

IN BRIEF

- Diet, choice of snack food and socio-economic status were shown to affect dental health.
- Level of obesity was not seen to influence DMF score or oral health.
- Vending machines in schools can be hazardous to dental health and should be removed or replaced with 'healthy' vending machines.
- Health promotion should focus on the role of snacking and vending machines in schools.

The effect of social demographic factors, snack consumption and vending machine use on oral health of children living in London

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Objective To investigate the effect of socio-economic status, sugar, snack consumption and vending machine use on the prevalence and severity of caries (DMF) in children.

Design An observational study was carried out in a dental practice in inner city London. Sixty children were asked to complete a questionnaire and a three day food and drink diary. After a dental examination the number of decayed (D), missing (M) or filled (F) teeth provided a DMF score. Anova and Pearsons correlations were used to analyse the data statistically.

Results Children from social groups I and II consumed significantly less ($P < 0.05$) sugar, confectionery, crisps and used a vending machine less often than children from other social groups. Children from Social groups I, II and III had significantly lower DMF scores. The average DMF from social group I children was 0.5 ± 0.6 , whilst group IV children had the greatest incidence and a DMF of 4.6 ± 0.8 . Significant correlations were identified between DMF and sugar, confectionery and crisp consumption and vending machine use, and a negative correlation between DMF and vegetable consumption.

Conclusions Socio-economic status and access to vending machines were found to have a significant effect on sugar intakes, foods choices, and dental health. The removal of vending machines from schools or at least installing 'healthy' vending machines is recommended. Health promotion programmes that account for social groups and snacking habits that are cost effective are required.

INTRODUCTION

Diet has long been recognised as a major cause of dental caries. In particular, sugars, especially non-milk extrinsic sugars (NMES), are overwhelmingly concluded as being the principle

dietary cause of caries.¹ NMES, otherwise known as refined or added sugars but more specifically referring to all sugars except those present in milk or within the cell walls of fruit and vegetables, are a favoured substrate for the cariogenic bacteria that reside in plaque, particularly *mutans Streptococci*. The acid by-products of this metabolic process induce demineralisation of the enamel surface. Whether this initial demineralisation proceeds to clinically detectable caries or whether the lesion is remineralised by plaque minerals depends on a number of factors, one of which is the amount and frequency of further sugar consumption.

Children are a group urgently requiring diet-related dental health promotion and intervention, since food habits derived in childhood often remain into adulthood. Currently, 80% of British children consume sugar at levels above recommendations. Typically, 16.7% for boys and 16.4% for girls of food energy comes from NMES; this is above the recommended intake of no more than 11%.² As a result, the prevalence of dental caries in Britain remains unacceptably high, with 38% of 12-year-olds living in England and Wales having dental decay.³ Alarming this trend is also seen in much younger children, with Hinds & Gregory⁴ reporting levels of 30% in children aged 3-4 years old. Typical sources of dietary sugars are soft drinks and confectionery, biscuits and breakfast cereals. Data from the National Diet and Nutrition Survey has shown that soft drinks make up more than 25% and confectionery more than 20% of the total NMES consumed by children.¹ Numerous studies have identified the popularity of certain snack foods amongst children. Confectionery, chocolate and sweets are clearly the favourite choices of most children, crisps, biscuits and fruit also being commonly selected.^{5,6} Since most researchers⁷ agree that limiting sugar intake is still the most important factor in the prevention of caries, studies that identify the role of snacks on overall sugar consumption are important. The role of soft drinks on dental erosion is already well established.⁸

According to Hunter *et al.*,⁹ around 89% of secondary schools have vending machines. Vending machines are usually associated with high sugar and fatty snacks such as confectionery, crisps and fizzy drinks. Whilst the Food Standards Agency is currently running a pilot study to see the effect of the introduction of 'healthy' vending machines in schools, this has yet to be

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introduced nationally. Indeed most studies show that the use of school vending machines is positively correlated with confectionery consumption and negatively correlated with fruit consumption.¹⁰ Hence it is possible there may also be a link between the consumption of vending machine snacks and dental caries.

It has been reported that people of lower socioeconomic status have worse oral health than people in higher groups. In particular, children from lower social groups, families receiving benefits, or from ethnic minority groups are more likely to be at risk of severe caries. Studies have shown that socio-economic status affects dietary intake,^{11,12} hence it is likely that differences in diet, and in particular sugar intakes, may be a significant determinant of the variation in caries seen between social classes.¹³

Therefore the present study aims to study the association between prevalence and severity of caries (DMF score) with sugar, snack consumption and vending machine use in a sample of children in London. In addition, we wanted to determine to what extent socio-economic status is linked to oral health.

METHOD

A total of 60 children (34 girls and 26 boys) aged 5–16 years old were recruited from a dental surgery in the Chelsea area of London. The children were from mixed ethnic groups and socio-economic backgrounds. Once the participant's willingness was confirmed, their parents were contacted in person and asked to sign a consent form. Ethical approval was obtained from Roehampton University and the Principal of the dental practice where the survey took place.

Each subject was asked to complete a three-day food and drink diary that contained full instructions and included information on portion sizes and how to record each food item. The diary was completed over three consecutive days including one week day and one weekend day. The food diary data were analysed using Microdiet (Downlee Systems, UK). A questionnaire was used to obtain information regarding demographic and socio-economic status of the family, feeding history, dietary habits, food preferences, dental and oral hygiene practices. The questionnaire also acted as a cross-reference tool for detecting under-reporting of food intake in the food diaries. Body mass and height were measured by the investigator before the questionnaire was given to each subject. The children's teeth were examined at a routine checkup by a dental practitioner using standard dental instruments. Diagnosis of dental caries was made in accordance to the criteria laid down by the

World Health Organisation.¹⁴ The numbers of decayed (D), missing (M) or filled (F) teeth were aggregated together to provide a DMF score for each child.

Data analysis was performed using SPSS version 11.5. One way analysis of variance (ANOVA) was used to test for differences between socio-economic groups and Pearson correlations were performed to assess the relationship between diet and DMF. A significance level of $P < 0.05$ was adopted.

RESULTS

The physical characteristics of the subjects recruited are presented in Table 1. By comparing the children's body mass index (BMI) with tables appropriate for children,¹⁵ it was revealed that 26% of boys and 32% of girls were classified as being overweight and 11% of boys and 5% of girls were classified as obese.

No significant differences were identified between boys and girls in the amount of sugar, different foods consumed, vending machine use, or DMF. Furthermore, there were no differences in these variables between the overweight and obese children and those who were underweight and of acceptable weight. However, differences were identified when the effects of social groupings were considered (Table 2). Social group I and II consumed significantly ($P < 0.05$) less sugar, confectionery, crisps and used a vending machine less often than all other groups. In addition, social groups I and II consumed more servings of fruit and vegetables per day than the other groups ($P < 0.05$).

The results of social background and DMF values are presented in Table 3. In general it can be seen that children from families where the parents work in professional or managerial occupations have fewer problems with their teeth than children who come from families where the parents are unskilled or unemployed. In fact, 92% of children from social group I had a DMF score of zero, whereas in families with partly skilled, unskilled and unemployed parents, 80%, 86% and 67% of the children respectively had a DMF score greater than four. Thus it would appear that DMF score does reflect social background ($P < 0.05$).

The children were all asked to name their favorite snack foods. There were a variety of responses, sweet foods being the most popular (23%). However, choice of snack food was not found to correlate with DMF. As expected, sugar and confectionery consumption were closely correlated with DMF ($R = 0.83$, $P < 0.001$ and $R = 0.7$, $P < 0.01$ respectively). Additionally, correlations were found between the consumption of crisps and DMF ($R = 0.7$, $P < 0.05$) and vending machine use and DMF ($R = 0.4$, $P < 0.01$). Furthermore, there was a significant difference ($P < 0.05$) between the DMF scores for children who attended schools that had a vending machine and those children who attended schools that did not. Mean DMF for the schools with a vending machine was 2.94 ± 1 compared with 1.48 ± 1 for schools without a vending machine. A strong negative correlation was found between vegetable consumption and DMF ($R = -0.72$, $P < 0.05$), although it is likely that the children who

Table 1 The subjects' physical characteristics (mean \pm sd)

	n	Age (years)	Weight (kg)	Height (m)	BMI (kg/m ²)
Boys	26	11.3 \pm 2.8	45.1 \pm 13.8	1.44 \pm 0.17	20.9 \pm 3.4
Girls	34	11.9 \pm 2.4	47.1 \pm 12.8	1.47 \pm 0.13	20.6 \pm 4.5

Table 2 The effect of social group on sugar, snacks and vegetable consumption and vending machine use (mean \pm sd); * $P < 0.05$

Social group	n	Sugar (g/day)	Confectionery (items/day)	Crisps (packs/day)	Fruit & veg. (portions/day)	Vending machine (use/day)
I	13	58.3 \pm 36*	0.23 \pm 0.2*	0.35 \pm 0.59*	4.0 \pm 1.2*	0*
II	12	67.4 \pm 14*	0.6 \pm 0.6*	0.59 \pm 0.3*	4.0 \pm 1.5*	0.2 \pm 0.2*
III	9	167.5 \pm 40	1.4 \pm 1.2	1.25 \pm 0.5	1.8 \pm 1.3	1.2 \pm 1.2
IV	10	214.8 \pm 26	2.8 \pm 1.3	1.8 \pm 1.3	0.9 \pm 0.8	2.6 \pm 1.8
V	7	231.1 \pm 38	2.7 \pm 0.4	2.3 \pm 0.7	0.49 \pm 0.3	1.3 \pm 0.8
VI	9	205.9 \pm 54	3.6 \pm 1.4	2.3 \pm 0.7	0.72 \pm 0.6	2.3 \pm 1

Table 3 Social background and DMF (mean \pm sd);

Social group	DMF
I	0.5 \pm 0.6*
II	0.6 \pm 0.6*
III	2.6 \pm 1.2*
IV	4.6 \pm 0.8
V	4.3 \pm 0.9
VI	4.1 \pm 1.05

*significant differences ($P < 0.05$) between the lower and higher social groups

consumed the greatest numbers of portions of fruit and vegetables per day were also the children that consumed the least sugar and the fewest items of confectionery.

DISCUSSION

A large proportion of the group were reported to be overweight or obese. Although these figures are alarmingly high, unfortunately they are similar to findings of other studies.^{16,17} However, no significant differences were observed in sugar consumption or the dental health of those that were overweight or obese compared to the rest of the group.

There were no significant differences between boys and girls in the amount of sugar consumed, although on average the girls did consume slightly more (145 \pm 32 g/day compared to the boys 134 \pm 26 g/day.) This is in contrast to a study by Inchley *et al.*¹⁸ where sugar consumption was found to be higher amongst boys. However, the National Diet and Nutrition Survey¹⁹ reported for young people aged 4-18 years, non-milk intrinsic sugar intakes of 85 \pm 38.7 g/day and 69 \pm 29.0 g/day in boys and girls respectively. A clear link between sugar consumption and social grouping was established in the present study, whereby children from groups I and II consumed significantly less sugar than those from groups III, IV, V and VI. The highest sugar consumption was observed in children from families with unskilled occupations. Similar patterns were shown for confectionery consumption. Other studies¹³ have failed to demonstrate clear social class differences in consumption of sugar-containing foods. However, Inchley *et al.*¹⁸ investigated dietary trends amongst Scottish schoolchildren and concluded that the consumption of high-sugar foods was higher in children from lower socio-economic groups. It has even been suggested by Sreebny²⁰ that sugar consumption at the individual level, recognised as one of the main aetiological factors of caries, might be considered as a proxy measure of socioeconomic development. The link between DMF and sugar consumption has long been clear. Buttner,²¹ using data from 18 countries, revealed a positive correlation between sucrose consumption and the average number of decayed, missing, and filled teeth of children. More recently, Ismail *et al.*²² also found a strong positive correlation between per person sugar supplies and dental caries in children. However, the association between sugar consumption and caries may be weak in countries where caries prevalence is low; this failure may be partly a result of the introduction of preventive methods, particularly those involving fluoride.^{23,24} Failure to demonstrate a relationship between caries and sugar consumption may also be related to inherent difficulties in measuring sugar intake and relating this to disease. Often, information about diet is drawn from questionnaires, completed on a single occasion and related to accumulated caries experience in the form of DMF values. Diet may change with time so this may not be an appropriate approach in older children and adults; it may be more suitable in young children where teeth

have erupted more recently and where there has been less opportunity for dietary habits to have changed greatly.

Whilst many studies have discussed sugar, NMES, confectionery consumption and DMF, few have identified the role of other dietary foods. From our study it was clear that fruit and vegetable consumption was negatively associated with DMF. Furthermore, children that ate more than four portions of fruit and vegetables per day had either one or no problems with their teeth. Available evidence⁶ shows that a quarter of 13-14 year olds in urban areas throughout the UK had eaten no salad or vegetables the day before when questioned. It would seem that whilst health education programmes have succeeded in increasing knowledge about food and healthy eating, this knowledge gain has failed to be translated into sustained behavioural change. Current intakes of vegetables among children and adolescents in the UK as a whole fall well below dietary recommendations.²⁵ High levels of fruit and vegetable consumption are associated with a healthy lifestyle which is of key importance in childhood and adolescence. Eating a well-balanced diet throughout childhood promotes optimal growth and development and helps prevent problems such as tooth decay, overweight and obesity by ensuring sufficient nutritional intake and reducing over-consumption of high-sugar foods.

Crisp consumption was again associated with social grouping, those in groups I and II consuming significantly ($P < 0.05$) fewer packets per day than other groups. In addition there was a strong correlation between crisp consumption and DMF. Whilst some salty snacks may be associated with low cariogenicity, studies²⁶ have shown that depending on the severity of the processing and the nature of the flavouring agents, certain crisp-type snacks have a cariogenicity not far short of some biscuits.

For those children who have a vending machine on their school premises, snacks such as crisps and confectionery are more easily accessible and as the results show, those children that had a vending machine had a significantly higher DMF score. 65.7% of the children that had access to a vending machine had three or more problems with their teeth, whilst 76% of the children that did not have access either had none or just one problem with their teeth. This must surely provide strong evidence for the removal of vending machines from school premises or the substitution of machines selling more healthy items.

The importance of regular meals, restriction of sugar or replacement of sugar with non-fermented sugar substitutes, avoidance of drinks and juices sweetened with sugar, and regular brushing of the teeth with fluoride toothpaste, should be the main topics in counselling schoolchildren and their parents in dental health at health centres and schools. If between-meal snacking is unavoidable, it is important to recommend food and drinks that carry a lower caries risk or may help to prevent caries. According to advice from the Dairy Council,²⁷ children should be encouraged to eat foods such as fruit and vegetables, cheese and chew sugar-free gum after meals to neutralise the acidogenic effects of dietary sugars. Prevention and simple treatment should be undertaken at an early age when intervention is most cost-effective.²⁸ A dental programme for providing preventive care, dietary advice and early interceptive treatment to school children in London needs to be developed. Further studies are needed to show how best to bring the benefits of caries prevention to the parents and caregivers of high-risk children (those in lower social groupings, including the poor, the deprived and racial/ethnic minorities). It has been suggested²⁹ that oral health treatment policy should be revised and dental healthcare staff should be educated towards more evidence-based knowledge and flexible attitudes. A new approach to diet, oral health and caries prevention is needed. For decision-makers in the administrative and practical field of dentistry, it is important to choose the most effective methods with acceptable costs. For this purpose, longitudinal preventative

programmes which take into account social group, snacking habits and access to vending machines, as well as cost-effectiveness, are needed.

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