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School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas

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Abstract

Objective: To determine whether an educational programme aimed at discouraging students from drinking sugar-sweetened beverages could prevent excessive weight gain.
Design: Forty-seven classes in twenty-two schools were randomised as intervention or control.
Subjects: Participants were 1140, 9–12-year-old fourth graders (435 in the intervention group and 608 in the control group). Sugar-sweetened beverages and juice intake were measured through one 24 h recall at baseline and another at the end of the trial. The main outcome was the change in BMI (BMI = weight (kg)/height (m^2)), measured at the beginning and at the end of the school year. Intention-to-treat analysis was performed taking into account the cluster (classes) effect.
Results: A statistically significant decrease in the daily consumption of carbonated drinks in the intervention compared to control (mean difference = −56 ml; 95 % CI −119, −7 ml) was followed by a non-significant overall reduction in BMI, $P = 0{\cdot}33$. However, among those students overweight at baseline, the intervention group showed greater BMI reduction ($-0{\cdot}4\,kg/m^2$ compared with $-0{\cdot}2\,kg/m^2$ in the control group ($P = 0{\cdot}11$)), and this difference was statistically significant among girls ($P = 0{\cdot}009$). Fruit juice consumption was slightly increased in the intervention group ($P = 0{\cdot}08$), but not among girls.
Conclusion: Decreasing sugar-sweetened beverages intake significantly reduced BMI among overweight children, and mainly among girls. Efforts to reduce energy intake through liquids need to emphasise overall sweetened beverages and addition of sugar on juices.

Keywords
Randomised controlled trial
Obesity
Children
Carbonated beverages
Brazil

Obesity is a major public health problem in many countries throughout the world, especially for the young population and for the poor[(1)]. In Brazil, obesity and overweight have been increasingly common in adults[(2)], as well as in adolescents[(3)]. Dietary interventions that could prevent excessive weight gain in adolescents are fundamental to curb this epidemic.

School is considered a suitable setting for the promotion of healthy lifestyles in children[(4,5)]. For obesity prevention many programmes have been tested among schoolchildren. Usually, these programmes have multiple focuses, including physical activity and nutritional behaviours, and most of them have attained good results in educating children on these issues[(6,7)], but with little or no effect on weight change[(7,8)]. On the other hand, a randomised trial with British schoolchildren with a focus on reduction of carbonated sodas showed a statistically significant and clinically relevant reduction in the weight gain in the experimental group compared with controls[(9)]. The strategy for the study was to reduce overall energy intake by the substitution of sugar-sweetened beverages for non-caloric drinks. Several educational activities were employed in order to incorporate this message. Two other longitudinal studies conducted in the USA observed increased BMI and prevalence of overweight associated with sugar-sweetened beverages[(10–12)], and a review of sugar-sweetened carbonated beverages linked their intake to weight gain in both children and adults[(13)].

Although some educators think that schools already have too much to do, and that prevention of obesity should not be expected to be an added responsibility[(14)], school is considered an important part in the effort to prevent childhood obesity[(15)]. Also, in countries such as Brazil, public schools are one of the few public institutions that reach the majority in the low socio-economic groups.

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The result of the British study[9] is particularly important for developing countries, since it was based only on sugar-sweetened carbonated beverages. The result of this intervention can be more appealing for public health programmes compared with the usually more successful school interventions, which are comprehensive in nature[8] and harder to be implemented in most countries.

The aim of the present study was to determine whether a school-based intervention addressing the issue of a healthy lifestyle aimed at discouraging adolescents from drinking sugar-sweetened carbonated beverages could prevent excessive weight gain.

Methods

A cluster randomised controlled trial of fourth graders from twenty-two public schools in the metropolitan city of Niterói, Rio de Janeiro, Brazil, was conducted from March to December 2005. Most students in the public schools are from families of low socio-economic level. Children go to school either in the morning (08.00–12.00 hours) or in the afternoon (13.00–17.00 hours). Only morning classes were included in the study. Families of fourth grade children (most of them 10 and 11 years old) were informed of the study and only those children with informed consent given by the parents were included in the study, but all of them received information as well as baseball caps and water bottles with the campaign logo.

Sample size

Sample size was estimated based on data from a previous study conducted in the same geographical area, for which the standard deviation of sugar-sweetened beverages consumption was 1·49 cups per day. In order to detect a difference of 0·5 glass of sugar-sweetened beverages between the two groups with a power of 80 % and a 5 % significance level, the sample size needed to be of 140 children in each arm of the trial. This sample size would also allow the detection of a difference of about 1 unit in BMI. Due to the cluster design (classes) and anticipating a rate of parental agreement of around 80 %, the sample size was set at 600 students. Since the school principals did not agree to select only one class of fourth graders, all classes were included, increasing the sample size to 1166 children, in forty-seven classes from twenty-two schools (Fig. 1). Schools, instead of classes, were randomised to reduce contamination of the intervention. We began the study by ranking schools based on the prevalence of overweight and of obesity, and randomisation was generated by blocking of four schools. The last two in the list were randomly assigned to intervention or control groups, balancing the groups by BMI.

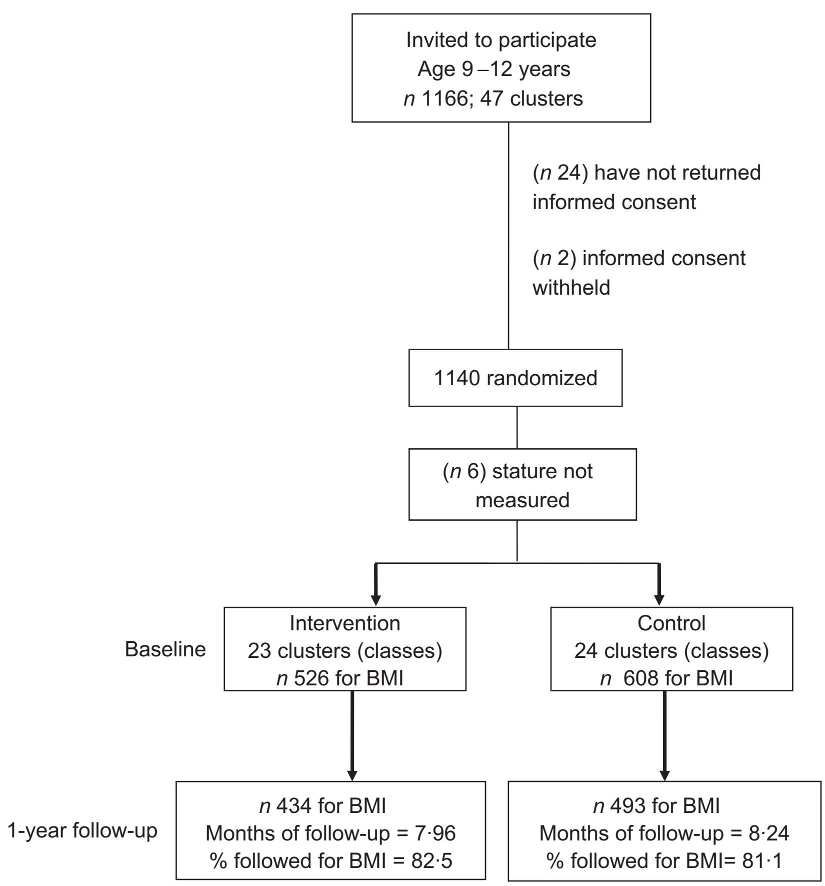

Fig. 1 Progress of students during the study

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Intervention

The intervention evaluated in the present study focused on the reduction in consumption of sugar-sweetened carbonated beverages by students. During seven months of one school year, a healthy lifestyle education programme was implemented using simple messages encouraging water consumption instead of sugar-sweetened carbonated beverages. The messages were previously tested for understanding in two small groups of children of the same age and socio-economic background as the study participants. Also, beliefs and behaviours of children in these focus groups were recorded in order to orient activities and the production of printed materials to be given to participants. Education was delivered via classroom activities; banners were hung promoting water consumption, and water bottles with the logo of the campaign were given to children and schoolteachers.

All children in the intervention classes were taught the importance of drinking water and asked to make drawings and songs about water and how much the body needs it. The main strategy was to convey the message that drinking water is positive. The body needs water and water should be drunk frequently. A 'pyramid of drinking' was created to communicate the message that water (the basis of the pyramid) should take prevalence over sugar-sweetened beverages (at the top of the pyramid). The centre of the campaign was to encourage the exchange of sugar-sweetened beverages for water. Ten one-hour sessions of activities facilitated by four trained research assistants were assigned for each class. The activities required 20–30 min and teachers were encouraged to reiterate the message during their lesson. Classroom quizzes and games using water *v.* sugar-sweetened carbonated beverages as the theme, as well as song and drawing competitions, were promoted. In addition, a musician using a tambourine helped each class to collectively develop songs related to drinking water and reducing the consumption of sugar-sweetened carbonated beverages. This musical activity was conducted during three one-hour sessions. The four research assistants and the musician received printed instructions and orientation on how to facilitate the activities.

The control group received only two one-hour general sessions on health issues and printed general advices regarding healthy diets.

Beverage intake measurement

Beverage intake was measured through one 24 h recall at baseline and another at the end of the trial. At baseline, following the 24 h recall, children were also asked about usual frequency of intake of beverages using a short questionnaire with the previous month as the time frame. The questionnaire included sugar-sweetened carbonated beverages (regular and diet), other sugar-sweetened beverages (regular and diet), milk, 100 % fruit juices (referred from now on simply as fruit juice) and powdered flavoured beverages containing sugar. Only five children reported the consumption of diet drinks.

The 24 h recall and answers to the short questionnaire were obtained by nutritionists during in-person interviews with the children at school.

Main outcome

Weight variation was measured by change in mean BMI (BMI = weight (kg)/height (m^2)). Anthropometric measurements were taken at the beginning and at the end of the school year. Height (without shoes) was measured to the nearest 0·1 cm using a portable anthropometer. Weight (in light clothing) was measured to the nearest 0·1 kg on portable scales.

Secondary outcomes

Overweight and obesity, defined using the BMI cutoffs proposed by Cole *et al.* (2000)[16], was also examined, since some studies have found changes in body mass following intervention only among those overweight at baseline, and mainly among girls[6,8]. Underweight was defined based on WHO (1995) criteria[17].

Data analysis

Data from 24 h recall were computed for all beverages and total added sugar. Schools serve two meals daily for free: breakfast and lunch. The meals are the same for every student, which makes it easy for recording purposes, since children need to only report the portions they consumed. Following the interview by the nutritionist, the reports of items eaten at or out of school were reviewed for adequate description, preparation and their portions. A software containing usual portion sizes developed for analysing Brazilian dietary intake data was used, Programa de Apoio a Nutriçao – NutWin version 2·0 (Departamento de Informática em Saúde, Universidade Federal de Sao Paulo, Brazil).

Regarding the short-frequency questionnaire, the total frequency of intake was estimated using frequency values that ranged from 'zero' to 'three per day.' The questionnaire includes seven exclusive categories, raging from '3 or more per day' to 'never or almost never.'

Statistical analysis

Baseline characteristics of the two groups were compared using either the Student's t test or the χ^2 test. Data on those students who completed the study were compared (baseline *v.* after intervention) using paired t-tests. Intention-to-treat analysis was also performed using longitudinal analysis taking into account the cluster (classes) effect through mixed models[18]. Data were analysed using SAS, version 8·2 (SAS Institute Inc., Cary, NC, USA). Two analyses were conducted: (i) change in BMI, therefore only data on completers were included; and (ii) modelling the change of BMI using all data. BMI was log-transformed because BMI distribution was skewed to the right. Correlation between the intake of juices and beverages and the intake of added sugars based on 24 h recall was calculated through the Spearman correlation coefficient.

Individuals were the unit of analysis for anthropometric variables. However, for changes in beverage consumption, the mean beverage intake of classes was used instead of individual data since 24 h is a good estimate for a group but not for individuals.

Results

Consent was given by most of the parents. Only twenty-six students refused or did not return the informed consent. Loss to follow-up added up to 18 %. Children out of the age range of between 9 and 12 years were allowed to participate but they did not contribute data. The mean follow-up time was slightly greater in the control group (8·24 months *v.* 7·96 months; P value = 0·02) and the percentage of students followed was slightly greater in the intervention group (82·5 % *v.* 81·1 % in the control group) (Fig. 1). A large number of children participated in the trial, but some of them did not agree to be interviewed for the 24 h recall at baseline and at the end of the study, with 85 % answering the 24 h recall at baseline, and 86 % of those followed also answered the 24 h recall at the end of the study. Anthropometric indices between those students with follow-up data on intake compared with those who refused to participate were similar for BMI (18·1 *v.* 18·3 kg/m^2; t test P value = 0·43).

Groups were similar at baseline for age, sex, race, anthropometric measurements and beverage intake (Table 1a). The intracluster correlation coefficient for BMI was 0·024. At baseline, the intake of sugar-sweetened beverages was reported by 53 % of participants in the 24 h recall. The mean amount of carbonated beverages reported was 547 ml, which was greater than the amount of juices reported, which varied from 388 ml for powdered juice to 404 ml for fresh or concentrated juice (Table 1b).

Twenty-five students reported drinking juices and powdered flavoured beverages only, and 224 reported in the 24 h recall drinking both sugar-sweetened beverages and juices. The correlation coefficient between added sugar, for those 651 students reporting sugar intake in the previous day, was 0·34 (P < 0·0001) with the amount of juice/powdered flavoured beverages intake, and −0·15 (P < 0·0001) with amount of carbonated beverages intake.

The questionnaire regarding the usual intake of beverages in the previous month indicated that 98·8 % drink sugar-sweetened beverages with a daily intake frequency of 0·62.

At the end of the study, BMI and weight had increased in both groups and the mean intake of sodas per class was reduced in both groups, with reduction being about four times greater in the intervention compared with the control group (−69 ml *v.* −13 ml) (Table 2). The overall change in the BMI was not statistically significant between the two groups even after adjusting for age and time of follow-up. However, among those students overweight at

Table 1 Baseline data: (a) intervention and control group data. (b) number (n) and percentage of students (%) reporting beverage intake, and means and SE of selected drinks and sugar added to beverages, among those 968 who answered the 24 h recall

(a)	Intervention (n 526) Mean	SD	Control (n 608) Mean	SD	P value
Age (years)	10·9	0·81	10·9	0·75	0·30
Weight (kg)	38·4	10·6	38·0	9·7	0·39
Stature (cm)	144·3	8·2	144·2	7·7	0·22
BMI (kg/m^2)	18·3	3·6	18·2	3·2	0·69
Race (%)					
White	41·8		42·3		0·90
Mulatto	25·9		30·6		
Black	32·3		26·9		
Males (%)	46·9		47·4		0·90
Underweight (%)*	6·3		6·9		
Overweight (%)†	15·8		14·3		0·70
Obese (%)†	5·5		4·3		
Carbonated beverages (ml/d)	(n 435)		(n 533)		
	552	365	542	367	0·76

(b)	n	%	SE	Mean (ml or g)	SE
Carbonated beverages‡	518	53·5	1·6	547	16·4
Powdered flavoured beverage with sugar	148	15·3	1·2	388	18·5
Fruit juice fresh or bottled	260	26·9	1·4	404	17·1
Sugar added to beverages	651	69·9	1·5	34·5	1·03

*WHO (1995)[17].
†Cole *et al.* (2000)[16].
‡Only five students reported consumption of diet or light beverages.

Table 2 Mean change in weight, BMI and intake of sodas and 95 % CI in the intervention and control groups, from baseline to the end of the school year for completers

	Intervention (*n* 434)		Control (*n* 493)		Intervention–control	
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI
Weight (kg)	2·8	2·5, 3·2	2·8	2·6, 3·0	−0·00009	−0·40, 0·40
BMI (kg/m^2)	0·32	0·19, 0·46	0·22	0·13, 0·32	0·10	−0·06, 0·10
Carbonated beverages (ml/d) per class	−69·0	−114·0, −24·0	−13·0	−56·0, 31·0	−56·0	−119·0, −7·0

Table 3 Change in BMI (kg/m^2) according to intervention, adjusted for other age and follow-up

	Regression coefficient*	*P* value
All participants		
Intervention/control (log BMI)	−0·003	0·33
Age (years)	0·015	0·002
Months of follow-up	−0·001	0·39
Overweight at baseline		
Intervention/control (log BMI)	−0·007	0·11
Girls-overweight at baseline		
Intervention/control (log BMI)	−0·01	0·009

*Proc mixed models taking into account the cluster effect.

Table 4 Prevalence (%) of overweight and obesity* according to intervention and mean intake of beverages in ml for those completing the study

	Baseline (%)	End of the study (%)	*P* value†
Overweight			
Intervention	16·2	19·2	0·13
Control	13·9	16·0	
Obesity			
Intervention	4·06	4·4	0·95
Control	4·10	4·5	
	Mean	Mean	
Daily intake of carbonated beverages (ml)‡			
Intervention	295	228	0·03
Control	292	280	
Daily intake of juices (ml)			
Intervention	146	151	0·08
Control	103	115	

*Cole *et al*. (2000)[16].
†χ^2 or *t* test at the end of the study.
‡For those not reporting intake, value was set 0.

baseline, the intervention group showed greater BMI reduction, and this difference was statistically significant among girls ($P = 0·009$; Table 3).

For both groups, obesity changed from about 4 to 4·5 % (Table 4). Carbonated beverage intake was significantly reduced in the intervention group compared with the control group, but fruit juice consumption was slightly increased in the intervention group ($P = 0·08$); for those who had not reported intake it was assumed to be zero (Table 4).

Discussion

Soda intake has grown more than 400 % in the last three decades in Brazil[19], and now there are many low-cost brands of soda available for the low-income population. We anticipated that this scenario would be adequate to test the hypothesis that the discouragement of intake of carbonated beverages would prevent excessive weight gain, but this single message was not effective in reducing excessive weight gain. However, we found a statistically significant decrease in BMI among overweight or obese girls at baseline, even though their sample size was small. Other studies have shown that gender and baseline BMI may explain better the changes in body weight associated with sugar-sweetened beverages[20].

Overall baseline intake of carbonated drinks in the English study was slightly greater (approximately two glasses per day), whereas the mean baseline daily intake in our study was one and a half glasses, and 50 % of the students at baseline in our trial did not drink carbonated beverages.

We anticipated a reduction of consumption of half a glass of sodas per student per day, but our results showed a statistically significant reduction in soda intake of 66 ml in the intervention group compared with the control group (0·25 glasses). However, because of the large sample size in our study, this small change may have contributed to the overall negative findings. Also, the small self-reported change, representing about a 10 % reduction of baseline intake, was associated with compensation due to an increase in juices. The changes in consumption indicate that future interventions should allow exchanges to low sugar products, instead of a too big switch such as, in this case, to plain water.

A limitation in the study was the use of one 24 h recall, which is not the best method to measure intake. During the pre-test, a 3 d diary was used, but most children did not return them or brought them with highly incomplete data. Nevertheless, one 24 h recall provides a good estimation of group intake (classes)[21]. Also, at baseline, the usual frequency of beverage intake measured by a frequency questionnaire indicated that 98 % of students drink sodas with a daily frequency of 0·62, a value that is close to the 53 % reported use in the previous day, measured by the 24 h recall.

The negative finding of the study may also be due to slight family involvement. Meeting with the parents was attempted at the beginning of the study without success, so we only sent them fliers and a fridge magnet to remind them of cutting down on carbonated beverages. Also, the intervention may not have been sufficiently intense or long enough to change behaviour. In addition, the reduction in drinking sugar-sweetened carbonated beverages as reported by students was combined with an increase in juice intake, which suggests that juices may have blurred the effects of soda reduction. A trend of substitution of sodas by juices or flavoured beverages has been observed in the USA[22]. Powdered fruit-flavoured drinks are very inexpensive in Brazil, and our data showed that the amount of sugar added per day in these beverages is greater than the amount of sugar in one glass of soda. The mean of sugar added was 34·5 g/d, whereas 250 ml of soda has 26 g of sugar.

Although the results from a systematic review indicate that regular sugar-sweetened beverage consumption is associated with weight gain[13], in a large national survey – UK National Dietary and Nutritional Survey of Young People – using weighed 7 d food records, the risk associated with caloric soft drinks was non-linear with an increased risk only for very high consumers[20], not frequent in our population.

Strategies of primary prevention of obesity that may prove effective, mainly among low socio-economic groups, are desperately needed and may be mandatory in developing countries given the burden associated with chronic diseases related to obesity. Unfortunately, the single message of cutting down on sodas was effective only among overweight girls, suggesting that efforts to reduce energy intake though liquids should also emphasise overall sweetened beverages, including the addition of sugar to juices.

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Conflict of interest: None.

Authors' contributions: R.S. was the principal investigator, led the research project and participated in all phases of the study. G.V.V. was a co-investigator of the project and participated in conceptualisation of the intervention and collaborated in the manuscript. A.P.T. and R.A.S. conducted the analysis and collaborated in the manuscript.

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