Dental caries in Iraqi 12-year-olds and background fluoride exposure

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Objective: The aim of this study was to assess the prevalence and severity of dental caries among 12-year-old Iraqi schoolchildren ingesting water and beverages with low fluoride content. ***Method*** A total of 1,526 twelve-year-olds were clinically examined in autumn 2013 for dental caries in accordance with the WHO criteria. Two questionnaires were distributed to gather data concerning daily intakes of drinking water, beverages and tea extracts and how often participants brushed their teeth, visiting doctors and eating snacks between meals. The fluoride content of 279 brands of drinking water, beverages, tea, toothpaste and table salts were determined using fluoride ion selective electrode. ***Results*** The mean DMFT and SIC index were 1.6 (SD 1.7) and 3.5 (SD 1.4) respectively. The caries prevalence was 64.0%, and the Care Index was 1.9%. The average fluoride content of drinking water, beverages, toothpaste and food was less than 0.50 mg/kg. ***Conclusion*** The mean DMFT value for Iraqi 12-year-olds is still higher than the WHO category of very low caries (<1.2). The daily fluoride exposure by 12-year-old Iraqi children was too low for caries prevention. In order to improve the oral health status, the Iraqi health authorities had to focus more care on the preventive oral health programme.

Key words: caries, Iraqi DMFT index, significant caries index (SiC), fluoride in water and beverages

Introduction

In the last 30 years, the prevalence of dental caries in most western countries has steadily declined. The decline was attributed to improved public health measures, including effective use of fluorides, changed living conditions and lifestyles and improved self-care practices (Petersen, 2003). The opposite trend is often reported in some developing countries due to increasing sugar consumption and inadequate exposure to fluoride (Bagramian *et al.*, 2009; Petersen *et al.*, 2005). Since the cost of traditional restorative care of dental diseases would probably exceed the available resources for health care, the World Health Organization (WHO) has put more emphasis on prevention in setting global oral health goals for the year 2020 (Hobdell *et al*., 2003; Petersen, 2008).

Preventive measures such as water fluoridation, the widespread use of fluoridated dentifrices, reducing the frequency and amount of sugar consumption and oral health education seem to be the main contributors for caries reduction.

One of the requirements for the success of prevention-orientated strategies is the availability of a systematic flow of information between the community and the dental profession (Hobdell *et al*., 2003). WHO recommends that countries conduct regular oral health surveys every five years if possible, so that changes in oral health patterns and trends can be identified early enough for appropriate and timely planning of services (Nithila, 1998).

So far little is known about the current oral health status of Iraqi children although two destructive wars, and a decade of debilitating sanctions, have left Iraqis without genuine oral health care. Recently Ahmed (2007), reported that the mean DMFT index (Decayed, Missing, or Filled Permanent Teeth) of Iraqi children was 1.7 and the caries prevalence (DMFT>0) was 62%. These levels are higher than the WHO category of very low caries (<1.2) and behind the leaders in dental caries prevention such as Switzerland, Britain, Netherland, Germany and Denmark (0.9, 0.7, 0.8, 0.7 and 0.7 respectively) (WHO, 2011).

This study has been carried out to assess the prevalence and severity of dental caries among 12-year-olds in urban areas of Babil-Iraq and to estimate the average daily fluoride intake of children from drinking water, beverages, toothpaste, table salt and food. This study is the largest and most systematically representative epidemiological dental survey of Iraqi 12-year-olds during the last decade.

Method

The prevalence and severity of dental caries was investigated in autumn 2013 among 1,526 (844 boys and 682 girls), 12-year-olds attending public schools with good general health. Babil city was divided into four zones: North, South, East and West. In each zone, six public schools were randomly selected (three for boys and three for girls) from the list of 296 urban government schools in order to have equal representation from each zone. The socioeconomic conditions in these schools were similar. This sample size was calculated using the formula $Z^2 \times p \times (1-p)/d^2$. Based on a standard error of 3.5% with 95% confidence intervals (CIs: Z=1.96) and previously reported carries prevalence (62%: Ahmed *et al.*, 2007), a sample of 739 would be needed. This was doubled to give 1,478 as a conservative measure and account for a possible design factors like clustering.

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Children with major systemic diseases or syndromes, and those who were not cooperative and refused examination were excluded. A sample of 1,526 twelve-year-olds was available in the study anticipating some exclusion.

Before the start of the study, the children, their parents and the class teachers were informed and informed consent obtained from all participants prior to data collection. The study design and method were approved by the Iraqi Ministries of Health and Education.

Oral Examination

The oral examination was performed by two calibrated dentists (Kappa>0.80), using No. 4 disposable mouth mirror, sterilized instruments, disinfectant solution, disposable gloves, mask and periodontal probe. Caries was only recorded if there were visible signs of cavitations. Children with developmental defects of the teeth and those who are under fixed orthodontic treatment were excluded. Dental caries experience was reported by the DMFT Index, the prevalence (%) with DMFT>0 and the Significant Caries Index (Petersen *et al.*, 2005).

Fluoride analysis

Fifty samples of tap water (originated from the Euphrates River), 15 nectars, 38 juices, 53 carbonated beverages (carbonated fruit drinks and cola drinks), 13 nonalcoholic beers, 40 bottled waters, 22 black teas, 16 toothpaste and 32 table salts were analyzed for fluoride ion content.

The fluoride concentration was assessed in triplicate with a combined selective electrode (WTW, model F800), coupled with an ion analyzer (WTW, model inoLab pH/ION 735, GmbH Company).

For the determination of fluoride in drinking water and soft drinks, ten mL of each liquid and 10mL of a total ionic strength adjustment buffer solution (TISAB), were mixed with a magnetic stirrer for 20 min (Matloob, 2011). The electrode potentials of the sample solutions were directly compared with those of fluoride standard solutions.

Tea infusions were prepared using 1% tea to boiling water ratio, since this is the infusion ratio commonly used for making of commercial tea drinks (Giljanović *et al.*, 2012; Shyu, 2009). In this procedure, distilled water was boiled in 100mL beaker; 1.0 gram of tea leaves was added to the beaker and allowed to infuse at 80 °C for 30 min (Giljanović *et al.*, 2012). The tea was filtered using a plastic mesh filter and allowed to cool to room temperature. The infusion was filtered again using Whatman 42 filter papers. Finally the volume of the infusion was made 100mL with deionized water to compensate for the loss during boiling. TISAB solution was added and the fluoride contents in tea liquor were determined using the ion-meter.

For the determination of fluoride in toothpaste two grams of each brand was oven-dried at 105°C until constant weight was obtained. Dried toothpastes (1g each) was transferred into Teflon crucible and digested with 5mL concentrated HNO_3 at moderate temperature. After heating for 3-4h, another 5mL acid and few drops of H_2O_2 were added. The mixture was heated further, until the brownish fumes of nitrous oxide ceased and clear solution was obtained. The solution was cooled, filtered, diluted to 100mL and analyzed as before with ion-meter (Oyewale, 2005).

Regarding table salts, two grams of each brand were ashed at 315°C for 6 hours. One gram of ashed salt was weighed into a beaker and mixed with 50mL of boiling deionized water. The mixture was filtered through a Whatman 42 filter paper and analyzed immediately. As controls, ultra-pure 2g NaF samples were similarly ashed and analyzed (Martinez-Mier *et al.*, 2009).

With reference to food, the vast majority (90%) of the dietary energy consumption in Iraq is acquired from 50 food items and the remaining 190 food items consumed by Iraqis provides very little dietary energy (FAO, 2010). In the present work the analysis mainly focuses on these 50 food items (Table 1). Fluoride content of these 50 food items were obtained from various published sources (USDA, 2005). Where a range was quoted the midpoint figure was taken.

Analytical-reagent grade chemicals (Merck, Darmstadt, Germany) were used without further purification. Deionized water was used throughout the experiments. The glassware was kept overnight in a 5% nitric acid solution prior to being used.

The accuracy of this method has been tested in previous work (Matloob, 2011).

Questionnaire survey

Self-administered questionnaires were distributed amongst all the examined children. They were instructed to take them home and fill them as accurately as possible with the aid of their parents. The first questionnaire comprising information on the types, flavors, brand names, frequency of consumption, and the amount of total liquid consumed for seven consecutive days. In the second questionnaire the frequency of tooth brushing, snacking, educational level of the parents and dental visit behavior were recorded.

The response rate from the children was only 1,220 (75%) who returned the questionnaires (completed). All other forms are partially filled.

The present study was carried out in autumn of 2013. Drinking water and beverage consumption at this time of the year is higher than in winter but lower than in summer. The opposite is true for tea extract. However, it was thought that liquid intake in autumn and spring would approximate the annual mean daily consumption. Fluoride exposure through inhalation from the air and soils were not taken into account because these sources of exposure are assumed to be negligible. Moreover, tap water used for cooking or preparing meals and for brushing teeth, was not taken into account.

Data were analyzed using SPSS, v17.0 with analysis of variance (ANOVA) employed when necessary to detect significance differences among means. Unless otherwise indicated, data are presented as mean with standard deviations (SDs). A probability level of $p<0.05$ was considered statistically significant.

Results

Prevalence and severity of dental caries

Included in the study of 12-year-olds were 844 boys and 682 girls with an overall mean of 22.8 (SD 5.1) permanent teeth (Table 2). Their mean number of primary teeth still present was small (0.8) so the report refers only to their permanent dentition.

Table 1. Dietary fluoride intake (mg) calculated using dietary intake

| Food commodity group (mg F/kg)	Quantity consumed (g/person/day)	Mean F* mg/kg	F intake mg/day
Cereals and products	391.2	0.49	0.192
Biscuits 0.26, Bread 0.49, Cake 0.22, Rice 0.19, Wheat 0.27, Macaroni and spaghetti 0.07.			
Vegetables and fruits (average of 18 items)	532.8	0.08	0.043
Apple 0.03, Avocado 0.07, Bananas 0.02, Grape 0.08, Peaches 0.04, Pears 0.02, Plums 0.02, Strawberries 0.04, Watermelon 0.01, Cucumber 0.01, Lettuce 0.05, Lima beans 0.07, Mushrooms 0.10, Onions 0.01, Peppers 0.02, Tomatoes 0.02, Tomato juice 0.07			
Sugars, Syrups and Products	72.6	0.05	0.004
Sugar, granulated 0.01, Chocolate, mix for milk 0.05			
Milk, Yogurt and Cheese	69.7	0.32	0.022
Buttermilk 0.04, Cheese 0.32, Milk 0.03, Yogurt 0.12			
Meat	64.5	0.32	0.021
Beef 0.22, Chicken 0.16, Lamb chop 0.32			
Pulses, Roots and Tubers	79.4	0.49	0.039
Beans 0.02, Potatoes 0.49, Peanuts 0.16, Cowpeas 0.03			
Oils and fats:	36.1	0.05	0.002
Butter 0.03, Margarine 0.05, Vegetable oil 0.01			
Eggs	18.7	0.05	0.001
Fish and Fish Products	16.7	0.18	0.003
Spices	13.5	0.34	0.005
Pepper black 0.34, Mustard, 0.01			
Total	1295.2		0.332

* The maximum concentrations were used in the exposure assessment to provide a conservative estimate of the fluoride exposure in Iraqi 12-year-olds

The distribution of the children's DMFT value is shown in Figure 1 and Table 2. The results indicated that the prevalence of dental caries with DMFT>0 was 64.0%. The mean DMFT for all children examined was 1.63. The mean DMFT in girls was higher of that in boys (1.7 vs 1.5, P<0.05). The decayed component accounted for 95.8% of the DMFT while missing and filling teeth accounted for 2.3% and 1.9% respectively. The filled component contribution was very low, compared with developed countries such as the UK (55%) in 2000-2001 (Pitts *et al.*, 2002).

The same data set was used to compute the SiC index. The mean value of SiC index for 12-year-olds was 3.5 (SD 1.4), with no significant difference between boys 3.5 (SD 1.4) and girls 3.5 (SD 1.5). As expected, the SiC value was about twice the value of the DMFT index.

The main sources of fluoride exposure

The distribution of fluoride contents in drinking water, soft drinks, nonalcoholic beers and 1% infusions of black tea samples is shown in Figure 2. The mean fluoride content of 50 samples of tap water and 40 bottled waters were 0.18mg/L (SD 0.04) and 0.07 mg/L (SD 0.07) respectively. No significant difference was found in fluoride levels between Iraqi bottled waters and those imported from Iran, Turkey, Kuwait and Jordan. The average quantity of tap and bottled water consumed by Iraqi children in Babil was estimated (through questionnaires) to be 1,320ml (SD 360) daily in autumn (Table 3).
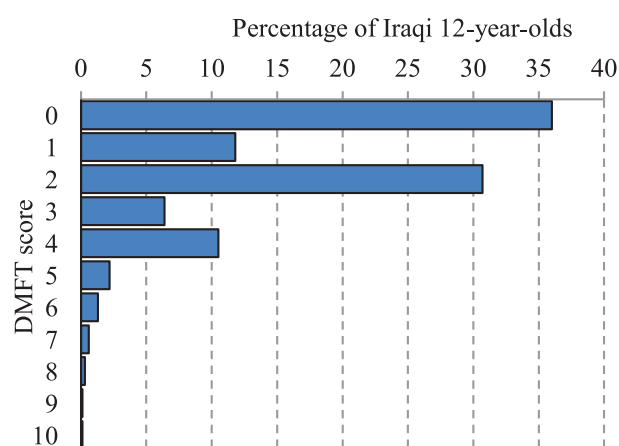
Figure 1. *Distribution of 12-year-old Iraqis according to their DMFT score*

The mean fluoride contents in 119 samples of beverages studied were nectars 0.12mg/L (SD 0.09), carbonated fruit drinks 0.12mg/L (SD 0.11), non-carbonated fruit drinks 0.20mg/L (SD 0.33), cola drinks 0.10mg/L (SD 0.04) and nonalcoholic beers 0.20mg/L (SD 0.10). The fluoride concentration of all the beverages analyzed ranged from 0.02 to 0.50 mg/L. The fluoride content of most juices and juice flavored drinks in this study was well correlated with the amount of fluoride in the water used to manufacture the product. Of the juices and juice-flavored drinks tested,

Table 2. Prevalence of dental caries in permanent teeth of 12-year-schoolchildren

Variables	Overall (n=1,526)	SD	n	Boys (n=844)	SD	n	Girls (n=682)	SD	n
Mean number of teeth present	22.8	5.1		21.1	6.0		23.3	4.9	
Mean DMFT	1.63	1.66		1.55	1.68		1.71	1.63	
Mean DT	1.55	1.48		1.48	1.47		1.64	1.59	
Mean MT	0.04	0.02		0.04	0.03		0.03	0.06	
Mean FT	0.03	0.04		0.03	0.03		0.03	0.06	
Significant Caries Index	3.52	1.42		3.52	1.40		3.54	1.46	
% with DMFT >0	64.0%		976	60.6%		511	68.2%		465
% caries-free	36.0%		550	39.5%		333	31.8%		217
Care Index (%)	1.9%			1.9%			1.9%		

Table 3. Daily fluoride consumption from drinking water, soft drinks, tea extracts, toothpaste and diet

| Source	n	Average concentration (mg/L) mean	(SD)	Quantity consumed (ml) mean	(SD)	Daily intake (mg/day) mean	(SD)
a. Tap water	50	0.184	0.041	1,056	336	0.194	0.076
b. Bottled water	40	0.073	0.066	264	130	0.019	0.019
c. Soft drinks[*]	119	0.148	0.241	307	297	0.039	0.074
d. Tea extracts	22	1.343	0.666	224	214	0.301	0.324
From a,b,c and d				1,851	514	0.553	0.341
e. Toothpaste						0.200	
f. Diet						0.332	
From a,b,c,d,e and f						1.085	0.341

[*]Soft drinks include: nectars, juices, carbonated fruit drinks, cola drinks and nonalcoholic beers

only (5%) were manufactured at fluoridated sites. Regarding nonalcoholic beers, the highest fluoride level was shown in Festival (Turkey) and Delester (Iran), containing 0.40mg/L and 0.39mg/L respectively. The lowest concentration was found in Barbican pineapple (UAE), which contained 0.06mg/L of fluoride. The average quantity of beverages consumed by Iraqi children in Babil was found to be 307mL (SD 297) daily in autumn (Table 3).

Tea (*Camellia sinensis*) is the second most commonly consumed beverage in Iraq. As can be seen from Figure 2, tea had the highest fluoride concentration among other beverages. The fluoride level ranged between Al Barari from Sri Lanka (0.65mg/L) and Al-Nabaa from India (2.06mg/L), with a mean of 1.34mg/L (SD 0.67) (Table 3). The fluoride levels in the present work were within the range recorded by several workers (0.10 to 6.87mg/L) (Karak and Bhagat, 2010).The average quantity of tea extract consumed by Iraqi children in Babil was estimated to be 224mL (SD 214) daily in autumn.

The mean fluoride intake from food was found to be 0.33mg/day (Table 1). This value is slightly lower than the level (0.47mg/day) given by USEPA (2010), based on a relatively high body weight of 51.0kg. This estimate does not include drinking water, beverages and tea extractions, since these are treated separately. On the other hand, none of the thirty two (Iraqi and imported) salt samples analyzed contained significant amount of fluoride. Therefore, there is no considerable contribution from table salts to the total fluoride intake by Iraqi consumers.

Toothpaste that is currently consumed in Iraq is imported from different sources. The mean fluoride concentration of the 16 brands of toothpaste analyzed was 1174mg/kg (SD 175) (684 to 1473mg/kg). Based on information reviewed by Levy *et al.* (1995) and given by USEPA (2010), 0.20mg of fluoride was ingested by young adults who used toothpaste
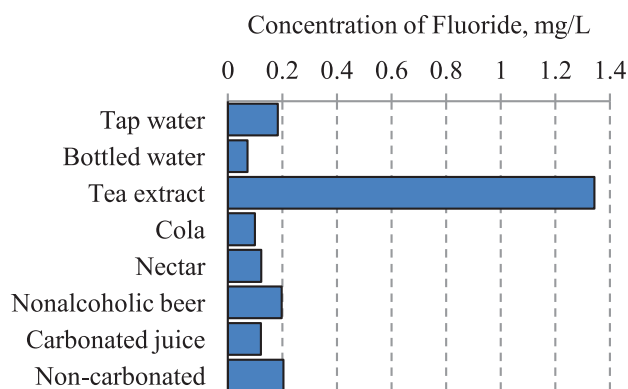
Figure 2. *The distribution of fluoride contents in 1% infusions of black tea samples, drinking water, soft drinks and nonalcoholic beers*

assuming one brushing per day with fluoride toothpaste (0.1% fluoride) and moderate rinsing. These estimates were adopted in this work as an upper bound intake because the questionnaire survey indicated that 80% of Iraqi schoolchildren are brushing once or less daily.

Factors related to high caries experience

The effect of tooth brushing, dietary sugars and snacking habit and dental visits on care experience was investigated using two questionnaires. Out of 1,220 participants, 39% brushed once daily, 17% twice a day, 3% more often and 41% never or less than once. Under 5% used fluoride supplements or mouth rinses. Children who brushed their teeth regularly (twice daily) were found to have healthier teeth than those who brushed seldom (average DMFT 1.5 vs 1.7). More girls than boys (ratio about 3:2) brushed their teeth twice daily (p<0.05).

The surveyed snacking habits among 12-year-old Iraqis found that few children (11%) never snacked between meals. Over 89% of children were reported to have snacked at least once a day and 29% more than twice a day - the latter being at high risk (r=+0.6) of developing tooth decay.

On the other side, most of the children (81%) had never visited a dentist. Of those who had, 10% had teeth extracted and 1% had restorations. Only 1% stated that the reason for the visit was orthodontic treatment, while 7% reported pain. Furthermore, a significant inverse association was observed between DMFT and visiting a dentist (r=-0.4).

Discussion

According to the WHO classification, Iraq with DMFT value of 1.6 is categorized as being low and better than its neighbors: Iran 1.9 (2004), Jordan 3.3 (1995), Turkey 1.9 (2004-2005), Kuwait 2.6 (2000), Saudi Arabia 5.9 (2002), Syria 2.3 (1998) and Lebanon 3.4 (2000) and significantly better than the global goal of no more than three by the year 2000 (WHO, 2011).

Historically, the DMFT score for 12-year-old Iraqis showed a remarkable reduction of 37.0% (from 2.7 to 1.7) between (1982 and 2003) (Ahmed *et al.*, 2007; Baghdady and Ghose, 1982; Jamel *et al.*, 1997; 2004). Despite this overall decline the prevalence of dental caries remains unacceptably high and showed no improvement between 2003 and 2013 although remarkable changes in Iraqis revenue have occurred. Moreover, although caries levels in Iraq could be regarded as low in terms of the WHO classification, the high levels of untreated caries are a cause for concern. These facts make the implementation of prevention strategy a necessity.

Calculation of fluoride Intake

If contributions from drinking water, commercial beverages, tea extracts, food and toothpastes are added together (Table 3), the cumulative daily fluoride intake by Iraqi children will reach 1.085 mg/day (SD 0.341). These values matched well those recently reported by other workers for fluoride intakes in non-fluoridated communities assuming body weights of 40-42 kg for individuals (Health Canada, 2010).

Because data are not available to determine an Estimated Average Requirement (EAR), the reference value that was adopted in the present work is the American Canadian Adequate Intake (AI) (USEPA, 2010; Health Canada, 2010; IoM, 1997). The AI is based on estimated intakes that have been shown to reduce the occurrence of dental caries maximally in a population without causing unwanted side effects including moderate dental fluorosis. For 12-year-olds with a reference weight of 40kg, the AI value is 2.0mg/day (IoM, 1997). In the present work the total fluoride intakes by Iraqi children was 1.09mg/day (SD 0.34). This is about 50% of the recommended AI level to prevent dental caries.

Moreover, the Institute of Medicine (IoM, 1997) established a Tolerable Upper Intake Level (UL) for fluoride in different age, life-stage, and gender groupings. A UL is defined as the maximum level of a total chronic daily intake of a nutrient that is unlikely to pose risks of adverse health effects. In the case of fluoride, the UL

for infants and children up to age 8; (0.9-2.2 mg/day) was selected based on prevention of moderate dental fluorosis. For 12 year olds and all other age groups, the UL (10mg/day) was selected based on the prevention of skeletal fluorosis (USEPA, 2010). Both directives (AI and UL) suggest that in Iraq, there is still room for further reduction of caries by targeting the provision of constant amount of fluoride in potable water.

Water fluoridation

The outcomes of 120 fluoridation studies from different countries have shown ranges of reductions in dental caries of between 40-60% better than their neighbours for permanent teeth and 50-60% for primary teeth in children aged 5 to 15 years who consumed fluoridated water for long periods (Zohouri *et al.*, 2003). Worldwide around 355 million people are receiving artificially fluoridated water. In addition, around 50 million people receive water naturally fluoridated at a concentration of around 1mg/L (Petersen, 2005). Currently, countries like USA, Canada, Brazil, Argentina, Columbia, Chile, Australia, New Zealand, Malaysia, and cities like Hong Kong and Singapore all employ fluoridation schemes (Pizzo *et al.*, 2007).

In Iraq all means of fluoridation other than water fluoridation are hardly controlled and their success depends on frequency of use by persons and their educational and socioeconomic status. In contrast, water fluoridation remains the most equitable and cost-effective method of delivering fluoride to all members of most communities, regardless of age, educational attainment, or income level. Water fluoridation is especially beneficial for communities of low socioeconomic status and has been hailed as one of the ten greatest achievements in public health in the 20th century (Pizzo, 2007).

In the light of these directives, it is recommended that drinking water in Iraq can be fluoridated to enhance the DMFT index. The optimal concentration of fluoride varies according to climatic conditions with the range 0.5-0.7mg/L being generally recommended (Petersen, 2005). Optimizing fluoride levels in water supplies is an ideal public health measure because it is effective and inexpensive and does not require active daily cooperation from individuals.

Tooth brushing

The poor oral hygiene condition of most Iraqi children reflected irregular tooth brushing habits despite the claim that 59% of the children had regular tooth brushing. This could be due to inadequate brushing time, ineffective brushing technique or both factors. It was also possible that some of the children did not brush as they claim.

Our findings link twice daily brushing with healthier teeth, supporting the association reported by others (Harris, 2004). Girls were more likely to brush their teeth twice a day suggesting that they are more aware of their teeth than boys of the same age.

Fluoride toothpaste is effective in preventing dental caries, but its effectiveness depends on frequency of use by persons. In contrast, water fluoridation reaches all residents of communities and generally is not dependent on individual behavior. Combined use of fluoride toothpaste and fluoridated water offers protection above either used alone.

Dietary sugars and snacking habit

To increase fluoridation efficiency and to reach a low caries prevalence, oral health education aiming the control of dental plaque through reduction in sugar consumption and brushing is necessary. In the absence of those sugars in foods and drinks dental caries will not be a public health problem. Sreebny (1982) correlated the dental caries experience (DMFT) of 12-year-olds with data on sugar supplies of 47 countries and found a significant correlation (+0.7). Also, Miyazaki and Morimoto (1996) reported a significant correlation (r=+0.91) between sugar availability in Japan and DMFT at age 12 years between 1957 and 1987. Populations that had experienced reduced sugar availability during the Second World War showed a reduction in dental caries which subsequently increased again when the restriction was lifted.

Iraq society is embarking on a period of rapid socio-economic progress in which changes in traditional habits and customs may be expected. There were corner shops selling sweets to children round every school visited for this study. This easy access to sweets leads to relatively high DMFT index. The vast majority of surveyed children were snacking between meals and those snacking more than once a day were at high risk of developing caries. Recommendations in this regard should be aimed at reducing the frequency and amount of sugar consumption by limiting it to mealtimes.

Dental visit

The mean percentage of children who attended dental clinics in Babil-Iraq is still considered low, when compared with other regions in the world (Zhu *et al*., 2003). Only 19% of children had visited the dentist. The treatment received during these dental visits are professional teeth cleaning (scaling). A smaller proportion of children received curative treatment such as filling, orthodontic treatment and removal of teeth. The explanation for this could be that a high proportion of children were satisfied with the status of their teeth and only children who have problems with their teeth seek dental care. In this study, it has been observed a significant association between lower DMFT and more frequent visits to a dentist (r=-0.4). Accordingly, the parents should not wait for pain occur before they consult the dentist, but should go for regular dental check-ups which may prevent any painful experience in future.

Conclusions

The mean DMFT value for Iraqi 12-year olds is still higher than the WHO category of very low caries (<1.2) and behind the leaders in dental caries prevention

Although caries levels in Iraq could be regarded as low in terms of the WHO classification, the high levels of untreated caries are a cause for concern. This indicates the need to enhance dental care measures among children by increasing awareness of good oral hygiene practices, to focus on restoration of teeth at an early stage of caries and to implement an active prevention programs.

The average fluoride content of drinking water, beverages, toothpaste and food currently consumed in Iraq was too low for caries prevention. The DMFT index rate in Iraq might be reduced further through fluoridation to achieve the WHO very low classification.

There is a need to establish a national system in Iraq for the periodic collection, analysis, and interpretation of oral health data for all indicator age groups suggested by the WHO. Water fluoridation, topical fluoride application, oral health educational programs, an emphasis on proper tooth brushing with fluoride dentifrice, a proper diet, reduction of sugar consumption and regular dental office visits are the most recommended means to achieve maximum protection against dental caries.

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