Original Article

# Relation between Past and Present Dietary Sugar Intake and Dental Caries in A High Caries Population

**T. Malek Mohammadi [1], EJ. Kay [2], A. Hajizamani [1]**

[1]Assistant Professor, Department of Dental Public Health, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran
[2]Professor, Department of Oral Health and Development, Manchester Dental School, Manchester, UK

## Abstract:

**Objective:** The main objective of this study was to investigate relationship between reported dietary habits and dental caries in five and six-year-old children referred for dental extractions.

**Materials and Methods:** Two hundred children were examined using standard caries diagnostic criteria. The numbers of decayed, missing and filled deciduous teeth were recorded. A food frequency table was completed by the parents of each child and analyzed through weighting the cariogenic potential by the frequency of consumption, and summing the two scores.

**Results:** The mean number of decayed, missing and filled teeth (dmft) was 7.1 (SD=3.29). There was no statistically significant correlation between the reported dietary intake and the caries rate in the study population P=0.07. Use of bottles with sugared drinks during infancy was associated with increased caries levels (P<0.01).

**Conclusion:** Poor infant feeding practices promote caries in childhood. A method of diet assessment which would evaluate diet-related health education is required.

**Key Words:** Diet; Dental Caries; Nursing; Epidemiology

Corresponding author:
T. Malek Mohammadi, Assistant Professor, Department of Dental public Health, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran.
tmalekmohammadi@yahoo.com

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## INTRODUCTION

Despite the wide acceptance that dietary sugar causes dental caries, a number of authorities have questioned the effectiveness of dietary manipulation for the promotion of oral health [1].

Dental caries is believed to be a complex, multi-factorial disease and as well as a significant health and social problem affecting people of all ages and is responsible for a vast amount of pain, misery and economic loss. It is a major problem in young children [2]. Caries of the primary teeth "early childhood caries" (ECC) is one of the most prevalent health problems seen in infants and toddlers [3]. It can be considered an epidemic in lower-income families as well as under developed parts of the world [4]. ECC is one of the major causes of hospitalization in young children, who often must undergo general anesthesia for extraction [5].

The prevalence of dental caries in the UK remains unacceptably high. A total of 53% of 4-18-year-olds have dental decay, and the occurrence of decay increases with age from 37% in 4-6-year-olds to 67% in 15-18-year-olds [3]. There is also evidence that the prevalence of caries in pre-school children may be increasing; 17% of this age group have decayed teeth, the prevalence increasing with age to 30% in 3.5-4.5-year-olds [6].

It is also accepted that dental caries is strongly

modified by diet. Sucrose, the most widely used sugar, is the only substrate used for bacterial generation of plaque dextrans essential for bacterial adherence and facilitating the implantation of cariogenic bacteria in the oral cavity [7]. In the UK, the largest source of sugar is confectionary followed by soft drinks and table sugar [8]. Consumption of fruit juices and soft drinks may decrease the oral Ph, predisposing the teeth to loss of enamel. In the presence of sugar in drinks, this fall in Ph is likely to bacterial fermentation of carbohydrates, causing more profound enamel demineralization. Such drinks are commonly given to infants in bottles or reservoir feeders as pacifiers. Around 10% of children have extensive dental caries (rampant caries) related to the use of bottles or comforters containing sugared fruit-flavored drinks [9].

Although the type of sugar consumed is an important factor in the development of caries, the frequency of sugar consumption is believed to be of greater significance [10,11]. Since the publication of the Vipeholm study, it has been accepted that the frequency of sugar ingestion is directly proportional to caries experience [12]. In addition, a study by König et al [13] showed approved the issue through an animal. Holt found pre-school children with caries to have between meal snacks approximately four times each day [14].

The main aims and objectives of the study presented here were to identify the frequency of high sucrose containing food consumption in the study population and to investigate the relationship between the reported dietary habits and dental caries in a population with severe dental caries.

## MATERIALS AND METHODS

Two hundred children (five to six year-old) referred for extraction of deciduous teeth under general anesthesia were recruited to the study and briefed about the procedure. We also had the approval of the Local Research Ethics Committee and informed consents were obtained from all the children's.

Each participating child was dentally examined by a dentist, trained and calibrated according to the British Association for the Study of Community Dentistry (BASCD) criteria [15] and whose internal reliability had been scored as Kappa=0.80. The examination was performed under standardized conditions using a dental unit, a plane dental mirror and a CPITN probe used only to remove debris. Numbers of decayed, missing and filled deciduous teeth were recorded, and the parents were instructed to complete a questionnaire including medical, familial and social history in addition to infant feeding habits and a "food frequency table" with a range of 33 foods likely to be consumed by children at this age. The food questionnaire had previously been used in a nutrition study in Newcastle [16]. A single examiner conducted all the measurements to ensure that inter-observer variability did not compromise the findings. The parents were asked to indicate in a tick-box table how often each food was consumed by their child. They were offered a forced choice frequency of: never, weekly, 2-3 times a week, daily,

**Table 1.** The frequency distribution of using bottle for feeding in infancy.

| Methods of bottle usage | Number of children | Used (%) | Not used (%) |
|---|---|---|---|
| **Children used the bottle in infancy** | 200 | 164 (82%) | 36 (18%) |
| **Children used the bottle in bed** | 164 | 65 (36.5%) | 113 (63.5%) |
| **Children used bottle sometimes with sweet drink** | 164 | 72 (42.9%) | 92 (57.1%) |
| **Children used bottle more than 12 months** | 164 | 82 (49.2%) | 82 (50.8%) |
| **Children used bottle only ever with milk** | 164 | 89 (54.2%) | 75 (45.8%) |
| **Children used bottle always with a sweet drink** | 163 | 5 (2.8%) | 158 (97.2%) |

twice daily, three times daily and more than three times daily. The questionnaires had been developed, piloted and assessed prior to the main study.

The foods were classified into three groups according to the guideline of the Department of health Committee on Medical Aspects of Food Policy (COMA) on the basis of their sugar content. Those deemed to have "low" cariogenic potential were scored 1, those with some element of non-milk extrinsic sugars were scored 2 (medium) and those consisted wholly of non-milk extrinsic sugars were scored 3 (high). Then, the cariogenicity of each food was weighted according to its frequency of consumption, i.e. the scores for cariogenic potential were multiplied by the frequency score for each food. A total cariogenicity score was then calculated by summing the weighted cariogenicity scores.

Cariogenicity score = Σ (cariogenic potential x frequency score).

The number of decayed, missing and filled teeth (dmft) and decayed teeth scores were then correlated against the cariogenicity score.

The data were analyzed using SPSS Version 13.0 (Pearson correlation coefficient).

## RESULTS

A total of 108 boys and 92 girls, aged five (64%) and six (36%) agreed to take part in the study. The mean dmft was 7.18 (SD=3.27). The d, m, and f components of the index were 6.78, 0.16 and 0.20 respectively.

Most of the participating children came from families with two children, although 17% had more than three children in the family. In regards to infant and weaning patterns, of the 200 children, 82% (164) had been bottle fed as an infant and only 3.8 % of them had the history of breast feeding in infancy. The remaining children reported history of both breast and bottle feeding also in addition to Soya milk. Thirty six percent of the children had been put to bed, at least occasionally, with their bottle and 42% (70) had had sweetened drinks put in their feeding bottles. Both issues were found to be associated with the recorded caries levels ($P<0.01$). The mean reported age of weaning was 6 months (Table 1 and 2).

Of the 200 parents whose children were recruited to the study, only 64 (32.5%) depicted a frequency of consumption for all the 33 food groups listed in the food frequency table. Approximately 10% of the respondents had more than eight food groups with missing data (Table 3). Sixty percent of the study population consumed sweetened breakfast cereal on a daily basis and about 42% reported to drink sweetened drinks every day (Table 4).

Data were imputed for patients with less than nine dietary foods unrecorded and individuals with more than nine food items with missing data were excluded from data analysis (n=21).

The mean diet cariogenicity score was 74.5 (SD=19.1). The maximum possible score (consumption of all cariogenic foods more than five times daily) was 260; whilst a score of 22 would represent a diet consisted of the whole range of low cariogenicity foods on a weekly basis.

Pearson correlation coefficient for the relationship between caries and the total cariogenicity scores showed that for decayed, missing and

**Table 2.** Association between dmft and using bottle (T-test).

| Bottle utilization | dmft | | |
|---|---|---|---|
| | Degree of freedom (df) | Sig.(2-tailed) | Mean difference |
| **Bottle used in bed** | 164 | 0.01 | -1.30 |
| **Bottle only used with milk** | 164 | 0.01 | 1.24 |
| **Bottle sometimes used with sweet drinks** | 164 | 0.01 | -1.24 |

dmft=The mean number of decayed, missing and filled teeth

**Table 3.** Missing data related to food consumption.

| Missing data | Frequency | Percentage |
|---|---|---|
| **0** | 65 | 32.5 |
| **1** | 30 | 15.0 |
| **2** | 37 | 18.5 |
| **3** | 26 | 13.0 |
| **4** | 10 | 5.0 |
| **5** | 3 | 1.5 |
| **6** | 5 | 2.5 |
| **7** | 3 | 1.5 |
| **8 or more** | 21 | 10.5 |
| **Total** | 200 | 100 |

filled teeth there was a Pearson correlation coefficient of 0.13 (P=0.08) and for decayed teeth 0.131 (P=0.07).

## DISCUSSION

The association between childhood caries and infant feeding practices has been documented in a number of studies; however, there is limited information concerning the importance of general feeding behaviors and dietary intake in caries development [17]. Previous studies have often focused on dietary sugar rather than the diet as a whole; whilst, in the present study a range of different common and available foods was involved. Both the frequency of intake and the cariogenic potential of each food were therefore taken into account when estimating the cariogenicity score for each individual.

Roberts et al [18] reported that infant feeding methods are not related to the prevalence of caries in primary teeth; although, when caries is present, its magnitude is related to feeding methods. In this study children who used a bottle, especially with sweet drinks were at more risk for dental caries as well. The association between overall reported dietary sugar intake and dental caries in the study population was not statistically significant. However, accurate measuring of childhood dietary sugar intake is difficult and a proper method contributing to the issue and its association with caries development has not yet been developed.

Researchers have used many instruments and methods in an attempt to accurately document the amount, type, and effects of foods consumed by children, but a simple chair-side method supporting dietary advice in the surgery is still lacked. The data collection method used in the present study is likely to have introduced a Hawthorne effect [19]. That is because there is a widespread knowledge among the population that 'sugar is bad for teeth'; though, respondents may tend to avoid reporting high sugar consumption accurately, particularly when the questioning occurs in a health-service environment. While examining diet, under some circumstances, food other than sugar may, be considered cariogenic. There are no specific or agreed criteria available to rank foods on the basis of their carcinogenicity. There was also no agreement among the experts about a daily safe number of cariogenic intakes leaving it an important issue which must be clarified [20].

This study showed that by using a "cariogenicity score" an association between dietary sugar intake and the numbers of decayed, missing

**Table 4.** Proportion of children who take sugary foods in the study population.

| Food items | Proportion of children (intake of food ) | | |
|---|---|---|---|
| | Weekly or less | Daily | More than 2-3 times per day |
| **Breakfast sweetened-cereals** | 26.6 | 59.6 | 7.3 |
| **Jam and other sweet spreads, peanut butter** | 46.3 | 6.9 | 0.9 |
| **Rice pudding, sponge pudding, crumble** | 45.9 | 5.0 | 0.0 |
| **Ice-cream, mousses** | 72.5 | 7.8 | 0.5 |
| **Biscuits, chocolate/cream/plain/savory** | 51.8 | 34.3 | 4.6 |
| **Cakes** | 72.5 | 7.3 | 0.5 |
| **Pop/squash** | 18.8 | 42.2 | 22.0 |

and filled teeth could be demonstrated but not with statistical significance. This may be due to problems in data collection, as well as the study population having an exceptionally high caries rate i.e. it could be explained by the "threshold effect" in diet referred to by other authors. The current dose-response relationship between caries and extrinsic sugars suggests that sugars levels above 60 g/person/day for teenagers and adults tends to increase the rate of caries. For pre-school and young children the intakes should be proportional to those for teenagers; about 30 g/person/day for pre-school children [21]. Whichever is the correct explanation for the observations made, it is clear from the results of the present study that in a population with a high caries rate, there is only a weak relationship between the number of decayed teeth, and the reported dietary sugar intake, when measured by a "cariogenicity score" through a food frequency questionnaire.

It is important to note that the 'score' was not a real number and not an absolute measure of the dietary sugar intake. It was a pragmatic approach which attempted to take account of the fact that a food can be identified as relatively non-cariogenic when eaten as a meal yet cariogenic when eaten frequently as a snack.

It is possible that a stronger association between diet and dental caries does in fact exist, although not identified through our study due to mentioned problems. An alternative to explain the weak correlation observed between caries and diet may be related to changes in the dietary patterns of the children between the ages of two and five. Caries may be caused early in life by high intake of sugar, while the diet at the age of five might include lower levels of sugar intake.

## CONCLUSION

(1) The present study confirms findings from previous studies that there is a statistically significant association between infant feeding habits; especially bottle feeding, and childhood caries.

(2) There is only a weak correlation between dietary sugar intakes and dental caries, when a high caries population is under study.

(3) Therefore, the role of early feeding pattern (past dietary intake) in caries process is very clear but the role of dietary sugar intake in the matter needs a reliable measuring method facilitating the evaluation of diet related oral health education.

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