Factors Associated with Severe Caries among Adults in Kuwait

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Key Words

Caries, severe · Sugar · Bacteria · Saliva · Kuwait

Abstract

Aim: To investigate the relationship between caries etiological factors and occurrence of severe caries among adults in Kuwait. **Methods:** Forty-two adult patients with severe caries, attending Kuwait polyclinics, were compared with 36 caries-free subjects in a cross-sectional study. The patients with severe caries were aged 16 years or older and had a minimum of eight open coronal carious cavities, with the involvement of at least one anterior tooth. In addition, their salivary glands had not been compromised by disease or medication. The caries-free subjects had at least 24 standing teeth, and no carious cavities. Salivary flow rates, buffering capacity, frequency of sugar consumption, and oral hygiene index were measured. Mutans streptococci and *Lactobacillus* counts were determined by the dip-slide method. **Results:** Fisher's exact test or χ^2 test showed that the patients with severe caries had a significantly higher frequency of sugar consumption, plaque index, *Lactobacillus* and mutans streptococci counts, as compared with those who were caries-free. In contrast, no significant difference was observed in salivary flow rates or buffering capacity between the two groups of patients. In the multiple logistic regression analysis, only frequency of sugar consumption, oral hygiene, and mutans streptococci count were found to be significantly as-

sociated with the occurrence of severe caries. **Conclusion:** Severe caries may occur in Kuwait even among adults whose salivary gland functions have not been compromised.

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Introduction

Rampant caries may be defined as a rapidly progressive disease of acute onset, leading to coronal tissue destruction as well as early pulp involvement; it affects all, or almost all erupted teeth, including mandibular incisors that are usually unaffected by tooth decay [1]. The condition is usually found in children and is rare in adults. When found in adults, it is often associated with conditions that cause salivary gland hypofunction, e.g. irradiation of salivary glands, use of antisialogogic drugs, as well as substance abuse, particularly methamphetamine addiction [2, 3], psychogenic disorders, such as late-life depression [4], and autoimmune diseases, e.g. Sjögren's syndrome [5, 6]. Furthermore, Chizonga [7] reported rampant caries as one of the oral manifestations of HIV/AIDS in Zimbabwe.

However, in Saudi Arabia, rampant caries has been described in adult patients with apparently normal salivary gland function [8], but the etiology of the condition was not investigated. In Kuwait severe caries, with clinical presentation rather similar to rampant caries, occurs in

adult patients whose salivary gland functions also appear to be normal. However, severe caries might not only be due to aggressiveness of the disease (as in rampant caries), but also to inability of oral health services to offer restorative care, as well as nonutilization of these services by potential patients. We therefore hypothesized that severe caries occurs among adults in Kuwait, even when their salivary gland functions have not been compromised by disease or medication. A study of primary and secondary caries etiological factors in these adult patients may throw some light on the occurrence of severe caries in adult populations with apparently normal salivary gland functions. Furthermore, results from the study may provide a basis for planning an appropriate preventive management strategy.

The aim of this study was to compare salivary flow rate and buffering capacity, frequency of sugar consumption, oral hygiene, mutans streptococci and *Lactobacillus* counts among caries-free adults and those with severe caries in Kuwait.

Subjects and Methods

Preliminary Study

A preliminary study was conducted to assess the occurrence of severe dental caries among patients attending Primary Health Centers in Kuwait. Dentists randomly selected from 30 Primary Health Centers located in different governorates in Kuwait were requested to document the number of patients that they examined during a period of 1 month, and also to chart the dentitions of adults who had severe caries. Severe caries in adults was defined as the presence of a minimum of 8 open coronal carious cavities in a patient aged 16 years or older, with the involvement of at least one anterior tooth.

Selection of Patients

Forty-two adults with severe caries were selected from dental clinics in Jahra, an administrative area (Governorate) of Kuwait where occurrence of the condition was known to be relatively high. Exclusion criteria were the presence of autoimmune diseases (e.g. Sjögren's syndrome), use of antisialogogic drugs within the past week, history of irradiation of salivary glands, methamphetamine addiction, or any other severe illness.

Data were obtained from patients with severe caries prior to categorizing them into 10-year age groups (i.e. 16–24, 25–34, 35–44, and 45 years and above). Thirty-six caries-free male and female subjects formed the control group, the criteria being at least 24 standing teeth, absence of carious cavities or obvious medical conditions.

The nature of the research was explained to all patients, and they gave their informed consent. In addition, the Research Committee of the Kuwait University Faculty of Dentistry had given ethical clearance for the research.

Caries Diagnosis and Determination of Frequency of Sugar Consumption

Caries diagnosis was by visual examination under adequate illumination in the dental clinic. The explorer was used only for plaque removal.

The frequency of sugar consumption at and between meals was determined for each patient on the basis of dietary history by interview method (11 questions) [9]. To test reproducibility of the results, the interview was repeated in 10 randomly selected patients, after a minimum interval of approximately 3 months.

Salivary Flow Rates

Resting and stimulated salivary flow rates were measured at least 2 h after a meal, with the patient seated comfortably in an upright position. To obtain resting saliva, the patients were told to swallow saliva, stay relaxed, and allow saliva to seep gradually into their mouths. They were then told to hold the saliva for 2 min before spitting into a sterile disposable graduated container (through a funnel) every 2 min, for a total of 6 min, without swallowing in between.

To collect stimulated saliva, the patients were given a small piece of wax 1 cm long, and asked to chew for a period of 30 s, then to swallow any saliva but not the paraffin. The patient continued to chew the wax, and saliva was again collected every 2 min, over a total period of 6 min.

From the volumes of saliva collected, the resting and stimulated salivary flow rates per minute were calculated.

Salivary Buffering Capacity

Salivary buffering capacity was estimated using a commercial colorimetric strip test kit (Vivacare Line CRT buffer, Vivadent, Schaan, Liechtenstein). The test strip was placed on a flat surface and one drop of stimulated saliva was discharged on it, using the pipette supplied by the manufacturer. After 5 min, the color of the test strip was compared with the standard provided. Interpretation of the color chart was as described by Ericson and Bratt-hall [10]: yellow – low salivary buffering capacity (final pH ≤ 4); green – intermediate salivary buffering capacity (final pH 4.5–5.5); blue – high salivary buffering capacity (final pH ≥ 6).

If an uneven color reaction was observed on the test strip, the color representing the lowest buffering capacity was chosen.

Counts of Lactobacilli and Mutans Streptococci

Counts of salivary lactobacilli and mutans streptococci were carried out using a commercial dip-slide kit (Vivacare Line CRT Bacteria 2-in-1, Vivadent). Stimulated saliva was discharged on both surfaces of the dip slide, coated with selective culture media: one surface coated with Rogosa agar for culturing lactobacilli, and the other with mitis salivarius agar for culturing mutans streptococci. A sodium bicarbonate tablet was dropped into the vial before closing it tightly with the cover. After a 48-hour incubation period at 37°C, bacterial growth on the dip slide was compared with standards provided by the manufacturer and a score assigned as follows: 1 = low ($\leq 10^5$ cfu/ml saliva); 2 = high ($>10^5$ cfu/ml saliva).

Oral Hygiene

Oral hygiene status of each patient was measured by the O'Leary hygiene index [11]. This entailed recording the presence or absence of plaque on individual tooth surfaces (mesial, distal

Table 1. Percentage of adults with severe caries among patients attending dental clinics at Primary Health Centers in different Governorates of Kuwait during 1 month

Governorate	Patients	Patients with severe caries	
		n	%
Capital	3,291	5	0.15
Hawally	2,960	12	0.41
Farwaniya	2,402	4	0.17
Ahmadi	1,413	3	0.21
Jahra	1,472	6	0.41
Total	11,538	30	0.26

facial and lingual). The plaque was disclosed with red cat (D&C Red 28, John O. Butler Co., Chicago, Ill., USA). After scoring all teeth, the index was calculated by expressing the number of surfaces with dental plaque as a percentage of all available tooth surfaces. Any crowned or badly broken down teeth were excluded.

Statistical Analysis

Descriptive statistics were presented as median and range, in addition to frequency and percentages. Fisher's exact test or χ^2 test was used to determine any significant differences in the frequency of salivary buffering capacity, in counts of mutans streptococci and lactobacilli between the patients with severe caries and caries-free subjects. The continuous variables, daily sugar consumption, stimulated salivary flow rates and oral hygiene index in the two groups of patients were compared using nonparametric Kolmogorov-Smirnov test, as they lacked the assumption of normal distribution. Stepwise multiple logistic regression analysis was used to determine the effect of frequency of sugar consumption, oral hygiene index, bacterial counts, age and gender on the occurrence of severe caries. The outcome variable in the multiple logistic regression model was categorized into the presence or absence of severe caries. Frequency of sugar consumption, oral hygiene index and age were continuous variables, while bacterial counts and gender were categorical variables in the models. The probability level of $p < 0.05$ was considered significant. The data management and analysis were carried out using statistical software SPSS-PC version 15.0 (Chicago, Ill., USA).

Results

Preliminary Study

The number of adult patients seen by dentists at the selected clinics, together with the number of those with severe caries, are given in table 1. The percentage of patients with severe caries varied between 0.15 and 0.41%, the highest proportion of adults with severe caries being seen in Hawally and Jahra Governorates. On average, se-

Fig. 1. Frequency distribution of teeth with open carious cavities among patients with severe caries.

vere caries occurred in 0.26% of the patients. This indicates that 1 in every 385 patients seen at the selected dental clinics had severe caries. Furthermore, on average, 6 patients with a severe caries problem were seen each month in each governorate.

Age, Gender, and Number of Carious Teeth

The median age of patients with severe caries was 23 years, ranging from 16 to 58 years, while it was 30 (range 17–41) years in the caries-free group. The majority of patients with severe caries were females: 61.9% as compared to 86.1% among the caries-free group. No caries-free subjects could be found to match the patients with severe caries in the age group 45 years and above. The number of teeth with open carious cavities among the patients with severe caries ranged between 8 and 25 (fig. 1). The ratio of posterior teeth to anterior teeth with open carious cavities was approximately 3:1.

Salivary Flow Rates

Data on resting salivary flow rates were collected for only 57 of the patients (30 with severe caries and 27 controls), but stimulated salivary flow rates were measured for all the 78 patients. The median resting salivary flow rates were 0.25 (range 0.02–0.42) and 0.33 (range 0.08–1.17) ml/min among the patients with severe caries and the caries-free controls, respectively (table 2). Similarly, stimulated salivary flow rate was lower in the severe car-

Table 2. Salivary flow rates, oral hygiene index, and daily sugar consumption in patients with severe caries and caries-free controls in Kuwait

Variable	Severe caries (n = 42)		Caries-free (n = 36)		p value
	median	range	median	range	
Salivary flow rates, ml/min					
Resting ^a	0.25	0.02–0.42	0.33	0.08–1.17	0.058
Stimulated	0.67	0.17–2.17	0.92	0.30–3.42	0.381
Oral hygiene index	91.5	0–100	35.9	0–100	0.001
Daily sugar consumption	7.0	3–11	4.0	0–6	0.001

^a Resting salivary flow rates were measured for 30 patients with severe caries and 27 controls.

Table 3. Salivary buffering capacity and bacterial counts in patients with severe caries and caries-free controls in Kuwait

Variable	Severe caries (n = 42)		Caries-free (n = 36)		p value
	n	%	n	%	
Buffering capacity					
Low	7	16.7	3	8.3	0.473
Medium	33	78.6	32	88.9	
High	2	4.8	1	2.8	
Mutans streptococci count					
≤10 ⁵ cfu/ml	18	43.9	32	88.9	0.001
>10 ⁵ cfu/ml	24	56.1	4	11.1	
<i>Lactobacillus</i> count					
≤10 ⁵ cfu/ml	12	28.6	29	80.6	0.001
>10 ⁵ cfu/ml	30	71.4	7	19.4	

For each variable, p value refers to the difference between caries-free (n = 36) and severe caries groups (n = 42).

Table 4. Multiple logistic regression model showing the effect of sugar consumption, oral hygiene, bacterial counts and age on the occurrence of severe caries

Independent variables	Coefficient	Standard error	p value	Odds ratio
Sugar consumption	3.125	1.501	0.037	22.750
Oral hygiene index	0.112	0.055	0.043	1.118
<i>Lactobacillus</i> count ^a	−5.259	3.447	0.005	8.582
Mutans streptococci count ^b	−7.445	3.512	0.034	0.001
Age	−0.151	0.100	0.130	0.859
Constant	−14.560	7.525	0.053	0.000

^a ≤5 × 10⁵ cfu/ml. ^b >5 × 10⁵ cfu/ml.

ies group, in comparison to the caries-free group; however, the difference in the two groups did not reach a statistically significant level.

Oral Hygiene Index and Frequency of Sugar Consumption

The patients with severe caries had a significantly higher O'Leary plaque index (91.5%) than the caries-free subjects (35.9%) (table 2). The median daily sugar consumption was significantly higher among patients with severe caries than in caries-free controls: 7 (range 3–11) among the patients with severe caries, while it was 4.0 (range 0–6) among the caries-free group. The test of intraexaminer reproducibility in the 10 repeated cases resulted in Cronbach's alpha of 0.884, indicating a strong correlation (0.81) and reliability between initial and repeated values.

Salivary Buffering Capacity

Salivary buffering capacity was medium in most of the patients: in 33 (78.6%) of the patients with severe caries, and in 32 (88.9%) subjects of the caries-free group (table 3). Only 2 (4.8%) of the patients with severe caries and 1 (2.8%) of the caries-free subjects had high salivary buffering capacity. No statistically significant difference in salivary buffering capacity was found between patients with severe caries and controls who were caries-free (χ^2 test).

Bacterial Counts

Most of the patients with severe caries had high counts of mutans streptococci and lactobacilli, >10⁵ cfu/ml of saliva being recorded in 24 (56.1%) and 30 (71.4%) of the patients, respectively. In contrast, ≤10⁵ cfu/ml of saliva was recorded for mutans streptococci in 88.9% of the car-

ies-free subjects; the corresponding figure for lactobacilli was 80.6%. χ^2 test showed a statistically significant difference in bacterial counts between patients having severe caries and caries-free subjects (table 3).

Effect of the Variables on the Occurrence of Rampant Caries

Stepwise multiple logistic regression analysis showed that the frequency of sugar consumption, oral hygiene index and counts of mutans streptococci were significantly associated with the occurrence of severe caries in adults. In contrast, *Lactobacillus* count and age were not significantly associated with the occurrence of the disease (table 4). When gender was included in the model, the effect of frequency of sugar consumption on the occurrence of severe caries became insignificant. In contrast, oral hygiene and mutans streptococci counts remained significant, while gender had no significant effect.

Discussion

The definition of rampant caries by Winter et al. [1] presumed carious involvement of mandibular incisors, teeth that are usually unaffected by tooth decay. However, in our preliminary study of patients attending Kuwait polyclinics, there were many adult patients who had open carious cavities on most of their maxillary anterior and posterior teeth, but with no carious mandibular incisors. This is similar to the clinical picture sometimes seen in early childhood caries [12]. Therefore, in the present study, we defined adult severe caries cases as patients aged 16 years or older with multiple open coronal carious cavities (at least 8), including caries of an anterior tooth (mandibular or maxillary incisor, or canine). The minimum number of 8 open carious cavities is much higher than the mean number of carious cavities in Kuwaiti adults [13] aged 16–50. Besides, Al-Ghanim et al. [14] considered dmft >8 as severe caries among children in Saudi Arabia.

As there appears to be no published data on adult rampant or severe caries in Kuwait, the sample size was based on the relationship between the frequency of sugar consumption and caries experience in Riyadh, Saudi Arabia [15]. In this study, the proportion of caries-free subjects who had high frequency of daily sugar consumption (4–5+) was 12.6%, while it was 36% among those with DFS of 7+ (OR = 3.9). Thus, a sample size of approximately 40 each in the experimental and control groups was calcu-

lated to give an 80% power of achieving a 5% level of significance in two-sides test, using the formula described by Lwanga and Lemeshow [16]. Patients with a history of compromised salivary gland functions were excluded in order to test our hypothesis.

The data were collected by one of the investigators (E.S.A.) and his assistant, an experienced dental surgeon in one of the dental centers, located in Jahra, an administrative area of Kuwait, where the prevalence of severe caries in adults was known to be relatively high. The data collection was practiced on several patients, until the research assistant was confident in carrying out the experimental procedures. We initially felt that the procedures lasted too long (over 30 min per patient). To simplify the procedures, and ensure higher patient cooperation, we excluded the measurement of resting salivary flow rate, but measured stimulated salivary flow rate, as salivary buffering capacity and bacterial counts are estimated from stimulated saliva [17]. As the data collection progressed, however, we were able to obtain the data in much less than 30 min. At this stage, we included the measurement of resting salivary flow rate. Thus, we had data on this variable for only 57 patients.

It was apparent from our preliminary study that caries-free adult subjects were not commonly seen at Kuwait Primary Health Centers, the setting for the present study. In fact, a recent national study showed that only 21.7% of 14-year-olds in Kuwait were caries-free [18], and this figure would be expected to be lower among adults. Hence, we were only able to match 10-year age groups for age and gender in the experimental and control groups. Even so, we could not find caries-free subjects in the groups aged 45 years or older that met the selection criteria; hence, the difference in age and gender between the two groups of participants. In spite of this limitation, stepwise multiple logistic regression analysis showed that age and gender had no significant effect on the occurrence of severe caries among adult patients. Therefore, it is unlikely that this factor had a significant effect on the overall results of this study.

Several methods are available for dietary analysis, including the estimation of frequency of sugar consumption, but none is without some shortcoming [19]. Among the popular methods is the use of the 3- to 7-day dietary diary. This method depends heavily on the dedication of the subjects. The intake frequency questionnaire has often been used in field studies, but this depends on an accurate and comprehensive compilation of dietary habits in the community. The 24-hour recall method has been used extensively in research, but the result may not be

representative of the usual diet of the subjects. In the present study, we made use of the dietary history interview [9]. This method aims to obtain dietary history over a long period of time. Although the method requires establishing rapport with the subject to obtain accurate response, it is reasonably reliable: using this method in Saudi Arabia, Al-Qattan [20] reported kappa statistic of 0.816 in the intraexaminer reproducibility test. In the present study, there was also a high level of intraexaminer reliability.

Salivary *Lactobacillus* count has been reported to be of caries-predictive value in healthy subjects [21, 22]. However, in the present study, even though there was a statistically significant difference in the occurrence of *Lactobacillus* counts among patients with severe caries and subjects who were caries-free, multiple logistic regression analysis showed that there was no significant association between these bacterial counts and the occurrence of severe caries among adults. Thus, the significantly higher *Lactobacillus* count may simply be a response to higher daily sugar consumption [23] and cavitated teeth among patients with severe caries, rather than being a factor in the initiation of the disease.

In contrast, this study showed a statistically significant difference in mutans streptococci counts between patients with severe caries and subjects who were caries-free; in addition, stepwise multiple logistic regression analysis showed that these bacterial counts had a significant effect on the occurrence of severe caries. This suggests higher caries activity among patients with severe caries, compared to caries-free controls, which is in agreement with the statement that individuals with high counts of salivary mutans streptococci are more likely to develop caries than those with a lower count in the same community [24, 25].

The statistically significant difference in the frequency of sugar consumption between patients with severe caries and caries-free subjects, as well as the significant effect of the variable on the occurrence of severe caries in the regression models, clearly demonstrate the importance of sugar exposure in the etiology of the disease. This association between frequency of sugar consumption and dental caries is in agreement with previous reports [26–29]. Cury et al. [30] concluded that consumption of sucrose 4–8 times/day results in the development of white spot lesions, and that the oral environment cannot tolerate more than twice daily sugar exposure without significant caries activity, even in the presence of water fluoridation. It is, therefore, not surprising that, in the present study, patients with a median frequency of sugar

consumption of 7 developed severe caries. In fact, frequency of sugar consumption as a risk factor in the development of severe caries had an odds ratio of 22.8 in the present study.

Poor oral hygiene among patients with severe caries and a high frequency of sugar consumption provided an environment for the development of highly cariogenic dental plaque. Thus, oral hygiene was significantly associated with the occurrence of rampant caries in the multiple logistic regression model. The fact that there was no statistically significant difference in median stimulated salivary flow rates and buffering capacity among patients with severe caries and caries-free subjects indicates that host defense against caries attack was similar among the two groups of participants, even though cariogenic challenge was significantly higher among the patients with severe caries. This resulted in higher caries vulnerability among the patients with severe caries. Thus, in Kuwait, a severe caries problem may occur even among adults whose salivary gland functions have not been compromised by disease or medication.

Management of adult rampant caries must, therefore, emphasize dietary control and improved oral hygiene. In particular, maintaining good oral hygiene would be expected to be a crucial practical step in the preventive management of severe caries among adults, especially as the oral hygiene index remained significant when the stepwise multiple logistic regression analysis allowed for both age and gender.

In Kuwait the fluoride level in public water supplies is low (0.177 ppm), but it is possible that the two groups of subjects had dissimilar exposure to fluorides from other sources. The extent to which this could explain the differences observed in the present study is difficult to assess, in view of the very severe cariogenic challenge posed by high frequency of sugar consumption and poor oral hygiene among patients with severe caries. Future studies should, therefore, investigate fluoride exposure from various sources among the patients. It is possible that the onset of rampant caries in the selected patients was during their childhood days [31]. Future longitudinal studies will be needed to clarify this question. Furthermore, the prevalence of severe caries among adults in the Middle East and other parts of the world needs to be determined, as the condition places considerable burden on dental services.

Conclusion

A severe caries problem may occur in Kuwait even among adults whose salivary gland functions have not been compromised.

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