

An investigation of the association between vending machine confectionery purchase frequency by schoolchildren in the UK and other dietary and lifestyle factors

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Abstract

Objective: Availability of confectionery from vending machines in secondary schools provides a convenient point of purchase. There is concern that this may lead to 'over-indulgence' and hence an increase in susceptibility to obesity and poor 'dietary quality'. The study objective was to investigate the association between the frequency of consumption of confectionery purchased from vending machines and other sources and related lifestyle factors in adolescent boys and girls.

Design: A secondary school-based, cross-sectional study.

Subjects and setting: A total of 504 subjects were investigated (age range 12–15 years), from three schools in southern and northern England. Using a lifestyle questionnaire, frequency of confectionery consumption (CC) from all sources (AS) and vending machines (VM) was recorded for a typical school week. Subjects were categorised into non-consumers, low, medium and high consumers using the following criteria: none, 0 times per week; low, 1–5 times per week; medium, 6–9 times per week; high, 10 times per week or greater.

Results: No differences were found in the frequency of CC from AS or VM between those who consumed breakfast and lunch and those who did not. No differences were found in the frequency of fruit and vegetable intake in high VM CC vs. none VM CC groups, or in any of the VM CC groups. Confectionery consumption from AS (but not VM) was found to be higher in subjects who were physically active on the journey to school ($P < 0.01$) but also higher in those who spent more time watching television and playing computer games ($P < 0.01$). No associations were found between smoking habits or alcohol consumption and frequency of CC.

Conclusions: These results do not show a link between consumption of confectionery purchased from vending machines and 'poor' dietary practice or 'undesirable' lifestyle habits. Findings for total confectionery consumption showed some interesting trends, but the results were not consistent, either for a negative or positive effect.

Keywords
Confectionery
Vending machines
Local shop
Breakfast
Fruit and vegetables

There is increasing concern that a high consumption of ready-to-eat foods such as confectionery may be associated with poor dietary quality and an increase in susceptibility to obesity in children. These concerns are reinforced by evidence that fat and sugar levels are particularly high in snacks purchased from tuck shops in schools¹. In a sample of 11–15-year-old schoolchildren living in Adelaide, snacks were shown to provide one-third of simple sugars and more saturated than polyunsaturated fat². Furthermore, in the absence of good oral hygiene, an increased frequency of snacking on products high in fermentable carbohydrates sugar may lead to dental caries³. However, recent analyses have shown that the top five sources of sugars (68% in total) in the UK diet contribute only 11% of dietary fat⁴ and snacks provide 33%

of key micronutrients including iron, calcium, vitamin C, thiamine and riboflavin⁵. Furthermore, the rising prevalence of obesity is most closely associated with trends in reduced physical activity rather than an increase in dietary intake⁶.

Several studies have examined patterns of confectionery consumption in a variety of population groups in relation to increasing an individual's susceptibility to obesity and encouraging a diet of 'poor quality'. Work by Gibson⁷ has shown that above-average intakes of cakes, biscuits and confectionery in British schoolchildren did not have a detrimental effect on nutrient intakes. The highest consumers of these foods also tended to consume more of other foods, and as a consequence had higher intakes of energy and nutrients. New and Grubb^{8,9} found that a high

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consumption frequency of biscuits, cakes and confectionery was positively associated with intakes of fat, protein, energy and micronutrients in premenopausal women but no associations were found between intakes of these foods and body weight or physical activity. Furthermore, findings in subjects aged 25–69 years who participated in the third Scottish MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) study showed that both men and women who were active at work tended to eat more confectionery, but this had little impact on their body mass index (BMI)¹⁰. Conversely, the authors also noted that women who were active in leisure tended to have a higher BMI but reported eating confectionery neither more nor less frequently than their leaner counterparts. Wrieden *et al.*¹¹ showed that, in non-overweight subjects ($BMI = 17\text{--}24.9 \text{ kg m}^{-2}$), those who ate most sweetened foods also consumed significantly more fruit.

Vending machines in schools provide a convenient method by which snacks in general, and confectionery products in particular, can be purchased by schoolchildren. Although no research studies have investigated the impact of confectionery purchase from these sources on dietary quality, there is concern that increased availability and consumption of these foods may compromise micronutrient intakes and promote over-consumption of energy and fat.

The aim of this study, therefore, was to investigate the association between confectionery consumption from vending machines in British schools, as well as from other sources (such as local convenience stores and tuck shops), and a variety of dietary and lifestyle habits in adolescent girls and boys. The specific hypothesis was to determine whether increased consumption of confectionery from vending machines and all sources was detrimentally associated with meal patterns, fruit and vegetable consumption, levels of physical activity, leisure-time pursuits such as TV viewing and computer games, as well as smoking habits and alcohol intake.

Subjects and methods

Development of the lifestyle questionnaire

A lifestyle questionnaire (LSQ) was developed to determine the frequency patterns of consumption of confectionery from both vending machines and other sources and to investigate their association with a range of dietary and lifestyle habits in British schoolchildren. The development of the LSQ was an iterative process which successfully 'designed out' inconsistencies and produced an LSQ that was both effective in terms of data collection and enjoyable for the subjects to complete. Iterations of the LSQ were reviewed for technical content both internally and externally, and, where appropriate, amendments were reviewed and incorporated. The LSQ

was piloted using 43 schoolchildren aged 11–15 years from a secondary school in south-west England.

The LSQ comprised key data-gathering questions designed to stimulate the subjects. The data-gathering questions pertaining to confectionery consumption and dietary/lifestyle habits were structured sequentially as the school day unfolded, with fun elements inserted randomly. The LSQ was divided into 10 core sections designed to elicit information about the following: (1) basic background data about the subject; (2) breakfast eating patterns including frequency and content; means of travel to and from school; physical activity; consumption of confectionery and other snacks (including source of consumption) on (3) the journey to school, (4) arrival at school, (5) morning break-time, (6) lunchtime, (7) afternoon break-time, (8) the journey home from school and (9) during the evening. The final section, (10), investigated smoking habits, alcohol consumption, fruit and vegetable intake and milk intake, as well as information on weight perceptions.

A copy of the LSQ is available from the author on request.

Subject selection and collection of data

Three comprehensive schools from different geographical regions in the UK, namely the South East (Wiltshire), North West (Liverpool) and North Central (Cheshire), were selected. Each school had approximately 650 schoolchildren aged 11–15 years enrolled, and all had vending machines installed. The vending machines included a variety of products including confectionery and crisps, and other items such as biscuits and fruit. The head teacher was approached by letter of invitation, and once permission had been granted for pupils to participate in the study, a visit was made to each school. To ensure subjects were of mixed academic ability and from different socio-economic backgrounds, subjects from form classes and not academic classes were selected at random using an open table design.

The general objectives of the study were explained to the school representatives (class teachers) and the data were collected, anonymously and under supervised conditions, during the summer term (May–July). The questionnaires were self-administered but members of staff were fully briefed on the questions to ensure that any help required by the subjects could be given. On average, the questionnaire took 20 min to complete.

The study was approved by the West Surrey Local Ethical Research Committee, Royal Surrey County Hospital, Guildford, Surrey. Informed consent was obtained from parents and children.

Data analysis

The data were analysed using the SPSS statistical package, version 10.1 (SPSS Inc., Chicago, IL, 2000). The frequency of confectionery consumption (CC) from all sources (AS)

and specifically from vending machines (VM) was recorded during a typical school day/week. Subjects were subsequently categorised into non-consumers, low, medium and high consumers using the following criteria: none, 0 times per week; low, 1–5 times per week; medium, 6–9 times per week; high, 10 times per week or greater. Appropriate descriptive analyses were applied to the data and non-parametric statistical tests including Mann–Whitney *U*-tests were used to evaluate differences between groups. Where appropriate, the mean rank of data is shown using non-parametric (Npar) analysis.

Results

LSQ completion

The LSQ was completed by a total of 504 subjects (46% boys, 54% girls) from each of the following year/age groups: Year 7 (12.2 years, $n = 66$); Year 8 (13.1 years, $n = 186$); Year 9 (14.2 years, $n = 90$); and Year 10 (15.2 years, $n = 162$). Subjects were from a variety of socio-economic status (SES) backgrounds, mainly SES classes II–IV, and responses to the LSQs were of a good standard on the whole, with none of the LSQs being totally disregarded. The subjects did not answer various questions but there was no particular trend with any one question.

General dietary and lifestyle habits

On average, subjects reported having 7 h of sleep per night, with the mean (standard deviation (SD)) time for going to bed being 22.08 (1.81 h) and the mean (SD) time for getting up in the morning being 07.15 (0.49 h). Physical activity levels were relatively low in the population group as assessed by lunchtime sporting activities and out-of-school physically active hobbies. A total of 35% of children stated that they walked to and from school. The number of hours spent watching television per day was 2.27 ± 1.38 (mean \pm SD).

A total of 6% of subjects smoked more than 14 cigarettes per week and a further 3.7% stated that they smoked

between 1 and 6 cigarettes per week. The percentage of subjects consuming alcohol was 25% for wine, 26.2% for Alco pops, 36.4% for beer/lager, 24% for shandy, 7.2% for martini/sherry and 21.6% for spirits.

The mean (SD) frequency of breakfast consumption was 3.64 (1.79) times per week, with over 50% of subjects reporting that they consumed breakfast on every school day. The frequency of consumption of breakfast amongst males and females and in different age groups was similar. The mean (SD) frequency of consumption of vegetables and fruit was 3.73 (1.44) and 3.26 (1.56) occasions per week, respectively. A total of 79% of subjects stated that they did not eat five portions of fruit and vegetables per day, with the main reason for not meeting this target being the ‘dislike of taste’.

Consumption of confectionery and other snacks during a typical school day/week

Frequency of consumption of the snacks – crisps, chocolate bars/chocolate sweets, other sweets, fizzy drinks and other (including fruit, biscuits, bread rolls, yoghurt) – during a typical school week, together with the purchasing outlets of these snacks, is shown in Table 1. For the journey to school, fizzy drinks were the most frequently consumed snack followed by chocolate bars/chocolate sweets, and the local shop was the most popular purchasing outlet. There was a trend for higher consumption of crisps in girls vs. boys (mean \pm SD: 2.35 ± 1.35 vs. 1.98 ± 1.29 times per week, $P < 0.08$). No differences were seen in the frequency of consumption of any snacks between breakfast and non-breakfast eaters.

Upon arrival at school, the local shop remained the most popular choice for purchase of snacks. Fizzy drinks and fruit were the snacks consumed most frequently (mean \pm SD: 2.67 ± 1.49 times per week). Intake of fruit was significantly higher in girls than boys (mean \pm SD: 3.40 ± 1.51 vs. 2.14 ± 1.29 times per week, $P < 0.04$) and there was a trend for higher fizzy drinks consumption by boys compared with girls (mean \pm SD: 2.93 ± 1.61 vs. 2.25 ± 1.48 times per week, $P < 0.09$). No differences

Table 1 Frequency of consumption of snacks by individuals and source of purchase during a typical school day

Activity	Frequency of consumption of snacks (times per week, mean \pm SD)					Source of purchase of snacks (number of subjects)								
	Crisps	Chocolate bars/chocolate sweets	Other sweets	Fizzy drinks	Other	VM(OS)	VM(IS)	H	LB	S	F	C	TS	O
Journey to school	2.16 ± 1.32	2.76 ± 1.42	2.57 ± 1.47	2.84 ± 1.53	2.94 ± 1.39	2	0	85	7	146	2	0	0	6
Arrival at school	2.15 ± 1.41	2.40 ± 1.67	2.20 ± 1.31	2.63 ± 1.58	2.65 ± 1.57	2	15	16	21	47	9	41	6	1
Morning break-time	2.98 ± 1.56	2.66 ± 1.37	2.49 ± 1.37	2.87 ± 1.58	3.38 ± 1.50	1	65	87	79	28	9	126	16	3
Lunchtime	3.08 ± 1.61	2.78 ± 1.43	2.39 ± 1.40	3.65 ± 1.55	3.74 ± 1.52	20	130	59	65	25	6	99	4	2
Afternoon break-time	2.76 ± 1.59	2.82 ± 1.57	2.28 ± 1.14	3.07 ± 1.68	3.50 ± 1.97	3	26	23	11	9	0	35	0	0
Journey from school	1.88 ± 1.13	2.38 ± 1.22	2.30 ± 1.22	2.69 ± 1.47	2.67 ± 1.56	3	20	34	18	135	4	9	6	6
During the evening	2.68 ± 1.38	3.01 ± 1.40	2.74 ± 1.36	3.86 ± 1.35	3.51 ± 1.37	0	0	352	2	69	6	4	0	2

SD – standard deviation; VM(OS) – vending machine outside school; VM(IS) – vending machine inside school; H – home; LB – lunch box; S – shop; F – friends; C – canteen; TS – tuck shop; O – other.

were found in the frequency of consumption of any of the snacks in general or confectionery eaten specifically from vending machines between breakfast and non-breakfast eaters. The canteen was the most popular source of snack purchase at morning break-time, followed by the lunch box and vending machines. Crisps were the most frequently consumed snacks. No differences were found in consumption patterns between breakfast and non-breakfast eaters.

Vending machines inside school were the favoured outlet for snack purchase at lunchtime. Fizzy drinks were the most frequently consumed snack at lunchtime and afternoon break-time, and were found to be higher in the breakfast eaters compared with the non-breakfast eaters (mean \pm SD: 3.74 ± 1.49 vs. 3.00 ± 1.80 times per week, $P < 0.01$). The intake of other sweets was significantly higher in boys than girls (mean \pm SD: 2.73 ± 1.48 vs. 2.02 ± 1.22 times per week, $P < 0.01$) and there was a trend for higher fruit intake by girls compared with boys (mean \pm SD: 3.44 ± 1.47 vs. 3.00 ± 1.52 times per week, $P < 0.07$).

The local shop was also the most popular choice for purchase of snacks on the journey home from school. Fizzy drinks remained the most frequently consumed snack both on the journey home from school and during the evening, although chocolate bars and chocolate sweets and fruit were popular at evening time. The subject's home was the most frequently stated source for snack consumption in the evening.

Differences in the frequency of confectionery consumption from different sources according to age, gender and lifestyle habits

Table 2 shows the differences in frequency of confectionery consumption from AS and VM in boys and girls, between the different age groups and according to breakfast eating habits. There was a trend for higher intake in boys than in girls for CC from AS ($P < 0.09$) but no

differences were seen for CC from VM. Consumption of confectionery from AS was significantly lower in the youngest age group compared with the other year groups. No differences were found in the frequency of confectionery consumed between breakfast and non-breakfast eaters, although there was a trend for higher consumption frequency of confectionery from AS in subjects who stated that they did eat breakfast (mean rank Npar test: 253 vs. 228, $P < 0.07$). No significant differences were found in the confectionery consumption frequency (either from AS or VM) between smokers and non-smokers.

Differences in 'dietary quality' between low and high consumers of confectionery

Table 3 shows the differences in markers of 'dietary quality' (as assessed by alcohol and fruit and vegetables) between low and high frequency consumers of confectionery. Frequency of wine intake was significantly higher in the low AS CC group ($P < 0.03$) and frequency of shandy consumption was significantly lower in the medium AS CC category ($P < 0.05$). A non-significant trend was seen with respect to a lower frequency of martini/sherry consumption in the medium AS CC group ($P < 0.09$).

Intake of vegetables showed a non-significant trend of being lower in those subjects categorised as medium and high consumers of confectionery from AS. No differences were seen in vegetable intake between low, medium and high consumers of confectionery purchased from VM. Intakes of fruit showed a non-significant trend of being lower in the medium frequency category group but not the high frequency category group. No differences were seen in fruit and vegetable intake in any of the frequency category groups of confectionery purchased from VM. Confectionery consumption (AS) was found to be lower in subjects who stated that they did not eat five portions of fruit and vegetables per day, but no differences were seen

Table 2 Differences in frequency of confectionery consumption from all sources (AS) and vending machines (VM): categorisation by age, gender and breakfast consumption

Category	Total confectionery consumption from AS (times per week, mean \pm SD)	P-value	Total confectionery consumption from VM (times per week, mean \pm SD)	P-value
Total mean intake in population	4.27 ± 5.09	–	0.86 ± 1.93	–
<i>Gender</i>				
Boys	4.67 ± 5.26	0.09	1.01 ± 2.24	0.20
Girls	3.80 ± 4.90		0.71 ± 1.55	
<i>Age group</i>				
12.2 years (Year 7)	3.44 ± 5.01^a	0.01	0.58 ± 1.56	0.20
13.1 years (Year 8)	3.74 ± 4.57^b		0.87 ± 1.79	
14.2 years (Year 9)	4.88 ± 5.04^b		0.91 ± 1.93	
15.2 years (Year 10)	4.80 ± 5.60^b		0.94 ± 2.24	
<i>Breakfast consumption</i>				
Breakfast eater	3.57 ± 4.91	0.20	1.00 ± 1.84	0.12
Non-breakfast eater	4.40 ± 5.13		0.85 ± 1.96	

SD – standard deviation.

Values with unlike superscripts are significantly different (Mann–Whitney *U*-test).

Table 3 Differences in related measures of 'dietary quality' by frequency category of confectionery consumption

Variable	Frequency category of confectionery consumption (mean rank or times per week, mean \pm SD)				<i>P</i> -value
	None	Low	Medium	High	
<i>Alcohol intake</i>					
Wine	190	215 ^a	183 ^b	190	0.03
Shandy	194	203 ^a	171 ^b	209 ^a	0.05
Martini	195	202 ^a	184 ^b	190	0.09
Fruit intake	3.36 \pm 1.61	3.37 \pm 1.42	2.78 \pm 1.82	3.23 \pm 1.44	0.12
Vegetable intake	3.78 \pm 1.44	3.86 \pm 1.37	3.56 \pm 1.46	3.48 \pm 1.53	0.14

SD – standard deviation.

Values with unlike superscripts are significantly different (*Mann–Whitney U*-test).

in the VM CC group (mean \pm SD: 4.44 \pm 4.97 vs. 3.39 \pm 5.22 times per week; mean rank using Npar: 256 vs. 207, $P < 0.05$).

No differences were found between the four AS CC and VM CC groups for milk consumption, frequency of consumption of lunch, lunch content, breakfast content, food preferences or for the reasons stated why fruit is not eaten every day.

Association between confectionery consumption and physical activity

As shown in Table 4, differences were found in the frequency of confectionery consumed from AS in subjects who walked or cycled on the journey to school compared with those children who did not walk at all (either travelling all the way by car or by bus/train with a car journey to the bus/train station). No differences were seen in AS CC on the journey from school or in VM CC on the journey to or from school. No differences were seen in AS CC or VM CC in subjects who participated in lunchtime hobbies. The hours spent watching television was significantly greater in the high AS CC group compared with the non-consumers (mean rank: 306 vs. 230, $P < 0.001$). Time spent on the computer working on school tasks showed a trend of being significantly greater in the high AS CC group ($P < 0.06$) although time spent on the computer playing games was also significantly greater in this group ($P < 0.05$).

Association between frequency of confectionery consumption and perception of body weight

Subjects who stated that they were 'happy with their weight' consumed confectionery from AS more frequently than those who were not happy ($P < 0.001$). No differences were seen for VM CC. Subjects who stated that they were 'trying to lose weight' consumed a significantly lower frequency of confectionery from AS ($P < 0.001$) and VM ($P < 0.05$) than those subjects who were not dieting. Subjects who stated that they would 'like to weigh more' consumed a significantly greater frequency of confectionery from AS ($P < 0.001$) and VM than those subjects who stated that they would 'like to weigh less'.

Discussion

The results of this study do not suggest a direct link between increased consumption of confectionery from vending machines and poor dietary quality or a reduction in physical activity. Clearly, vending machines were not the main purchase outlets for snacks. Rather the time of day dictated the most popular venue for purchasing snacks, namely the 'local shop' on the journey to and from school, with the canteen being used consistently throughout the day and vending machines most frequently used during the morning break-time and lunch hour. The 'evening' period represented an important time for the consumption of snacks (including confectionery, fizzy

Table 4 Differences in frequency of confectionery consumption according to physical activity level on the journey to school

	Physical activity level on journey to school (mean rank)			<i>P</i> -value
	Walking all the way	Cycling all the way	Travel by car all the way	
Total from all sources	217 ^a	216 ^a	185 ^b	0.01
Total from vending machines	198	214	214	NS

NS – not significant.

Values with unlike superscripts are significantly different ($P < 0.01$, *Mann–Whitney U*-test).

drink, crisps and biscuits), with 70% of subjects stating that the 'home' was the main source of confectionery provision.

No differences were found in the frequency of confectionery consumption (either from all sources or specifically from vending machines) between breakfast and non-breakfast eaters. This is in contrast to the work of Box and Landman¹², who showed that almost half of primary school children who missed breakfast had a mid-morning snack. The results of our study support the theory that those who are the most frequent consumers of confectionery and other sweet-based products tend to consume more food in general. Work by Gibson⁷ on British schoolchildren showed that children who consumed most of these food groups tended to consume more of other foods and thus had higher intakes of energy, but no relationship was found with body weight.

No significant differences were found in breakfast eating between boys and girls, although there was a trend for a higher frequency of intake of breakfast in boys. This is in agreement with the work of Box and Landman¹³, where it was shown that 60% of girls and 40% of boys skipped breakfast. Watt and Sheiham¹⁴ also reported that 47% of older girls stated never eating breakfast. Certainly, more girls than boys in our study wanted to lose weight and there is evidence in the literature that frequent skipping of breakfast by females has been linked to girls wanting to lose weight¹⁵. There was a trend for higher intake frequency of confectionery purchased from all sources in boys than girls, which, when taken together with the trend of a higher frequency of breakfast consumption amongst boys, lends further support to the argument that high consumers of snacks are higher consumers of food in general. There were no differences with intake purchased from vending machines between boys and girls.

Older subjects (14–15 years) consumed a greater frequency of confectionery from all sources compared with younger subjects (12–13 years). No differences were found with consumption from vending machines.

No differences were found in the frequency of fruit and vegetable intake in subjects classified as high vs. non-consumers or low consumers of confectionery from vending machines. However, non-significant trends were seen with confectionery consumed from all sources, with the frequency of vegetable intake being lower in subjects classified as medium and high confectionery consumers. This is a cause for some concern and supports, in part, the findings of Gibson *et al.*¹⁶. However, the frequency of fruit intake was lowest in the medium confectionery consumption group and not the high confectionery consumption group, suggesting that the association was not a 'dose-response' one. These relationships are similar to those found in an analysis of the National Diet and Nutrition Survey of young people aged 4–18 years (Gibson, personal communication, 2002). Fruit and vegetables are generally not popular amongst schoolchildren and the findings of

this study confirm this. More research work is required to establish if providing fruit in tuck shops/vending machines at school is effective in increasing fruit consumption in schools¹⁷.

Other dietary habits such as milk consumption, content of lunch and breakfast, food preferences or food choice did not vary across the different frequency groups of confectionery consumption. The high confectionery consumers were not consistently found to be the highest alcohol consumers and no associations were found between high vs. low confectionery consumers and smoking habits.

No associations were found between confectionery consumption from vending machines and physical activity levels, but there were some interesting findings with respect to confectionery purchased from all sources. The time for 'going to bed' was significantly later in the medium and high consumption categories and the hours spent watching television was significantly greater in these two groups. Furthermore, the time spent playing computer games was also significantly greater in the high confectionery consumption category. These findings are of potential concern because combination of high confectionery consumption coupled with a sedentary lifestyle could ultimately help to precipitate obesity in these subjects. However, it is interesting to note that the time spent on the computer 'working on school tasks' was significantly greater in this very high consumption group and the frequency of confectionery consumption was highest in subjects who either walked or cycled to school compared with those who travelled by car. No differences were found with lunchtime or 'out-of-school' physically active hobbies.

There is evidence that snacking *per se* does not compromise diet quality in young women. Subjects with a high snacking frequency were found to be eating more in general and choosing a wider variety of foods, which resulted in a much more balanced intake of nutrients¹⁸. Furthermore, there is evidence that consumption of regular snacks may be beneficial to health by (1) assisting the control of body weight^{19,20}; (2) reducing total blood cholesterol levels and reducing the ratio of low-density lipoprotein (LDL) cholesterol to high-density lipoprotein (HDL) cholesterol²¹; and (3) improving glucose tolerance²².

There are a number of limitations to this study and concomitantly with our interpretation of the results. The design is cross-sectional in nature and thus only associations rather than relationships can be explored. Only a relatively small number of subjects were investigated and hence our study may have been under-powered and our sample may not have been fully representative. Every effort was made to select schools from as wide a geographical area as possible and to include subjects selected at random from the school register, as opposed specific classes (such as the top

stream in a particular subject). A possible limitation of the survey instrument is, of course, the issue of the socially desirable responding and the need to achieve a self-presentation goal. However, we were aware the possibility of this happening and was why we chose to embed the issues we were looking at in a more general questionnaire.

Specific attempts were made to establish a completely anonymous and unbiased response from subjects. However, we do acknowledge it likely that a certain proportion of the subjects did not provide accurate answers to the questionnaire. Whilst every effort was made to develop an appropriate LSQ, it was not possible within the current study design to undertake any form of validation of it or indeed check the reliability of the information collected from the schoolchildren. Furthermore, we did not have a control school (i.e. without vending machines) which would have been important by way of enabling some form of comparison. Hence, further work should focus particularly on the older age groups (i.e. 14–15-year-olds) as these groups appeared to demonstrate the highest level of breakfast skipping, alcohol intake and smoking habits. We deliberately chose schools with vending machines and thus work is required to see if their absence has any effect on snack purchase or whether youngsters just purchase more from other outlets. We do not have good indications of the children's total dietary intake for the day. There is evidence that snacking *per se* does not compromise diet quality since subjects with a high snacking frequency have been found to be eating more in general and choosing a wider variety of foods, which results in a much more balanced intake of nutrients¹⁸. However, with our current study design, we were not able to make any definite conclusions concerning the overall quality of the diet.

Furthermore, we were unable to address with our study design other potential benefits that have been shown with regular snack consumption, such as control of body weight^{19,20}, reduction in total blood cholesterol levels and the LDL cholesterol/HDL cholesterol ratio²¹ and improvement in glucose tolerance²².

In conclusion, within our given limitations of this investigation, the results of this study do not lend support for the popular assumption of a link between the consumption of confectionery purchased from vending machines and either poor dietary practice or 'undesirable' lifestyle habits. Findings for consumption of total confectionery purchased from all sources showed some interesting trends and further work in this area is certainly justified, but the results shown in this study were not consistent, either for a negative or positive effect.

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