Dental caries prevalence and risk factors among 12-year old schoolchildren from Baghdad, Iraq: a post-war survey

Nibras AM Ahmed, Anne N Åstrøm and Nils Skaug
Bergen, Norway

Poul Erik Petersen
Geneva, Switzerland

Aim: To examine the prevalence of dental caries in 12-year-old schoolchildren from Baghdad after the end of the United Nations' economic sanctions and to investigate related dental caries risk factors including gender, socio-demographic factors, oral hygiene and sugar intake. **Design:** A cross-sectional dental caries examination and questionnaire survey was conducted in 10 schools from west Baghdad. **Methods:** Dental examinations based on WHO criteria and questionnaire surveys were performed on 392 children. Water samples were collected and fluoride concentration assessed. **Results:** The mean DMFT and DF were 1.7 and 1.3. The rate of caries experience (DMFT>0) was 62%. DMFT increased significantly with higher education of the mother, not being embarrassed to smile, missing school due to dental pain and between-meals mode of drinking. Increased sugar consumption was associated with being a boy, having mothers with low education, living in a low socio-economic area and brushing at least once-a-day. Positive oral hygiene practices were higher for girls. Western sweet snacks were preferred and sweet tea was frequently consumed. The fluoride content in drinking water was too low for caries prevention. **Conclusion:** It is important to maintain the low prevalence of caries among children by increasing awareness and promoting oral health care strategies

Key words: Dental caries, sugar intake, oral hygiene, Iraq

Previous studies have documented the effect of wartime on the prevalence of dental caries[1,2]. Iraq has been through two wars over the last two decades and suffered from 13 years of economic sanctions. Nutrition, the health system and daily living conditions of the Iraqi population have been profoundly influenced by the wars causing political and economical instability. During the last two decades, little has been published about the oral health status and oral health related behaviours of Iraqi children.

Information on the global level of dental caries has been recorded through the World Health Organisation (WHO) oral disease surveillance systems[3], in addition to information acquired from other oral epidemiological studies applying WHO methodology. In the developed countries, decline in dental caries prevalence has been attributed to population-based preventive programmes with use of fluoride, improved participation in oral health programmes and changes in oral hygiene and sugar intake habits. On the other hand, in many developing countries an increase in dental caries has resulted from unhealthy dietary habits, limited use of fluoride and poor access to oral health services. In many developing countries, most oral health services provide symptomatic treatment with little priority given to restoration and prevention. The urbanisation and adoption of Western lifestyles into many developing countries in the absence of public prevention programmes have also caused a sudden increase in dental caries. Dental caries affects 60-90% of schoolchildren in most developed

countries, and in several developing countries the prevalence rates are increasing[3]. Twelve-year-olds represent a standard age category used by the WHO to assess and compare dental caries levels in the permanent dentition of children worldwide.

Dental caries is a multi-factorial disease. Conclusive evidence show an association between frequent sugars intake and dental caries[4]. Shifts in caries prevalence have been noticed during wars when there were sugar cutbacks[1,2]. In modern societies, dental caries prevalence and sugar consumption have also been linked to ethnic background, socio-economic class and parents' educational level[5-11].

Few studies have investigated dental health in the Iraqi population. Previous reports on the sweet preferences and dental caries in Iraqi children demonstrated that the level of sugar intake was high and that sugar consumption was positively associated with DMFT scores[12,13]. Urban individuals showed a much higher preference and consumption of sugar than their rural counterparts. Within the urban population, individuals who had lived longer in the city and who were from families with lower educational backgrounds had the highest levels of sugar consumption[14]. Finally, the observed decrease in the caries prevalence among children after years of economic sanctions was attributed to the low availability and consequently low consumption of sugar during those years[15].

Focusing on 12-year-old schoolchildren from Baghdad, Iraq, this study addresses the following purposes; to assess the level of dental caries, oral hygiene and sugar consumption habits shortly after the end of sanctions; to examine socio-economic correlates of children's caries experience and sugar consumption; to provide baseline information for planning and evaluation of oral health promotion programmes for Iraqi schoolchildren.

Material and methods

Study area

Iraq is located in the Middle East, having a total area of 437,072 km^2 and a total population of 26,074,906[16]. About 4-5 million people live in the capital Baghdad. Baghdad is homogeneously divided by the Tigris River into a Western and Eastern section, which in turn is subdivided into many districts of varying socio-economic standards of living. All schools are public in Iraq and schoolchildren enter secondary school at the age of 12. Secondary schools are established by gender into girls' and boys' schools.

Study population and sampling procedure

The study population consisted of 12-year-olds attending secondary schools for boys and girls in western Baghdad. Five districts of varying socio-economic status were selected purposely for the present cross-sectional study. The districts chosen were densely populated, located in or close to the centre of the city with a well defined socio-economic status. Since schools in the low socio-economic areas had more students per class, two districts from each of the high and middle socio-economic areas were selected whereas only one district was chosen from the low socio-economic area. To meet the study objectives, the sample size was estimated to be a minimum of 384 participants. The sample size was calculated based on an assumed caries prevalence of 50% and a standard error of 5%. From each district two schools (one for boys and one for girls) were selected randomly. In each of the 10 schools selected, the first classroom (usually alphabetically listed as class A) was chosen. Each class consisted of approximately 25-45 students. Children were asked for their birth year and only those who confirmed that they were born in 1991 were invited to participate in the study. In case of need for more participants, additional children from the next class were asked to participate. In total, 392 12-year-olds (49% boys) were recruited for the study and the response rate was 99.7%.

The fieldwork took place in mid-October 2003 to allow for a higher student attendance. A legal permit and written statement was obtained from the Ministry of Education to conduct clinical oral examinations and questionnaire surveys in the classroom during school hours.

Data collection

A questionnaire was structured containing 42 questions on socio-demographic factors, perceived oral and general health, oral hygiene and oral diet. The questionnaire was constructed first in English and then translated into Arabic. A pilot study was conducted on 12-year-olds in Baghdad to validate the Arabic phrases used in the translation to match the local dialect and ensure the precise comprehension of the children. The Arabic version of the questionnaire was later back-translated into English. The schoolchildren were initially informed about the purpose of the study, the data anonymity and the free will to participate. Children were divided into sub-groups of 20 individuals. Each group was guided throughout the questionnaire by the supervisor first reading each question aloud. The supervisor kept strictly to the text of the questionnaire without expanding the meaning of the questions to avoid a guided questionnaire. Misunderstandings due to difficult sentence structure were clarified by rephrasing the questions to a simpler form. Care was taken that children answered all questions and did not duplicate each others' answers.

Social and demographic characteristics

Socio-demographic characteristics were assessed in terms of gender, parents' highest level of education and socio-economic status, which was classified according to the socio-economic area of the school they attended.

Perceived oral and general health

The children rated their oral and general health situation in four Likert-scale questions. Children were also asked if they had felt embarrassed to smile, missed school or experienced eating problems from dental pain.

Oral hygiene and dental visiting habits

Frequency of tooth cleaning was assessed in terms of more than once-a-day, once-a-day, several times a week and seldom/never. Cleaning teeth after eating, using a toothbrush or finger, using toothpaste, and visiting a dentist either for a regular check-up or for dental pain treatment were also assessed.

Sugar intake

The frequency of sugar snacks consumption was assessed in terms of chocolate/ice-cream/toffee, local sweets (usually in a form of pastry with nuts and syrup), cakes/biscuits and dates/date syrup (very sweet fruit traditionally consumed by many Iraqis) intake. Sweet drink intake was assessed in terms of sugared tea / milk and soft drinks. An additive index on sugar consumption ranging from scores 4 to 16 was constructed from questions regarding sugar snacks (i.e. chocolate, local sweets, biscuits and dates) with value 4 representing the least frequent intake and value 16 representing the most frequent intake. A sugar drink score ranging from 2 to 8 was also constructed as a sum score of sugared tea/milk and soft drinks intake with value 2 representing the least frequent intake and value 8 representing the most frequent intake. The mode and preferred time of day for eating and drinking were also assessed.

Oral examination

Oral examinations were performed in the classrooms under daylight using dental mirrors and ball-tipped WHO dental explorers (CPI probes). All examination instruments were sterilised in an autoclave. Cotton rolls were used to control salivation during examination. Examinations for dental caries by the main investigator and a calibrated dentist from Baghdad were carried out using the WHO standard criteria and procedures[17]. The registration system records dental caries at the cavity level and uniform caries registration between the two examiners was observed.

Water samples and fluoride concentration

The river Tigris is the main source of drinking water in Baghdad. All water pipe systems originate from the water purification centre which is located by the main river stream. Water samples were collected from the schools' drinking water and one school was chosen for each district. Another sample from the main river water purification centre was taken. Water samples were collected in special 30ml propylene tubes with screw caps. The samples were kept in a cool place and the level of water in the six water samples was marked to ensure no evaporation would occur during transfer. The samples were analysed in the Clinical Research Laboratory, Faculty of Dentistry, University of Bergen. The fluoride concentration was measured with a 9609 BN Model Fluoride Specific Electrode connected to Orion Research Model Ion Analyzer[18].

Statistical analysis

The Statistical Package for Social Science (SPSS version 12) was used for the analysis of data. Cross tabulation, Chi Square analysis and one way ANOVA were used for bivariate analyses. Multivariate analyses with sugar frequency sum score and DMFT as dependent variables were conducted using GLM ANOVA. The significance level was set at 5%.

Results

Sample profile

Table 1 shows distribution of the participants by socio-demographic factors. Significantly more girls reported a high level of father's education (*p<0.05)*. The educational levels of the parents were significantly associated with the socio-economic area of the children's school (*p<0.001)*.

Caries experience

The caries index for the study group as a whole was 1.7, and the D-component (DT) contributed most to the DMFT index in both boys and girls. The mean FT score was significantly higher for children having mothers with higher education, fathers with higher education and for residents of higher socio-economic areas, as compared to their counterparts in the opposite groups. Mean FT scores were also higher in girls than in boys while DT and MT scores showed minor variation according to gender, area or socio-economic status. DMFT scores varied with the mother's education being significantly higher in children with mothers of higher education compared to those having mothers of lower education (*Table 2)*.

Table 1 Percentage distribution of participants by socio-demographic factors

	Boys (n=193)	Girls (n= 199)	Total (n=392)
Father's education			
Low	29.5	20.6	25.0
Intermediate	24.9	22.6	23.7
High	45.6	56.8 *	51.3
Mother's education			
Low	38.9	31.2	34.9
Intermediate	28.5	30.2	29.3
High	32.6	37.7	35.7
Socio-economic area			
Low	34.7	31.2	33.0
Middle	33.2	39.7	36.5
High	32.1	29.1	30.6

** $p < 0.001$, * $p < 0.05$

Table 2 Mean DMFT index and standard deviation (sd) for 12-year olds by socio-demographic factors and gender

	DT (sd)	MT (sd)	FT (sd)	DMFT (sd)
Mother's education				
Low	1.3 (1.7)	0.09 (0.4)	0.1 (0.6)	1.5 (1.8)
Intermediate	1.2 (1.6)	0 (0)	0.2 (0.5)	1.4 (1.7)
High	1.4 (1.8)	0.06 (0.3)	0.5 (1) **	2.0 (2.2) *
Father's education				
Low	1.4 (1.8)	0.09 (0.4)	0.1 (0.5)	1.7 (2)
Intermediate	1.2 (1.6)	0.02 (0.2)	0.2 (0.6)	1.4 (1.7)
High	1.3 (1.7)	0.05 (0.3)	0.4 (0.9) *	1.7 (2)
Socio-economic area				
Low	1.2 (1.5)	0.08 (0.4)	0.01 (0.3)	1.3 (1.7)
Middle	1.5 (1.7)	0.05 (0.3)	0.3 (0.7)	1.8 (1.9)
High	1.2 (1.7)	0.04 (0.2)	0.4 (0.9) **	1.7 (2)
Gender				
Boys	1.4 (1.7)	0.04 (0.3)	0.2 (0.5)	1.6 (1.9)
Girls	1.2 (1.6)	0.07 (0.3)	0.4 (0.8)*	1.7 (1.8)
Total (sd)	1.3 (1.7)	0.1 (0.3)	0.3 (0.7)	1.7 (1.9)

** $p < 0.001$, * $p < 0.05$

The prevalence of dental caries (DMFT>0) was 62.0%. Corresponding figures for DT>0, MT>0 and FT>0 were 54.8%, 3.6% and 15.0%, respectively. There were no differences in dental caries prevalence rates measured by DMFT>0 between the different socio-economic areas or between boys and girls. FT>0 was significantly lower for children from the low socio-economic area compared to children from high and middle socio-economic areas. *Figure 1* depicts the frequency of decayed teeth (DT>0) by tooth-type in the upper and lower jaws. Ninety percent of all decayed teeth were molar teeth and 59% of all decayed teeth were lower molar teeth.

Self-reported dental health

Substantial proportions of children reported "good" oral health (89.8%), "good" general health (82.7%) and high satisfaction with their dental status (87.5%). More girls reported "good" general health compared to boys (90.7% *vs* 74.9%, *p<0.001*). Regarding dental problems, about one fifth of the children reported to have missed school hours because of dental pain. Nearly half of the children reported having experienced eating problems and almost one fifth reported feeling embarrassed to smile because of their teeth. The self-reported dental impacts were similar for boys and girls.
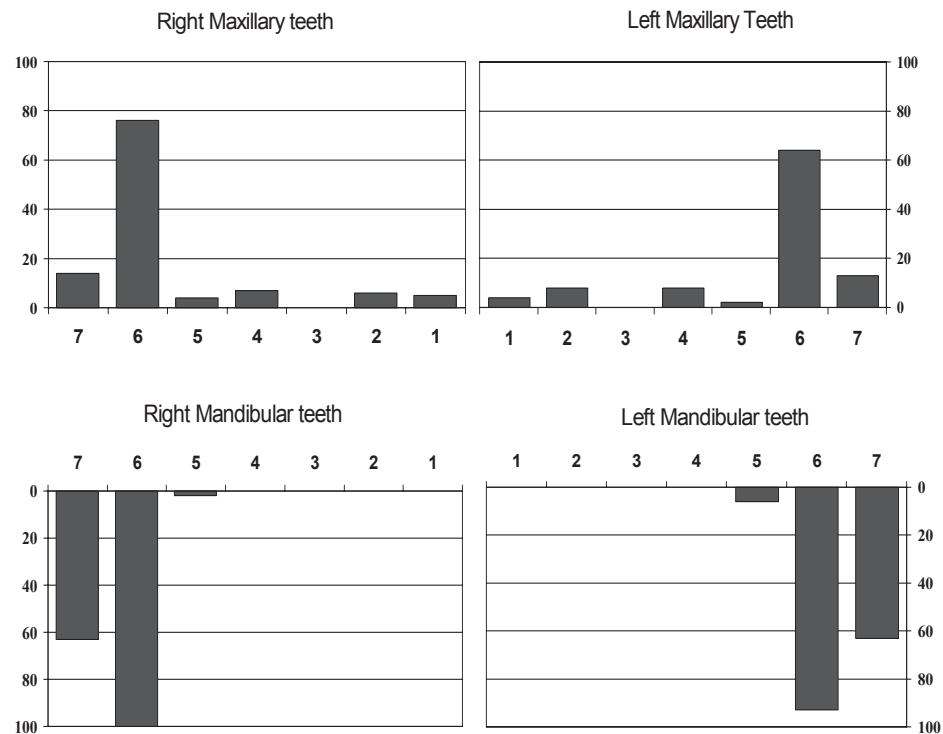
Figure 1. The frequency distribution (n) of decayed teeth (DT>0) in the upper and lower jaw

Table 3 Percentage distribution of sugar snacks and drinks intake and mean sugar sum score by gender (n= 392) among those who confirmed "at least once-a-day" intake

	Boys (n=193)	Girls (n=199)	Total (n=392)
Sugar snacks			
Chocolate/ice-cream/toffee	31.1	27.1	29.1
Local sweets	15.5 **	3.0	9.2
Cakes/pastry	14.5	11.1	12.8
Dates and date syrup	11.4	7.5	9.4
Sugar drinks			
Sugared tea/milk	40.9 **	23.1	31.9
Soft drinks	24.9	17.6	21.2
Mean Sugar snack score (sd)	9.5 (2.7) **	8.9 (2.4)	9.2 (2.6)
Mean sugar drink score (sd)	6.0 (1.2) **	5.32 (1.4)	5.65 (1.3)

* $p < 0.05$, ** $p < 0.001$

Oral hygiene and dental visiting habits

Sixty-three percent of all children reported tooth brushing at least once-a-day, 32.4% reported cleaning their teeth after meals, 78.1% made use of a toothbrush whereas 16.6% reported using their fingers instead. A total of 84.7% of children claimed to have their own toothbrush and 81.6% reported using toothpaste with a toothbrush to clean their teeth. Significantly more girls than boys confirmed using a toothbrush (91.5% *vs* 64.2%, *p<0.001*), tooth brushing at least once a day (73.9% *vs* 51.8%, *p<0.001*), having their own toothbrushes (94% *vs* 75.1%, *p<0.001*) and using toothpaste (93% *vs* 69.9%, *p<0.001*) whereas significantly more

boys admitted using their finger instead of tooth-brushing (26.4% *vs* 7%, *p<0.001*). Three out of four children confirmed that they had visited a dentist during their lifetime with 28.7% of the reported visits for regular dental check-ups and 71.2% for dental pain treatment.

Consumption of sugar snacks and drinks

The mean sugar snack score for all the study participants was 9.2 (sd =2.6) and the mean sugar drink score was 5.65 (sd =1.3). The average sugar snack and drink scores were significantly higher for boys than for girls (*p<0.001*). The sweets consumed most frequently more than once-a-day were chocolate/ice-cream/toffee (29%) followed

by cakes/biscuits, dates and local sweets (*Table* 3). The drink consumed most frequently more than once-a-day was sugared tea/milk (31.9%), while 21% reported taking soft drinks more than once-a-day.

A higher proportion of boys than girls reported intake of local sweets more than once-a-day (*p<0.001*). Consumption of tea/milk with sugar more than once-

a-day was also significantly more frequent in boys than girls (*p<0.001*). Boys also took their drinks "all in one go" more frequently than girls (*p<0.05*). Finally, girls had significantly higher preference to taking sweetened drinks "after meals" compared to boys (*p<0.05*) (*Table 4*).

Table 4 Percentage distributions of preferred mode and time of sugar snacks and drink intake by gender

	Boys (n=193)	Girls (n=199)	Total (n=392)
Preferred mode of sweet consumption			
Sugar snacks all in one go	40.9	40.7	40.8
Sugar drinks all in one go	67.9*	55.3	61.5
Preferred time for eating sweets			
At mealtimes	3.6	1.5	2.6
Between mealtimes	19.7	20.6	20.2
After meals	44.0	45.7	44.9
At all times	32.6	32.2	32.4
Preferred time for taking sugared drinks			
At mealtimes	23.8	23.1	23.5
Between mealtimes	7.8	9.5	8.7
After meals	41.5*	32.2	36.7
At all times	26.9	35.2	31.1

* *p* < 0.05

Table 5 Unadjusted and adjusted mean scores and 95 % CI for DMFT by socio-demographic and behavioural characteristics GLM ANOVA for potential confounding factors

	DMFT			
	Unadjusted Mean	95% CI	Adjusted Mean	95% CI
Mother's education				
Low	1.5	1.2-1.8	1.6	1.3-2.0
Intermediate	1.4	1.1-1.7	1.7	1.3-2.1
High	2.0	1.6-2.3	2.3*	1.8-2.7
Feeling embarrassed to smile				
Yes	1.4	1-1.8	1.5	1.1-1.9
No	1.7	1.5-1.9	2.1*	1.7-2.3
Preferred time for taking sugared drinks				
At mealtimes	1.7*	1.3-2.2	1.8	1.3-2.2
Between-meals	1.6	1.3-2.0	2.1*	1.5-2.8
After meals	1.6	1.3-1.9	1.9	1.5-2.2
At all times	1.5	0.9-2.2	1.3	1.0-1.7
Preferred mode of taking sugared drinks				
All in one go	1.8	1.5-2	2.0*	1.6-2.3
By portions	1.4	1.2-1.7	1.6	1.2-1.9
Missing school				
Yes	2.3**	1.8-2.8	2.3**	1.9-2.7
No	1.5	1.3-1.7	1.5	1.2-1.7

* *p* < 0.05, ** *p* < 0.001

Predictors of caries experience

GLM ANOVA with DMFT as dependent variables revealed statistically adjusted effects of the following socio-demographic and behavioural variables: mother's education (F= 3.2, *p<0.05*), feeling embarrassed when smiling (F= 4.4, *p<0.05*), missing school due to problems with teeth (F= 16.6, *p<0.001*), intake of soft drinks between mealtimes (F=2.9, *p<0.05*) and having soft drinks "all in one go" (F=4.0, *p<0.05*). Unadjusted and adjusted mean DMFT scores are depicted in *Table 5*. Caries experience increased with higher educational status of mother, not feeling embarrassed when smiling, having missed school due to dental problems and different modes of soft drink consumption. The highest caries experience was found for those who preferred between-meals mode of drinking.

Predictors of sugar snacks frequency score

GLM ANOVA was carried out with sugar snack sum score as dependent variable and socio-demographic and behavioural characteristics as independent variables. The analysis revealed statistically significant effects of gender (F= 10.1, *p<0.001*), mother's education (F=3.3, *p<0.05*), socio-demographic area (F=14.1, *p<0.001*) and tooth-brushing (F= 4.7, *p<0.05*) when controlling for father's education and self-reported family economic situation (*Table 6*). High consumption of sugar snacks was associated with being a boy, having mothers with low education, living in a low socio-economic area, and confirming brushing at least once-a-day.

Fluoride concentration of the water samples

There were no significant differences in the fluoride concentration between the five districts and the main Tigris river water supply. The mean fluoride concentration was 0.14ppm.

Discussion

This study was conducted on 12-year-old Iraqi schoolchildren, representing the first generation brought up during years of economic sanctions, sugar restrictions and food rationing systems. The survey was limited to the capital; meanwhile, the profile probably applies to most settings in the country.

The present study provides evidence of relatively low caries prevalence and severity. These results are concordant to the study of Jamel *et al*.[15] on the caries prevalence among 12-year olds children in Baghdad after United Nations' sanctions were imposed. After five years of low sugar availability, DMFT had significantly reduced in 12-year old schoolchildren, irrespective of their socio-economic backgrounds[15].

DT contributed most to the DMFT scores indicating that untreated caries is a problem for the children investigated. The average DMFT scores were higher in children having mothers of higher education compared to children having mothers of lower education. A similar pattern was observed for the FT component in the bivariate analyses indicating a higher prevalence of treated carious lesions in children having mothers of higher education. As shown in *Table 2*, FT varied

Table 6 Unadjusted and adjusted mean scores and 95 % CI for sugar sum score by socio-demographic and behavioural characteristics GLM ANOVA for potential confounding factors

	Sugar score			
	Unadjusted Mean	95% CI	Adjusted Mean	95% CI
Gender				
Boys	9.4**	9.2-10	9.5**	9.8-9.1
Girls	8.9	8.6-9.2	8.7	8.4-9.2
Mother's education				
Low	10.3**	9.8-10.8	9.6*	9.1-10.1
Intermediate	9.0	10.5-11.4	9.3	8.8-9.8
High	8.4	11.2-12.0	8.5	9.2-8.1
Tooth-brushing				
At least once-a-day	9.4	9.0-9.7	9.5*	9.1-9.8
Seldom	9.0	8.6-9.5	8.8	8.3-9.2
Socio-economic area				
Low	10.8 **	10.3-11.2	10.5**	9.9-11.0
Middle	8.7	8.3-9.1	8.7	8.3-9.2
High	8.4	8-8.8	8.3	7.8-8.8

*p < 0.05, ** p < 0.001

systematically with socio-economic area, father's education, and sex, reflecting better oral health awareness and access to dental treatment among girls than boys and among higher than lower socio-economic status groups. The higher mean FT component observed among girls than among boys might reflect a sex difference regarding consciousness over oral appearance. It has been shown that children who had a high consumption of soft drinks were more likely to develop dental caries than those who consumed water or milk[19]. The average DMFT score in the present study was highest among children who reported between-meal consumption of sugared drinks.

The chocolate/ice-cream/toffee category was the sugar item most frequently consumed (29.1%) compared to local sweets (9.2%) and dates/date syrup (9.4%) indicating a higher preference for Western sweets. The higher frequency of local sweet consumption among boys could be due to the fact that such sweets can often be sold in public streets making them more easily accessible for boys in the Iraqi community.

Substantial proportions of children preferred their intake 'after meals' regarding both sugar snacks (44.9%) and sugar drinks (36.7%) *(Table 3)*. As shown in *Table 6*, sugar consumption varied systematically with sex, mother's education and socio-economic status being highest among low educated subjects and among less affluent socio-economic status groups. This confirms previous evidence, suggesting that unhealthy food habits are most common among boys and children of less-educated parents[20]. Mothers from a more educated background might observe and regulate the dietary habits of their children while mothers from a lower educational background might encourage higher consumption of sugared food as a form of indulgence and luxury. Olojugba and Lennon[21] reported that sugar is regarded as a luxury item when it is first introduced or imported into a developing country. Therefore, children from higher social classes are initially those who consume sugared products and experience its oral health consequences. As the use of sugar evolves in a society, it becomes commonly available to the whole population and eventually children from low social classes might also experience an increase in the caries prevalence[22]. Sugar availability was low in Iraq during the 13 years of sanctions and therefore consumption was restricted to rich families who could afford expensive sugar products. This study was carried out shortly after the end of the sanctions when sugar products had become commonly available to the whole population causing a sudden elevation in sweet consumption among the deprived. The results presented in the present study, suggesting an opposite social gradient for caries experience and sugar intake of Baghdad schoolchildren might reflect such a situation.

The degree of satisfaction and attitudes towards oral and general health were high for both genders; however, regular oral hygiene practices were reported more frequently for girls. Most children reported visiting the dentist for symptomatic treatment of dental caries rather than for early diagnosis and prevention.

Even though previous studies in Iraq have documented the fluoride concentration in drinking water[23,24], it was important to re-assess the fluoride level since concentrations can vary with time as a result of climate, precipitation and temperatures over the year. The fluoride concentration was too low to have had any preventive effect on dental caries.

In summary, dental caries prevalence was low in 12-year-old schoolchildren in Baghdad although untreated carious lesions were prevalent. Dental caries were mostly related to higher maternal education and harmful sweet beverage drinking habits. On the other hand, sugar consumption was related to lower maternal education and low socio-economic status. Treated dental cavities were significantly higher in those with higher parents' education and among residents from the higher socio-economic area. It is important that countries with a low intake of free sugars do not increase the intake[4]. At this stage it is crucial to increase awareness among children and their parents of the oral health consequences of high sugar consumption after the ending of the economic sanctions. In addition, community based oral health promotion, fluoride prevention programmes and preventive oriented public dental health care services should be made available and accessible to all Iraqi children and especially for those from the disadvantaged population.

References

1. Toverud G. The influence of war and post-war conditions on the teeth of Norwegian school children. III. Discussion of food supply and dental condition in Norway and other European countries. *Milbank Mem Fund Q* 1957 **35**: 373-459.

2. Takeuchi M. Epidemiology study on dental caries in Japanese children before and after World War II. *Int Dent J* 1961 **11**: 443-457.

3. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century--the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol* 2003 31 **Suppl 1:** 3-23.

4. Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. *Public Health Nutr* 2004 **7**: 201-226.

5. Sundby A, Petersen PE. Oral health status in relation to ethnicity of children in the muncipality of Copenhagen, Denmark. *Int J Paediatr Dent* 2003 **3**: 150-157.

6. Olojugba OO, Lennon MA. Sugar consumption in 5 and 12-year-old school children in Ondo State, Nigeria in 1985. *Community Dent Health* 1990 **7**: 259-265.

7. Nyandindi U, Palin-Palokas T, Milen A *et al*. Oral health knowledge, attitudes, behaviour and skills of children entering school in urban and rural areas in Tanzania. *Public Health* 1994 **108**: 35-41.

8. Blay D, Astrom AN, Haugejorden O. Oral hygiene and sugar consumption among urban and rural adolescents in Ghana. *Community Dent Oral Epidemiol* 2000 **28**: 443-450.

9. Kiwanuka SN, Astrom AN, Trovik TA. Dental caries experience and its relationship to social and behavioural factors among 3-5-year-old children in Uganda. *Int J Paediatr Dent* 2004 **14**: 336-346.

10. Petersen PE. Sociobehavioural risk factors in dental caries-international perspectives. *Community Dent Oral Epidemiol* 2005 **4**: 274-279.

11. Petersen PE, Hoerup N, Poomviset N *et al*. Oral health status and oral health behaviour of urban and rural schoolchildren in Southern Thailand. *Int Dent J* 2001 **51**: 95-102.

12. Jamel HA, Sheiham A. The relationship between sweet preference and dental caries in Iraqi school children. *Odontostomatol Trop* 1986 **9**: 27-33.

13. Jamel HA, Sheiham A, Cowell CR *et al*. Taste preference for sweetness in urban and rural populations in Iraq. *J Dent Res* 1996 **75**: 1879-1884.

14. Jamel HA, Sheiham A, Watt RG *et al*. Sweet preference, consumption of sweet tea and dental caries; studies in urban and rural Iraqi populations. *Int Dent J* 1997 **47**: 213-217.

15. Jamel H, Plasschaert A, Sheiham A. Dental caries experience and availability of sugars in Iraqi children before and after the United Nations sanctions. *Int Dent J* 2004 **54**: 21-25.

16. Central Intelligence Agency. The World Fact Book. Iraq. (Available from the internet at: http://www.cia.gov/cia/publications/factbook/geos/iz.html

17. World Health Organisation. *Oral Health Surveys - Basic Methods*. 4th ed. Geneva: World Health Organisation, 1997.

18. Bardsen A, Bjorvatn K, Selvig KA. Variability in fluoride content of subsurface water reservoirs. *Acta Odontol Scand* 1996 **54**: 343-347.

19. Sohn W, Burt BA, Sowers MR. Carbonated soft drinks and dental caries in the primary dentition. *J Dent Res* 2006 **85**: 262-266.

20. de Vries HC, Lucker TP, Cremers SB *et al*. Food choice and caries experience in Dutch teenagers as a function of the level of education of their parents. *Eur J Clin Nutr* 1990 **44**: 839-846.

21. Olojugba OO, Lennon MA. Dental caries experience in 5- and 12-year-old school children in Ondo State, Nigeria in 1977 and 1983. *Community Dent Health* 1987 **4**: 129-135.

22. Ismail AI, Tanzer JM, Dingle JL. Current trends of sugar consumption in developing societies. *Community Dent Oral Epidemiol* 1997 **25**: 438-443.

23. Baghdady VS, Ghose LJ. Dental caries prevalence in schoolchildren of Baghdad province, Iraq. *Community Dent Oral Epidemiol* 1982 **10**: 148-151.

24. Legler DW, Al-Alousi W, Jamison HC. Dental caries prevalence in secondary school students in Iraq. *J Dent Res* 1980 **59**: 1936-1940.

Correspondence to: Dr. Nibras A. Abdul-Majeed, University of Oslo, Department of Oral Biology, Postbox 1052 Blindern, 0316 Oslo, Norway. Email: nibrasa@odont.uio.no