have reported the association between the number of dental decays and family socioeconomic status, the frequency of brushing, breastfeeding after one year, nocturnal milking, feeding with glass, the consumption of foods increasing the dental decay, and the frequency of consuming sweet substances. In this regard, Talebi et al. (2005) showed a reverse and significant relationship between DMFT health index and fat and protein consumption, while the effect of nutrition on oral and dental health has been proven already (Talebi et al., 2005). In addition, the findings of a study conducted by Pour Hashemi et al. (2007) showed that the value of vital micronutrients of iron, zinc, and especially calcium was not sufficient in the diet of Tehran city children, leading to mild malnutrition and increased dental decay (Pour Hashemi et al., 2007). In a study on 60 dentistry students, Azar Darbandi et al. (2007) showed that increasing the saliva pH with chewing the gums containing bicarbonate and usual sugar-free gums can be effective in oral hygiene and prevention of dental decays. It requires research and a long follow-up (Azar Darbandi et al., 2007). In a descriptive cross-sectional study conducted by Pour Hashemi and Golestan (2008) on 788 seven years of old healthy children in Tehran city to examine the effect of using sugar and carbonated beverages on anthropometric indices and dental health, the results showed that sugar and carbonated beverages are used highly by underweight children and a significant relationship was reported between the use of sugar and DMFT (Pour Hashemi and Golestan, 2008). In a cross-sectional and analytical study on 100 children (42 female and 58 male children) with a mean age of 40.5 ± 4.28 months in Isfahan, the results showed that the rate of dental decay in underweight or premature children (5.59 ± 4.05) was significantly higher than that in children with normal weight (3.72 ± 3.85). In addition, the use of breast milk and the frequency of using main food and snack per day were significantly higher in children with normal weight than that in underweight or premature children (Javadinejad et al., 2008). The results of the research conducted by Mosaheb et al. (2009) showed that frequent consumption of sugary, starchy and sticky foods and lack of brushing regularly (at least once per day) were the important factors involved in dental decay. Faezi et al. (2012) evaluated the relationship between DMFT and diet and social factors in elementary school children in Tehran and the results showed that health care, history of pain and the use of foods contribute to dental decay in children's nutrition had a direct effect on DMFT. In addition, DMFT increases with increasing number of siblings and low parental level of education and the use of foods contribute to dental decay (Faezi et al., 2012).

Among the research conducted out of Iran, Wyne et al. found that 27.3% of the children had nursing caries. There is disagreement on the prevalence of dental decay. Parkin reported dental decay abnormal in these patients in 1968. Siamopoulou et al. (1992) reported DMF in the patient group two times more than that of control group. In a cross-sectional study on the relationship between the nutritional status and permanent tooth decay in 12-14 years of old children in Thailand, Rodrigues Narksawat et al. (2009) showed that school age children with high weight were at greater risk of dental decay compared to normal or low-weight children at the age range of 12-14 years. A negative association was also found between nutritional status and DMFT index. The schools are recommended to improve and modify the food habits of students to reduce the dental decays among them (Narksawat et al., 2010).

In a cross-sectional study on the relationship between oral hygiene and the nutritional status of middle-aged people, Rodrigues et al (2012) showed that tooth loss is associated with harmful changes in anthropometry, which can increase the risk of chronic diseases (Rodrigues et al, 2012). Honne et al (2012) showed an association between obesity and overweight and tooth decay. A relationship was found between male gender, overweight, and consuming sugar more than once per day (Honne et al., 2012). Moreover, based on the results of research carried out by Lueangpiansamut et al. (2012), it was found that eating sweets before sleep is associated with tooth decay. Moreover, family income is related to decay of permanent teeth with CI of 95% and OR of 48.59 and 1.89 (Lueangpiansamut et al., 2012). In a cross-sectional study conducted to evaluate the effect of diet and lifestyle factors on the risk of tooth decay in Qatar children, Bener et al (2013) showed that using Cod liver oil at least once per week and regularly tooth brushing reduced tooth decay and knowledge on the health and providing training on tooth brushing, proper and adequate nutrition, prevention from obesity prevent tooth decay in children (Bener et al., 2013). The results of research conducted by Zúñiga et al (2013) on evaluation of prevalence and severity of tooth decay and its relationship with nutritional status in 17-47 month old Mexican children showed a relationship between DMFT index and age, weight, and height. No relationship was found between prevalence and tooth decay severity, nutritional status; also, prevention is important in oral hygiene of this age group (Zúñiga et al., 2013). Thus, based on the results of previous studies and the importance of primary teeth and their role in proper nutrition, the provision of beauty and the formation of speech in the early years of life and, most importantly, the provision of health and maintaining the space required for the growth of the anterior teeth, decay can reflect a major failure in the early stages of growth, development and health of the child.

Research Hypotheses

1. There is a relationship between saliva pH level and DMFT and students' tooth decay.
2. There is a significant relationship between the value, frequency and types of carbohydrate using and DMFT and tooth decay.
3. There is a significant relationship between the value, frequency and types of carbohydrate using and saliva pH level of students

Materials and Methods

Introducing the project

The current research was designed with ethics code of IR.AJUMS, REC. 13950556. It was a randomized clinical trial, conducted on 336 elementary school students aged 7 to 13 years old, healthy and without any mental or physical illness. They were selected by informing at Ahwaz Jundishapur University of Medical Sciences. They were initially examined by dental specialist in terms of the number of decayed teeth and decay-missing-filled index (DMFT). All participants signed the informed consent form to participate in this trial.

Sampling method

A demographic questionnaire is used to record the anthropometric measurements (weight, height, BMI) and a 3-day diet questionnaire (two normal days and one holiday) is completed by parents with the help of the students. Complete guideline is provided for students on the way of completing the diet recording questionnaire. Recorded data includes time of intake, type of food or drink, cooking method and value of intake based on home values. In addition, a sample of non-stimulated saliva (about 2 cc) will be immediately measured by Metrohm digital pH meter. The teeth status will be examined in school in an appropriate environment under the supervision of dental specialists.

- *Inclusion criteria*

Male elementary school students aged between 7 and 12 years will be randomly selected from one of the districts of Ahwaz Ministry of Education. Participants of the present study will be chosen among the first to fourth grade students from the considered district. A total of 84 students will be selected from each school and 14 students will be picked up randomly from each grade.

- *Exclusion criteria*

- People who were not willing to participate in the study.
- People with special diseases
- People who did not complete the questionnaire

Different evaluations

In this clinical trial, a total of 336 male students aged between 7 -12 years will be randomly selected from one of the districts of Ahwaz Ministry of Education. The research participants will be chosen from the first to sixth grade students of four schools. A total of 84 students will be randomly picked up from each school and 14 students will be selected randomly from each grade.

- *Anthropometric evaluation*

After taking consent from the parents, a demographic questionnaire for anthropometric measurements was recorded by the school health educator in the form in which the consent form has been attached.

- *Evaluation of saliva ph level*

One non-stimulated saliva sample (about 2 cc) poured in disposable container was immediately measured by Metrohm digital ph meter.

- *Dental examination*

All students were examined by a dentist with a disposable catheter, disposable mirror, and a disposable glove. Then, their DMFT was determined.

- *Dietary evaluation*

A 3-day diet questionnaire (two normal days and one holiday) is completed by parents with the help of the students. Complete guideline is provided for students on the way of completing the diet recording questionnaire. Recorded data includes time of intake, type of food or drink, cooking method and value of intake based on home values.

In addition, N4 software will be used to analyze food intake to determine the value of energy intake, total carbohydrates, and simple carbohydrates. The method to estimate NMES and resources is defined as "added sugars" and sugars derived from fruits in juices and other beverages. The sugar of fruits, seen in fruits' juices and drinks, is classified as intrinsic carbohydrates, while all sugars in chocolate are classified as NMES carbohydrates. Estimation of frequency of carbohydrates intake: It is possible to estimate the frequency of food intake due to determining the time to intake all foods and drinks in the food record booklet. All times to intake foods or drinks containing carbohydrates have been specified. The frequencies for carbohydrate intake per day are summed up and the average intake is considered over a period of 3 days. Using the food ingredients table, other carbohydrates will be calculated manually.

Sample collection

As the results of recent studies show that saliva ph is associated with tooth decay process, non-stimulated saliva was used as a sample to achieve high accurate results. Saliva samples were measured by digital ph meter at site.

Procedure

We first calibrated the digital ph meter with its buffers. Then, we collected the saliva sample inside the disposable containers, where the ph meter head placed inside it easily. In the next step, the measurement was performed at site and it was recorded. After that, students' teeth were examined by the dentist and the DMFT form was completed. The information needed to complete the 3-day diet questionnaire was given to parents in schools. The completed questionnaires were delivered to the health educator and analyzed by software N4.

Statistical methods to analyze the results

The collected data were analyzed by SPSS21 software. To examine the research objectives, Spearman correlation coefficient test was used. One-way ANOVA test was used to examine the quantitative variables. To control the confounding variable, linear regression model was used. Independent t-test was also applied to examine the significance of correlation between carbohydrates consumption, pH and tooth decay. In addition, $p < 0.05$ was considered as a significance level for result of the tests

Research variables

All variables are quantitative and continuous. The studied scales are presented in Table 1.

Table 1: Scale used in research variables

Variable	Total carbohydrate	Simple carbohydrate	Complex carbohydrate	NMES carbohydrate	Intrinsic carbohydrate	index DMFT	Saliva ph	gender	age	Height	Weight	Frequency of intake
scale	g/d	g/d	g/d	g/d	g/d	number	Ph	male	7-12	cm	kg	t/d

Results

Descriptive results

In this clinical trial, 336 male students aged between 7-12 years old were selected randomly from one of the districts of Ahwaz Ministry of Education. Participants of this study were selected randomly from 4 first to fourth grade elementary schools (84 students were randomly selected from each school and 14 students were randomly selected from each grade. The anthropometric and demographic information is presented in Table 2.

Table 2: Demographic characteristics of students

(Age (year)	height (cm)	Weight (kg)	BMI
9.5±1.71	131.15±11.74	28.57±6.19	16.44±1.53

Table 3- education level of parents

Illiterate	High school	Associate	Bachelor and higher
22	32	27	19

Table 4: the mean percentage of carbohydrate used to total energy at different times

Breakfast		Morning meal		Lunch		Afternoon meal		dinner		Late night	
n	%	n	%	%		n		%		n	
15.18	51	2.92	77	14.88	50	2.02	74	3.09	44	1.90	40

The mean consumed carbohydrate and frequency of its intake, mean of tooth decay, mean ph in students, total carbohydrate and NMES carbohydrate and total complex carbohydrates, frequency of using it, primary and permanent DMFT and saliva PH based on each grade (first to sixth grade) are presented in Table 5.

Table 5: mean and standard deviation of carbohydrate intake, frequency of using it, mean tooth decay, and saliva ph in students

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Pvalue
total carbohydrate (gr)	151.08±25.14	154.76±22.62	51.67±23.63	155.20±22.17	150.51±23.08	155.84±22.04	0.718
Complex carbohydrate (gr)	23.39±18.22	24.58±17.26	24.32±18.33	25.30±18.18	24.27±17.61	26.16±17.39	0.977
Carbohydrate NMES (gr)	19.80±11.77	18.61±11.66	19.65±12.30	16.83±9.68	18.78±10.17	14.83±8.76	0.895
Frequency of using types of carbohydrates	1.11±0.96	0.99±0.94	1.03±0.92	1.10±0.88	1.02±0.83	1.00±0.84	0.663
Primary tooth DMFT	1.95±1.65	1.91±1.54	1.86±1.51	1.49±1.46	1.63±1.45	1.61±1.42	0.936
permanent tooth DMFT	0.54±0.18	0.48±0.21	0.46±0.16	0.56±0.21	0.51±0.16	0.51±0.25	0.453
Saliva PH	7.0±0.22	7.03±0.19	7.03±0.21	7.08±0.22	7.05±0.21	7.07±0.21	0.763

Inferential results

Hypothesis 1: There is a direct relationship between the saliva ph level and DMFT of students.

To examine the first hypothesis, Pearson correlation test was used. The results of this test are presented in Table 6.

Table 6: The Relationship between saliva pH level and DMFT in elementary school students in Ahwaz

Saliva ph	Pearson coefficient of primary DMFT	P value	Pearson coefficient of permanent DMFT	P value
7.0±0.2	-0.838	0.001	-0.385	0.001

As shown in Table 6, there is a significant difference between the mean saliva pH of the permanent DMFT and the primary DMFT with Pearson coefficient of -0.838, -0.385, respectively, and P-value is less than 0.001. There is an inverse relationship between saliva pH and tooth decay, so that that more PH leads to less tooth decay, and vice versa. Therefore, hypothesis 1 is confirmed.

Hypothesis 2: There is no relationship between the value of intake, frequency and types of carbohydrates intake and DMFT in students.

The relationship between the mean intake, frequency and types of carbohydrates used and DMFT of students is shown in Table 7.

Table 7: The relationship between mean and standard deviation of value of intake, frequency, and type of carbohydrates used and DMFT in students

Types of carbohydrate	Mean	Correlation coefficient r	Pvalue	correlation coefficient r	Pvalue
Sugar	20.48±32.67	0.309	0.001	0.426	0.001
Glucose	3.93±3.54	0.166	0.028	0.053	0.328
fructose	8.89±8.48	0.064	0.239	0.059	0.277
Lactose	5.66±4.33	0.27	0.001	0.325	0.001
Galactose	1.17±0.74	0.112	0.04	0.073	0.182
Sucrose	9.23±8.74	0.281	0.001	0.252	0.001
Maltose	0.34±0.18	0.076	0.167	0.064	0.24
Total carbohydrates	151.08± 23.07	1.74±1.51	0.42	0.51±0.19	0.001

As shown in Table 7, there is a direct relationship between the intake of lactose, total carbohydrate, and DMFT. The results of the correlation coefficient of types of carbohydrate and DMFT in students are shown in Table 8.

Table 8: Relationship between Pearson correlation coefficient of rate of frequency and types of carbohydrate used and tooth decay in students

	Frequency of using (t/d)	R Pearson correlation of primary DMFT	P-value	R Pearson correlation of permanent DMFT	P-value
Intrinsic carbohydrate	1.43±1.13	-0.206	0.001	-0.071	0.194
Milk carbohydrate	0.40±0.33	0.242	0.082	0.196	0.001
Non-milk carbohydrate	0.92±0.40	0.787	0.001	0.486	0.001
Total		0.34	0.001	0.302	0.001

Table 8 shows intrinsic, milk, and non-milk types of carbohydrates. It is seen that intrinsic carbohydrate is associated with tooth decay.

Hypothesis 3: There is no direct relationship between the level of intake, frequency and types of carbohydrate used and saliva pH.

To examine this hypothesis, the mean of types of carbohydrate and saliva pH level was first examined (Table 9) and the correlation coefficient between carbohydrate types and saliva pH level is presented in Table 10.

Table 9: The relationship between mean and standard deviation of carbohydrate types and saliva pH level in students

ph=7.05±0.2 Types of carbohydrate	mean	Correlation coefficient	Pv-alue
Sugar (gr)	32.67±20.48	0.169	0.002
Glucose (gr)	3.93±3.54	0.117	0.032
Fructose (gr)	8.89±8.48	0.227	0.001
Lactose (gr)	4.33±5.66	-0.201	0.001
Galactose (gr)	1.17±0.74	0.142	0.009
Sucrose (gr)	9.23±8.74	-0.289	0.001

Maltose (gr)	0.34±0.18	0.298	0.001
Total carbohydrate (gr)	151.08±23.07	-0.033	0.544

As shown in Table 9, there is an inverse relationship between lactose and total carbohydrate intake and saliva pH level. This means that by increased consumption of lactose and sucrose, the saliva pH becomes acidic, and total carbohydrates will also make the saliva acidic or reduction in saliva pH. Table 9 shows the results of the correlation coefficient of types of carbohydrate and saliva pH in students.

Table 10: Relationship between Pearson correlation coefficient between types of carbohydrate used and frequency of using and saliva PH in students

Types of carbohydrates ph	Pearson correlation coefficient	P-value
Intrinsic carbohydrate	0.337	0.001
Milk carbohydrate	-0.059	0.279
Non-milk carbohydrate	-0.718	0.001
Frequency of use	-0.195	0.001

Table 10 shows that milk carbohydrate and non-milk carbohydrates and frequency of using carbohydrate are inversely correlated with saliva pH. It means that the students who use this carbohydrate more frequently, their saliva pH decreases.

Conclusion

The present study was conducted to evaluate the relationship between the type, value, and frequency of using carbohydrate and saliva pH and tooth decay in Ahwaz elementary school students in 2015. In this regard, previous studies were reviewed and hypotheses were presented and tested. The results showed a reverse relationship between saliva pH and tooth decay, meaning that more PH is associated with less tooth decay. Thus, the first hypothesis was confirmed. This result is in line with the research conducted by Darbandi et al (2006), which showed that increasing the saliva pH with chewing the gums containing bicarbonate and sugar-free gum can be effective in oral hygiene and prevention of tooth decay (Darbandi et al., 2007).

The result of the second hypothesis testing showed a direct relationship between lactose and sucrose and total carbohydrate using DMFT. In addition, among the intrinsic, milk, and non-milk carbohydrates, it was found that intrinsic carbohydrate is directly associated with tooth decay. Therefore, the second hypothesis was also confirmed. The results of this study are in line with the results of the research conducted by Faezi et al. (2010), which examined the relationship between DMFT and diet as well as the results of the research conducted by Pourhashemi et al. (2007), which showed that level of calcium intake in the diet of Tehran's children is not adequate, leading to mild malnutrition and increased tooth decay. These results are also in line with those of research conducted by Masaheb et al (2010) and Honne et al (2012). In addition, the results of this study are inconsistent with those of the research conducted by Narksawat et al (2009) and Zúñiga et al (2013) and Pourhashemi and Golestan (2008), which showed no correlation between the prevalence and severity of tooth decay and nutritional status and sugar-containing foods. Moreover, the results of the third hypothesis showed that there was a reverse relationship between lactose, sucrose, total carbohydrate and saliva pH. Also, milk carbohydrate and non-milk carbohydrate and frequency of using carbohydrate showed reverse relationship with saliva pH. The results of this study are in line with those of research conducted by Darbandi et al (2007), which showed that increasing the pH of saliva with chewing the gums containing bicarbonate and free-sugar gums can be effective in oral hygiene and prevention of tooth decay.

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