

# Dietary patterns and oral health in schoolchildren from Damascus, Syrian Arab Republic

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## الأنماط الغذائية وصحة الفم لدى أطفال المدارس في دمشق، الجمهورية العربية السورية

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الخلاصة: يستقصي الباحثون في هذه الدراسة الترابط بين الأنماط الغذائية وبين صحة الفم في أطفال المدارس الابتدائية في دمشق. وقد شملت الدراسة خمس مئة وأربعة أطفال تتراوح أعمارهم بين ستة أعوام واثني عشر عاماً، ووَزَّع الباحثون على أوليائهم استمارات لتقييم تواتر استهلاك الطعام لديهم. وقام الباحثون بتقييم صحة الأسنان بتحديد المُنسَب اللثوي ووجود نخر سني غير المعالج. ووجد الباحثون أن استهلاك المجموعات الغذائية كان أقل من التواتر الموصى به، وتحديد النسب اللثوي، ولو أن استهلاك السكريات مرتفع، كما وجدوا أن عوامل الاختطار التي لازالت تؤثر في النخر السني وفق التحليل التَّحَوُّفي المتعدّد تتمثل في الاستهلاك المرتفع للسكريات (OR=5.26)، الاستهلاك المنخفض لمنتجات الألبان (OR=2.45)، وسوء العناية بصحة الفم (OR=2.98). أما بالنسبة لالتهاب اللثة بغض النظر عن العوامل الأخرى المسببة للالتباس التي أدرجت في التحليل، فقد تمثّلت عوامل الاختطار في سوء العناية بصحة الفم (OR=18.5)، والاستهلاك المرتفع للسكريات (OR=1.82)، والتواتر المنخفض لتنظيف الأسنان بالفرشاة (OR=1.98). وخصّص الباحثون إلى وجوب تقديم برامج تثقيفية شاملة حول أنماط التغذية وعلاقتها بصحة الأسنان لدى الأطفال ولدى ذويهم.

ABSTRACT This study investigated the association between dietary patterns and oral health in primary-school children from Damascus. A total of 504 children aged 6–12 years were enrolled and food frequency questionnaires were distributed to their guardians to evaluate food consumption. Dental health was evaluated by gingival index and presence of untreated dental caries. Consumption of food groups was lower than recommended frequencies, whereas consumption of sugars was high. High sugar consumption (OR 5.26), low consumption of dairy products (OR 2.45) and poor oral hygiene (OR 2.98) remained risk factors for dental caries in multiple regression analysis. Poor oral hygiene (OR 18.5), high consumption of sugars (OR 1.82) and low frequency of tooth brushing (OR 1.98) also remained as risk factors for gingivitis regardless of all confounders included in the analysis. Comprehensive educational programmes about dietary patterns and their relation to oral health should be provided for children and their guardians.

## Habitudes alimentaires et santé bucco-dentaire chez des écoliers à Damas (République arabe syrienne)

RÉSUMÉ La présente étude a examiné l'association entre les habitudes alimentaires et la santé bucco-dentaire chez des écoliers du primaire à Damas. Au total, 504 enfants âgés de 6 à 12 ans ont été recrutés et des questionnaires de fréquence alimentaire ont été distribués aux personnes qui avaient la charge des enfants pour évaluer leur consommation d'aliments. La santé dentaire a été évaluée par rapport à un indice gingival et la présence de caries dentaires non soignées. La consommation des aliments des différents groupes était inférieure aux recommandations, alors que la consommation de sucre était supérieure. Dans l'analyse de régression multiple, une forte consommation de sucre (O.R. 5,26), une faible consommation de produits laitiers (O.R. 2,45) et une hygiène bucco-dentaire insuffisante (O.R. 2,98) étaient des facteurs de risque pour les caries dentaires. Une mauvaise hygiène bucco-dentaire (O.R. 18,5), une forte consommation de sucre (O.R. 1,82) et une fréquence insuffisante du brossage des dents (O.R. 1,98) représentaient aussi des facteurs de risque de gingivite, indépendamment de l'ensemble des facteurs de confusion inclus dans l'analyse. Des programmes d'éducation complets sur les habitudes alimentaires et leur relation avec la santé bucco-dentaire doivent être proposés aux enfants et aux personnes qui en ont la charge.

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## Introduction

The relationship between diet and dental diseases has been confirmed by many studies worldwide [1–14]. The intake of extrinsic sugars more than 4 times per day was found to be associated with an increased risk of dental caries [5]. A link was found between higher plaque volumes, increased gingivitis and high sucrose diets [9]. Milk, cheese and yogurt, however, were inversely associated with caries and therefore may have cariostatic properties [6–8]. In low income African American children aged 3–5 years the consumption of sweetened drink was a risk factor for dental caries, while the consumption of milk and real fruit juice was linked to decreased severity of dental caries [14]. Low intake of calcium has been found to be associated with periodontal disease, and consequently adequate calcium intakes may have a role in the treatment of periodontal disease [10]. Current studies have demonstrated a potential protective role of vitamin C in periodontal disease [11].

The role of diet as a direct cause of oral disease has also been reported in countries of the Eastern Mediterranean region. For example, Sayegh et al. undertook a study of the association between oral health, infant feeding and dietary practices in 4–5-year-old Jordanian children. They reported that eating confectionary as a snack and having marmalade/jam/ honey/halawi at breakfast and dinner were associated with dental caries, while dental plaque was associated with gingivitis [13]. There are no similar data, however, concerning children in Damascus, Syrian Arab Republic. The aim of this study was therefore to investigate the association between dietary patterns and oral health in schoolchildren aged 6–12 years in Damascus.

## Methods

### Sample

The Dimensions Research sample size calculator was used to determine the

sample size of the present study [15]. Assuming that the total population of schoolchildren aged 6–12 years was 122 000, the total estimated sample size was 384 subjects with a 95% confidence level and 80% power. To overcome sampling error, the sample size was increased by 30%, to give a minimum sample size of 500.

A random sample of pupils was selected from 8 primary schools located in 4 geographical areas with diverse socio-economic characteristics in Damascus city. The study was undertaken between 2010–11. Questionnaires were sent to the guardians of 650 children and 559 (86%) were returned. A further 43 uncompleted questionnaires were excluded and the data from 8 medically compromised children and 4 children from foreign nationals resident in Damascus were excluded. The results therefore related to 504 children (263 males and 241 females) aged 6–12 years.

Informed consent was obtained from the guardians of all children. Ethical approval was obtained from the Board of Scientific Affairs at the Faculty of Dentistry, University of Damascus. In addition, approval was obtained from the Syrian Ministry of Education in order to conduct this study in the selected primary schools.

### Data collection

Food intake was assessed by a food frequency questionnaire which contained a list of 70 food items. This was designed from a previous study undertaken to investigate eating patterns of children from New Zealand [16]. Foods that were not commonly consumed in the Syrian Arab Republic were excluded. The questionnaire was then translated into Arabic and validated on 25 children from the same population as a pilot.

Food was categorized into 6 groups: bread and cereals; fruits; vegetables; milk and dairy products; meat and legumes; and fat and sugars. Foods which contained both cereals and sugars (e.g.

cakes, biscuits, muffins) were categorized as sugars.

To analyse the association between food intake and gingivitis, fruits and vegetables were classified into 3 subgroups: vitamin-C-rich; vitamin-A-rich; and others [17]. Children were considered consumers of a food if the intake was daily or weekly. They were considered as non-consumers if they had never consumed that food or consumed it only monthly. Children were classified into 2 groups according to their daily consumption: adequate consumption or inadequate consumption. For consumption of sugars, children were divided into 3 groups: 1–3 times per day; 4–7 times per day; or > 7 times per day.

Clinical examinations were performed to determine the presence or absence of dental caries and/or gingivitis. The examination was conducted in schools by the same examiner (I.J.) under natural light. Dental caries was assessed using a plane mirror and dental probe, while oral hygiene and gingival inflammation was assessed using a World Health Organization (WHO) probe. Assessment of gingival inflammation was based on the gingival index of Löe and Silness [18]. The WHO diagnostic criteria were used and caries was only recorded if there was a visible break in the enamel or a marked shadow under the enamel. Where any doubt existed, the enamel surface was classified as sound [19]. Assessment of oral hygiene was based on the simplified debris index of Greene and Vermillion [20].

### Data analysis

SPSS, version 18 statistical package was used to analyse the data. The chi-squared test was used to determine the independence of the association between daily consumption of food groups, and caries prevalence or gingivitis. Multiple logistic regression was used to determine the risk factors for dental caries after adjusting for covariates. The dependent variable was dental caries.

It was coded as present/absent. The independent variables were: mother's education (high/low), father's education (high/low), economic status (good/bad), sugar consumption ( $\leq 3$ / $> 3$  times/day), milk and dairy consumption (adequate/inadequate), oral hygiene (good/poor) and tooth brushing (yes/no). In addition, multiple logistic regression was also used to determine the risk factors for gingivitis after adjusting for covariates. The dependent variable was gingivitis. It was coded as present or absent. The independent variables were: mother's education (high/low), father's education (high/low), economic status (good/bad), sugar consumption ( $\leq 3$ / $> 3$  times/day), consumption of milk and other dairy products (adequate/inadequate), consumption of vitamin-C-rich foods (adequate/inadequate), oral hygiene (good/poor) and tooth brushing (yes/no). Odds ratios (OR) with 95% confidence interval (CI) were also recorded for all variables investigated.

## Results

### Background demographic characteristics and dental health

The mean age of the 504 children included in this study was 9.5 (SD 1.9) years. Table 1 shows the general characteristics of the subjects investigated; 41% of children had poorly educated mothers (primary school), 42% had poorly educated fathers and 49% of children belonged to families with poor socioeconomic status.

Dental examination showed that 57% of the children had good oral hygiene while 8% had poor oral hygiene. One-quarter of children (26%) did not brush their teeth daily, while only 25% of children reported brushing more than once per day. In addition, 85% of the children had caries and 15% were free of caries in both dentitions. Half of

**Table 1** General characteristics of the children investigated ( $n = 504$ )

Variable	No.	%
<b>Economic status</b>		
Good	98	19
Moderate	159	32
Poor	244	49
<b>Mother's education</b>		
High (university)	76	15
Moderate (secondary, high school)	223	44
Low (primary)	204	41
<b>Father's education</b>		
High (university)	77	15
Moderate (secondary, high school)	217	43
Low (primary)	209	42
<b>Oral hygiene</b>		
Good	288	57
Fair	177	35
Poor	39	8
<b>Tooth brushing (times/day)</b>		
0	133	26
1	245	49
>1	124	25

the children (51%) had mild gingivitis, while 40% and 9% had moderate and severe gingivitis respectively.

### Dietary patterns

The most frequently reported food eaten was bread. About 86% of the children were reported to eat bread daily. Rice, chips and popcorn were popular cereals eaten daily by children. The most frequently reported vegetable consumed was tomatoes, reported to be eaten daily by 44% of the children. Consumption of fruits was low among schoolchildren. Apples, oranges and bananas were the fruits most frequently consumed daily. Apples were reported to be consumed daily by 30%, oranges by 26% and bananas by 21% of children. Consumption of yogurt and cheese was more common than consumption of milk. Yogurt was reported to be eaten by 62% of the children while cheese and milk were eaten by 50% and 38% of children respectively. Protein sources were mainly taken from eggs, as 38% of

the children were reported to eat eggs every day, while 10% ate *falafel* (deep-fried ground chickpeas), 7% luncheon meat and 6% *hummus* (ground chickpeas). Olives and olive oil were the most common fats eaten daily by children. Sugar consumption was high in general, as 45% of children consumed sugars 3–7 times a day and 29% > 7 times a day. Among the most common sugar sources, tea with sugar was consumed daily by 80% of children. Plain biscuits, biscuits with chocolate and chocolates were eaten by 52%, 44% and 33% of children respectively.

Consumption of food groups was deficient except for sugars (Table 2). Milk and dairy products group were mostly consumed at recommended frequencies; intake was sufficient in 61% of children. The intake of vegetables was sufficient in 43% of children and 42% of children consumed sufficient cereals. In contrast, 68% and 71% of children did not consume adequate amounts of meat and fruit respectively.

**Table 2 Association between caries prevalence and daily consumption of food groups**

Consumption of food groups	Total (n = 504)		Caries-free (n = 78)		Caries (n = 426)		P-value <sup>a</sup>
	No.	%	No.	%	No.	%	
<b>Fruit (apples, oranges)</b>							
Adequate	144	29	24	31	120	28	0.366
Inadequate	360	71	54	69	306	72	
<b>Vegetables (tomatoes, carrots)</b>							
Adequate	217	43	36	46	181	43	0.319
Inadequate	287	57	42	54	245	57	
<b>Bread &amp; cereals (pasta, rice)</b>							
Adequate	211	42	30	39	181	43	0.297
Inadequate	293	58	38	61	245	57	
<b>Dairy (milk, yogurt, cheese)</b>							
Adequate	309	61	57	73	252	59	0.013
Inadequate	195	39	21	27	174	41	
<b>Meat &amp; legumes (eggs, chicken)</b>							
Adequate	162	32	31	40	131	31	0.078
Inadequate	342	68	47	60	295	69	
<b>Sugars (chocolate, jam) (times/day)</b>							
≤ 3	133	26	42	54	86	20	< 0.001
4-7	228	45	26	33	203	48	
> 7	143	29	10	13	137	32	

<sup>a</sup>Chi-squared test.

### Association between dental caries and diet

Table 2 shows the association between caries prevalence and daily consumption of food groups. There was no significant difference between dental caries and daily consumption of fruits, vegetables, cereals, meat and legumes. However, there was a highly significant association between dental caries and daily consumption of sugars ( $P < 0.001$ ). Approximately half of children (54%) who were caries-free were reported to consume sugars  $\leq 3$  times per day. More children (73%) who were caries-free were reported to consume

adequate amounts of milk and other dairy products.

In order to determine the most important confounders associated with the risk of dental caries, all independent variables revealed by univariate analysis as significant were considered in the multiple logistic regression analysis (Table 3). This showed that sugar consumption  $> 3$  times a day increased the risk of caries by 5.26. Poor oral hygiene also increased the risk by 2.98, while consumption of dairy and other milk products reduced the risk of having dental caries by 2.45 regardless of mother's

education, father's education, economic status and tooth brushing.

Table 4 shows the association between gingivitis and daily consumption of food groups. There was a significant difference between gingivitis and daily consumption of sugars. Severe gingivitis was more frequent in children who reported to consume sugars  $> 7$  times a day (40% versus 22% who consumed sugar  $\leq 3$  times per day,  $P = 0.003$ ). In addition, severe gingivitis was more frequent in children who were reported not consuming adequate intake of milk and other dairy products (47% versus 33% mild gingivitis,  $P = 0.038$ ). Moreover, severe gingivitis was more frequent in children who reported inadequate intake of vegetables and fruits rich in vitamin C (51% versus 42% mild gingivitis,  $P = 0.027$ ). There was no significant difference between gingivitis and daily consumption of other food groups.

In order to determine the most important confounders associated with

**Table 3 Multiple logistic regression analysis for dental caries**

Independent variable	OR (95% CI)	P-value
Sugars ( $\leq 3$ versus $> 3$ times/day)	5.26 (3.06-9.06)	< 0.001
Dairy (adequate versus inadequate)	2.45 (1.35-4.42)	0.003
Oral hygiene (good/fair versus poor)	2.98 (1.63-5.47)	< 0.001

Dependent variable: dental caries.  
OR = odds ratio; CI = confidence interval.

**Table 4 Association between gingivitis and daily consumption of food groups**

Consumption of food groups	Mild (n = 258)		Moderate (n = 201)		Severe (n = 45)		P-value <sup>a</sup>
	No.	%	No.	%	No.	%	
<b>Fruit &amp; vegetables: vitamin C-rich (tomatoes, oranges)</b>							
Adequate	149	58	91	45	22	49	0.027
Inadequate	109	42	110	55	23	51	
<b>Fruit &amp; vegetables: vitamin A-rich (carrots, spinach)</b>							
Adequate	90	35	64	32	12	27	0.508
Inadequate	168	65	137	68	33	73	
<b>Fruit &amp; vegetables: other (bananas, peas)</b>							
Adequate	73	28	52	26	9	20	0.478
Inadequate	185	72	149	74	36	80	
<b>Bread &amp; cereals (pasta, rice)</b>							
Adequate	116	45	78	39	17	38	0.350
Inadequate	142	55	123	61	28	62	
<b>Dairy (milk, yogurt, cheese)</b>							
Adequate	172	67	113	56	24	53	0.038
Inadequate	86	33	88	44	21	47	
<b>Meat &amp; legumes (eggs, chicken)</b>							
Adequate	90	35	64	32	8	18	0.076
Inadequate	168	65	137	68	37	82	
<b>Sugars (chocolate, jam) (times/day)</b>							
≤ 3	80	31	38	19	10	22	0.003
3–7	120	47	92	46	17	38	
> 7	58	22	71	35	18	40	

<sup>a</sup>Chi-squared test.

the risk of gingivitis, all independent variables revealed by univariate analysis as significant were considered in the multiple logistic regression analysis (Table 5). Sugar consumption > 3 times a day increased the risk of having gingivitis by 1.82. Poor oral hygiene increased the risk of having gingivitis by 18.5 and not practising tooth brushing increased the risk of having gingivitis by 1.98 regardless of all variables included in the analysis.

## Discussion

The present study investigated the relationship between dietary patterns and oral health using a food frequency questionnaire to evaluate food consumption. Previous studies have found that food frequency questionnaires are a valid tool for investigating a relationship between diet and dental diseases [21]. In the present study, the questionnaire was designed to be easily understood,

simple and quick to complete and inexpensive to administer.

Inadequate intake of all food groups by schoolchildren was noted except for sugars. Milk and dairy products were sufficient in 61% of children because they ate yogurt and cheese daily at breakfast or dinner. The intake of vegetables was sufficient in 43% of children and about 42% of children had sufficient cereals. The reason for the low consumption of cereals may be due to the classification of all foods containing both cereals and sugars as sugars.

Only 32% and 29% of children consumed meat and fruits adequately. The majority of children consumed meat 2–3 times per month. The diet of the children was based on bread, yogurt and cheese, tomatoes and the main source of protein was eggs.

**Table 5 Multiple logistic regression analysis for gingivitis**

Independent variables	OR (95% CI)	P-value
Sugars (≤ 3 versus > 3 times/day)	1.82 (1.07–3.09)	0.026
Oral hygiene (good/fair versus poor)	18.5 (11.6–29.6)	< 0.001
Tooth brushing (yes versus no)	1.98 (1.18–3.32)	0.010

Dependent variable: gingivitis.

OR = odds ratio; CI = confidence interval.

The results presented were similar to those which demonstrated that diet was deficient in all food groups in Indian children aged 6–12 years [22]. The study reported that the intake of milk and fruits were almost zero, and the diet was supplemented by green leafy vegetables and rice. Similarly, in the United States it was found that only 30% of children aged 2–11 years met the recommendations for fruits, cereals, meat and dairy products, and only 36% of them met the recommended intake of vegetables [23]. In Taiwan, it was found that children aged 6–12 years had a low intake of fruit, vegetables, cereals and dairy products, but a high intake of protein-rich foods [24].

Our results showed a large intake of sugars. Yabao et al. reported similar results in children aged 6–12 years from the Philippines [25]. The intake of sugar was double the WHO recommended intake [25]. Similarly, other studies have noted a high intake of sweets and desserts by children in the United States [26,27].

Not surprisingly, this study found a highly significant association between dental caries and daily consumption of sugars (OR 5.26). These findings are in agreement with many other studies [5,28]. The drop in the pH of the oral environment and the consequent demineralization of the tooth enamel [3] may explain these findings.

Our study also found a significant relationship between dental caries and consumption of dairy products (OR 2.45), which again has been reported previously by many studies. These demonstrated an association between higher dairy intake and reduced rates of caries and attributed this to the presence of fat, calcium, phosphorus and case in which are considered as protective factors [7,8].

The present study did not find any association between fruit consumption and caries. This result may be due to the low consumption of fruits by the children. It should be emphasized that this point is controversial. Some studies have suggested that consumption of fresh fruit with its high carbohydrate content may increase the risk of dental caries [29], while others have found an association between eating fruits and decreased rates of dental caries [12]. Future, more comprehensive studies of fresh fruits and their carbohydrate content would be helpful to investigate the role of fruits in dental caries.

When all variables were combined in multiple logistic regression analysis, sugar consumption, dairy product consumption and oral hygiene emerged as having a significant effect on the prevalence of dental caries, while other variables (mother's education, father's education, economic status and tooth brushing) had no significant effect. Sugar consumption was also associated with a higher presence of severe gingivitis (OR 1.82). This is in agreement with a previous study which found that frequent sugar intake resulted in increased gingival inflammation in young adults [9]. Those results were explained by the association between high sucrose intake and increased plaque volume due to the production of extracellular glucans.

Interestingly, multiple logistic regression analysis showed that dairy products and the consumption of vitamin C did not have an important role in gingivitis when compared with factors such as oral hygiene (OR 18.5, 95% CI: 11.6–29.6), sugar consumption (OR 1.82, 95% CI: 1.07–3.09) and tooth brushing (OR 1.98, 95% CI: 1.18–3.32). Children at highest risk of

gingivitis were those who had abundant plaque and who consumed sugars > 3 times per day. Previous studies have found an inverse association between the intake of dairy products and the prevalence of periodontitis [30,31]. It has been suggested that adequate diet and nutrition may improve the resistance of individuals to infection and may also influence the virulence of periodontal pathogens and plaque formation by providing bacteria with the necessary nutrients or by altering their surrounding environment [31]. A previous study has found an association between reduced intake of vitamin C and increased risk of periodontal disease in adults [11], and explained the important role of vitamin C in decreasing the permeability of the gingival epithelium and thus preventing penetration of bacterial toxic substances into the periodontal tissue. Studies which investigated dietary patterns in different ethnic and age groups may explain the disagreement with our results.

The present study provides information about the dietary patterns and their relationship to oral health of children aged 6–12 years. Future research would benefit from a larger sample and investigation of different age groups to confirm these findings. Inadequate consumption of food groups except for sugars was found, and sugar consumption was a risk factor for dental caries and gingivitis. Oral hygiene had the strongest association with gingivitis. We recommend that advice about diet, especially restriction of sugar consumption, should be applied in educational programmes in schools in the Syrian Arab Republic. In addition, national programmes of dental health education are needed to improve the oral health behaviour and brushing habits.

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