Original Articles

CARIES INCREMENT OVER A 3-YEAR PERIOD IN ADOLESCENT CHILDREN IN RIYADH, SAUDI ARABIA

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العديد من أشكال السكر يمثل الجزء التقليدي من الغذاء في المملكة العربية السعودية، وخلال السنوات العشر تم استيراد كميات من السكر كل عام، مما زاد في كمية السكر المتوفرة في البلاد.

إن الدراسات السابقة لانتشار النخر في المملكة العربية السعودية كالتي تمت سابقاً بواسطة الشمري ومجموعته، والخطيب ومجموعته من الباحثين لم تعط معلومات عن علاقة استهلاك السكريات بزيادة النخر.

ومن المعروف أنه لم تجر دراسات منشورة على حدوث النخر في المجتمع العربي وعلاقته باستهلاك السكريات. وفي الحقيقة فإن مثل هذه الدراسات قليلة نسبياً في العالم.

في هذه الدراسة تم وصف النخر الحادث بين عينات من أطفال المدارس في عمر ١٢ـ١٣ سنة في منطقة الرياض عام ١٩٨٩م. وتم متابعة هؤلاء الأطفال لمدة ثلاث سنوات بهدف تقدير مقدار زيادة النخر لديهم.

وأظهرت هذه الدراسة أن الوجبات الغذائية بين طلاب المدارس تحتوي على الكثير من السكريات في حين يتوفر في المدرسة الشكولاتة والجاتو والمشروبات الغازية. لذلك يمكن توقع زيادة في حدوث النخر في المملكة.

وتبين هذه الدراسة علاقة بين زيادة النخر والخط الأمامي للنخر واستمرارية استهلاك السكر والاعتناء بصحة الفم عند هؤلاء الأطفال.

كما تبين أن زيادة النخر بين البنات كان أعلى بشكل واضح منه في الأولاد وبشكل تقريبي حوالي سن واحدة لكل طفل تصاب بالنخر كل عام.

على الرغم أن هناك علاقة إحصائية واضحة بين القاعدة الأساسية لحدوث النخر وزيادة النخر، فإن التحليل الأساسي أظهر أن القاعدة الأساسية للنخر لا يمكن استعمالها لتوقع النخر المستقبلي. وعلى عكس التوقعات، فإن الأطفال الذين يمارسون الاعتناء بصحة أفواههم ثلاث مرات أو أكثر يوميا لوحظ لديهم زيادة في النخر من هؤلاء الذين لم يمارسوا أي اعتناء بصحة أفواههم.

وأظهرت التحاليل الإحصائية أن هناك علاقة وثيقة بين القاعدة الأساسية لحدوث النخر وزيادته. والعامل الإحصائي كان أصغر من (٠,٠٥) وكان الكثير من الأطفال يتناولون السكر مرتين إلى ثلاث مرات يوميا. كما أنه لا يوجد علاقة أكيدة بين استمرارية استهلاك السكر وزيادة النخر وكان العامل الإحصائي أكبر من (٠,٠٥).

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والأكثر من ذلك لم يكن هناك فرق واضح بالنسبة لاستهلاك السكر بين الإناث والذكور . وكذلك بينت الدراسة الإحصائية أن الإصابة بالنخر كان أعلى في الإناث منه في الذكور وكان العامل الإحصائي أصغر من (٠,٠١).

A longitudinal epidemiological study was carried out to correlate caries increment with base-line DMFT, frequency of sugar consumption and oral hygiene in Riyadh children. A 3-day dietary diary was obtained from 12-13-year-old children prior to an initial dental examination and interview in 1989, while the final dental examination took place three years later. Information was also obtained on the children's oral hygiene practices. Caries increment was significantly higher in girls than boys ($p < 0.01$) and, on the average, approximately one tooth per child succumbed to caries each year. Although there was a statistically significant relationship between the base-line DMFT and caries increment, regression analysis showed that baseline DMFT could not be used to predict future caries experience. In addition, there was no association between frequency of sugar consumption and caries increment. Contrary to expectation, the children who practiced oral hygiene three or more times a day experienced significantly higher caries increment than those who did not practice any form of oral hygiene. As caries increment was relatively low, an annual check-up for caries would appear adequate for most of the children.

Introduction

Sugar forms a considerable part of the traditional diet in Saudi Arabia, an oil rich country, situated between the Red Sea and the Arabian Gulf. Concomitant with the rapid economic development in the Kingdom within the past few decades has been importation of substantial quantities of sugar each year. A study of the dietary habits in Riyadh school children showed that many of their meals contained sugar while school snacks commonly included soft drinks, cakes and chocolates.[1] It is therefore to be expected that caries experience in the Kingdom would be on the increase.

Previous studies of caries experience in the Kingdom, such as those by Al-Shammery et al[2] and Al-Khateeb et al[3], were cross-sectional and provided no information on caries increment. As far as is known, there has been no reported longitudinal study of caries experience in an Arab community. In fact, such studies are relatively few anywhere in the world.[4]

Previously, we described caries experience in 12-13-year-old school children[1] sampled from Riyadh metropolis in 1989. We have followed up these children for a period of three years with the aim of determining their caries increment. In this report, we describe the correlation between caries increment and baseline DMFT, frequency of sugar consumption and oral hygiene practices in these children.

Materials and Methods

A detailed description of the sampling, dietary data collection and clinical examination has been reported elsewhere.[1] Essentially, all the 342 Saudi children aged 12-13 years in 10 randomly selected schools in Riyadh metropolis were included in the sample. Informed consent for the work was obtained from the school headmasters and headmistresses. A 3-day dietary diary was obtained from each of the 342 children, and from the data obtained, the children were categorized according to their frequency of sugar consumption as follows: low, if sugar consumption was not more than once a day; medium, if sugar consumption was 2-3 times a day; and high, if sugar consumption was 4 or more times a day. At an interview carried out on the fourth day, uncertainties about the dietary diary were clarified and information was obtained from the children on their oral hygiene practices. The children were then grouped into those who cleaned their teeth once, twice or three or more times a day.

The children's dentitions were examined for dental caries under natural lighting conditions. Caries diagnosis was predominantly by the visual method, carious lesions being recorded at the cavitation stage. From the DMFT obtained for each of the subjects in 1989 and three years later in 1992, caries increment over the 3-year period was calculated.

The initial dental examination in 1989 was done by one examiner.[1] However, for social reasons, an

Table 1. Initial and final sample size.

Initial Age (Yr)	MALE		FEMALE		TOTAL	
	Initial	Final	Initial	Final	Initial	Final
12	31	29	62	54	93	82
13	110	106	139	121	249	227
Total	141	134	201	175	342	309

Table 2. Frequency distribution of base-line DMFT values in 309 Riyadh children aged 12-13 years.

DMFT	Boys	Girls	Total	% Frequency	% Cumulative Frequency
0	59	53	112	36.2	36.2
1	11	30	41	13.3	49.5
2	20	25	45	14.6	64.1
3	15	26	41	13.3	77.3
4	15	16	31	10.0	87.4
5	9	11	20	6.5	93.9
6	5	6	11	3.6	97.4
7	-	6	6	1.9	99.4
8	–	2	2	0.6	100.0

Table 3. Frequency distribution of DMFT caries increment in 309 Riyadh Children.

Caries	Freque Boys	Girls	Total	% Frequency	% Cumulative Frequency
0	53	24	77	24.9	24.9
1	25	17	42	13.6	38.5
2	30	19	49	15.9	54.4
3	9	21	30	9.7	64.1
4	8	25	33	10.7	74.8
5	5	17	22	7.1	81.9
6	1	19	20	6.5	88.3
7	1	16	17	5.5	93.9
8	1	10	11	3.6	97.4
9	-	2	2	0.6	98.1
10	1	2	3	1.0	99.0
11	-	1 -	1	0.3	99.4
12	-	2	2	0.6	100.0

Table 4. Caries increment over a 3-year period in 134 boys and 175 girls aged 12-13 years in Riyadh.

	Mean DMFT Boys	Girls	Total
Baseline	1.72	2.12	1.96
Increment	1.49	3.90	2.85
Final	3.21	6.02	4.81

Table 5. Relationship between caries increment (DMFT) and baseline DMFT in 309 Riyadh children aged 12-13 years.

Baseline DMFT	Caries Increment (DMFT)							
	0	1	2	3	4	5	6+	Total
0-1	49	20	23	8	11	10	32	153
2-3	19	11	13	10	11	7	15	86
4"	9	11	13	12	11	5	9	70
Total	77	42	49	30	33	22	56	309

df 12 chi square - 21.377 p - 0.045

Table 6. Mean caries increment, measured in DMFT (+ standard deviation) in 309 Riyadh children with varying patterns of sugar consumption as indicated on the 3-day dietary diary.

Dietary Diary	Frequency of Sugar Consumption		
	Low	Medium	High
First Dav			
No. of children	60	196	53
Mean caries increment (± S.D.)	3.10 ±2.92	2.80 ± 2.62	2.77 ± 2.58
Second Dav			
No. of children	51	211	47
Mean caries increment (±S.D.)	3.22 ±3.10	2.87 ± 2.59	2.40 ± 2.53
Third Dav			
No. of children	61	210	38
Mean caries increment (±S.D.)	2.93 ± 2.87	2.85 ± 2.59	2.76 ±2.81

ANOVA $p > 0.05$

Table 7. Caries increment measured in DMFT in 309 Riyadh children with varying frequencies of oral hygiene.

Oral Hygiene Practices		Caries Increment	
Frequency	No. of children	Mean DMFT	Standard Deviation
0	65	1.70	2.11
1	94	2.91	2.69
2	86	3.38	2.76
3	47	3.44	2.85
Unknown	17	0.54	1.18

ANOVA $p<0.01$

Table 8. Relationship between the frequency of oral hygiene and mean frequency of sugar consumption (± standard deviation).

Frequency of Oral Hygiene	Mean Frequency of Sugar Consumption (± Standard Deviation) 1st Day	2nd Day	3rd Day
0	2.30 ±1.08	2.42 ±1.07	2.43 ± 0.95
1	2.44 ±1.00	2.29 ± 0.90	2.20 ±1.58
2	2.55 ±1.13	2.54 ±1.12	2.47 ±1.02
3[+]	2.52 ±1.10	2.56 ±1.89	2.52 ±1.07

ANOVA p>0.05

Table 9. Oral hygiene methods practised by 309 12-13-year-old children in Riyadh.

Oral Hygiene Method	No. of Children	Percentage
Tooth brush/paste	163	52.8
Chewing stick (meswak)	35	11.3
Tooth brush/meswak	46	14.9
None	65	21.0
TOTAL	309	100

additional examiner participated in the final examination in 1992 so as to provide a male examiner for boys and a female examiner for girls. To calibrate the two examiners, they both examined 30 subjects prior to the final dental examination in 1992. In addition, the examiners each repeated caries diagnosis in 35 subjects during the course of the dental examination in 1992. The data were analyzed using the statistical analysis system (SAS).

Results

Inter-examiner reproducibility between the first and the second examiners gave a kappa statistic of 0.91 while intra-examiner reproducibility, during the final examination, gave values of 0.87 and 0.89, respectively.

Three hundred and nine out of the 342 children who completed the 3-day dietary diary in 1989 were available three years later for the final dental examination (Table 1), giving an attrition rate of 9.6% over the 3-year period. Thus only the 309 children with complete dietary and clinical data were included in the analysis. The mean base-line DMFT for the 309 12-13-year-old children in 1989 was 1.95, 36.2% of them being caries-free (Table 2). Although the mean base-line DMFT was higher in girls than boys, the difference was not statistically significant ($p > 0.05$).

Caries increment over the 3-year period varied between 0 and 12 DMFT, the mean being 2.85 DMFT, indicating that on the average, approximately one tooth per child succumbed to caries each year (Table 3). Furthermore, caries increment was significantly higher ($p < 0.01$) in girls than in boys (Table 4).

Table 5 shows a cross tabulation between caries increment and the base-line DMFT recorded in 1989. Chi square test showed that there was a statistically significant relationship between the base-line DMFT and the caries increment ($p < 0.05$). However, regression analysis revealed that the relationship was not linear, the p value for the slope being 0.9328. A vast majority of the children consumed sugar 2-3 times a day (Table 6) and analysis of variance showed that there was no statistically significant relationship between the frequency of sugar consumption and caries increment ($p > 0.05$). Furthermore, there was no significant difference between the frequency of sugar consumption in the boys and girls.

Contrary to expectation, caries increment was lowest (1.70 ± 2.11) in those who did not practice any form of oral hygiene and highest (3.44 ± 2.85) in those who practiced oral hygiene three or more times a day (Table 7). Analysis of variance showed that this inverse relationship between caries increment and frequency of oral hygiene was statistically significant ($p < 0.01$). In contrast, the relationship between the frequencies of sugar consumption and oral hygiene (Table 8) was not statistically significant ($p > 0.05$). About 53% of the children used tooth brush/paste for their oral hygiene, 15% used tooth brush/miswak and about 11% used miswak only (Table 9).

Discussion

Children aged 12-13 years were selected for this study because, at this caries active age, the effect of sugar consumption and/or oral hygiene practices on caries increment is most likely to be manifested clinically. In addition, the 3-year study period is in line with the recommendation by Rugg-Gunn et al,[4] being considered adequate to allow caries increment large enough for correlation with the various independent variables. Furthermore, Saudi children attend the intermediate school at ages 12-15 years, before proceeding to the high school. Hence

attrition rate of the cohort was not greatly affected by movement from one level of educational establishment to another (Table 1). The attrition rate of 9.6% over the 3-year period is lower than the rate of 12.9 over a period of one and one-half years reported by Leverett et al[5] in New York State, USA.

Caries diagnosis was mainly by the visual method and this has been validated by several workers.[6] For logistic and ethical reasons, radiographs were not used. It is unlikely that this had a significant effect on the result of our statistical analysis. For example, the inclusion of radiological variables did not substantially increase the quality of prediction of caries increment in a 4-year longitudinal study carried out in Zurich, Switzerland.[7]

There is no perfect method available for collecting data on sugar consumption,[8] and the reliability of the various methods remains a vexed question. Nevertheless, the choice of method depends on a number of factors: size of sample, financial resources, availability of trained personnel, educational level of the subjects, national characteristics and special food habits.[8] We utilized a 3-day dietary diary supported by an interview because, considering the sample size, among other factors, this method was practical[4] and economical.[9] The dietary data collection was not repeated later in the study (as originally planned) because we perceived a change in the children's dietary habits and/or reporting as they became aware of the nature of the caries research.[1]

The 3-year caries increment of 2.85 DMFT (0.95 per annum) is low when compared with the 2-year increment of 2.2 DMFT (1.1 per annum) recorded for 11-12- year-old English children[4] and annual value of approximately 1.5 for Icelandic children.[10] It is, however, in agreement with an annual caries increment of less than one DMFT in the non-fluoridated (0.2 ppm) communities of Michigan, USA.[11] As caries experience in Riyadh children is moderate (mean base-line DMFT was 1.95) and, on the average, caries increment is less than one DMFT per year, an annual dental check-up for caries would appear adequate for most of the children.

Slightly higher caries incidence in girls than boys has been reported,[12,13] but the difference observed in our study was surprisingly large (Table 4) and could not be explained from our data. Inter-examiner variability during the final dental examination cannot explain satisfactorily this large difference because inter-examiner reproducibility between the male and female examiners gave a kappa statistic of 0.91. A possible explanation might be high tea consumption in boys and not in girls, as has been reported in Syria,[14] a neighbouring Arab country. Tea has a high fluoride concentration[15] and may lead to lower caries incidence in boys compared with girls. It is also possible that adolescent girls consume more sugar than similarly aged boys; this needs to be clarified by future research.

The lack of association between the frequency of sugar consumption and caries increment in 12-13 year-olds observed in this study was also reported by Rugg-Gunn et al.[4] who observed a stronger correlation between caries increment and the amount of sugar intake rather than frequency of sugar consumption. Furthermore, such a poor correlation has been attributed to the errors inherent in the manner of dietary data collection in epidemiological studies of this nature,[16] insufficient variability in the pattern of sugar consumption amongst children in modern society and the predominance of pit and fissure caries in communities with relatively low caries experience.[11] In fact, decayed pit and fissures contributed 78.9-93.4% of the carious lesions in the Riyadh children. Hence it is likely that most of the incremental carious lesions affected pits and fissures, rather than smooth surfaces. This needs to be confirmed by future studies, as the finding would be useful for preventive programme planning.

Various workers have attempted to use past caries experience as a predictor of caries increment.[17,18] Koch[17] showed that if the subjects were categorized into high and low caries groups according to their DMFS smooth surfaces, past caries experience could be used to predict caries increment in about two-thirds of the subjects; but when all previously carious surfaces were considered, past DMFS was of predictive value in only 25% of the subjects. Thus, even though there was a statistically significant relationship between the base-line DMFT and caries increment in the present study, base-line DMFT was of little caries predictive value.

Precavitation lesions were excluded from our caries diagnosis and the effect of this on the predictive power of the base-line DMFT is uncertain. While Seppa and Hausen[19] concluded that the inclusion of precavitation lesions added little to the predictive power of conventional DFS scores, Klock and Krasse[20] and van Palenstein Helderman

et al.[21] held a contrary view. Future studies should therefore include precavitation lesions to throw some light on this controversy.

The inverse relationship between the frequency of oral hygiene and caries increment was unexpected. The fact that caries increment was highest in those who practiced oral hygiene most frequently underscores the interplay between various factors in caries aetiology. For example, the use of fluoridated toothpastes by some of the children might complicate the relationship between frequency of oral hygiene and caries increment. Besides, the frequency of oral hygiene may not necessarily reflect the state of oral cleanliness.

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