Table 1 Characteristics at baseline of children in intervention and control schools. Values are mean (SD) unless stated otherwise

	Intervention			Control		
	Boys	Girls	Total	Boys	Girls	Total
No (%)	161 (51)	153 (49)	314	189 (59)	133 (41)	322
Age	8.34 (0.62)	8.38 (0.64)	8.36 (0.63)	8.43 (0.65)	8.40 (0.60)	8.42 (0.63)
No in Year 4	76	69	145	80	65	145
No in Year 5	85	84	169	109	68	177
No (%) >85th centile*	27 (17)	27 (18)	54 (17)	30 (16)	23 (17)	53 (16)
No (%) >95th centile*	8 (5)	12 (8)	20 (6)	22 (12)	13 (10)	35 (11)
Body mass index SD score	0.07 (1.05)	0.17 (0.96)	0.12 (1.01)	0.06 (1.17)	0.02 (1.17)	0.04 (1.17)
Height SD score	0.10 (0.15)	0.03 (1.12)	0.09 (1.02)	0.30 (0.92)	0.01 (1.08)	0.17 (1.00)
Weight SD score	0.14 (0.98)	0.12 (1.04)	0.13 (1.01)	0.21 (1.08)	0.00 (1.20)	0.12 (1.14)
Fruit intake†	1.9 (1.7)	2.2 (1.7)	2.0 (1.7)	1.9 (1.6)	2.1 (1.6)	1.9 (1.6)
Vegetable intake†	0.5 (0.7)	0.7 (0.7)	0.6 (0.7)	0.6 (0.7)	0.5 (0.7)	0.5 (0.7)
Foods high in sugar†	7.9 (5.8)	6.3 (4.5)	7.3 (4.8)	8.3 (5.7)	7.1 (4.9)	7.8 (5.1)
Foods high in fat†	2.0 (1.2)	1.7 (1.0)	1.8 (1.1)	1.7 (1.2)	1.9 (1.1)	1.7 (1.1)
Physical activity‡	3.4 (1.2)	3.6 (1.1)	3.5 (1.2)	3.5 (1.0)	3.4 (1.1)	3.4 (1.1)
Sedentary behaviour¶	1.1 (0.8)	1.0 (0.7)	1.1 (0.8)	1.1 (0.8)	0.9 (0.7)	1.0 (0.7)

*For body mass index.
†Number of foods in this category recorded by 24 hour recall.
‡Number of activities recorded for past week.
¶Number of activities recorded for past 24 hours.

Table 2 Mean (SD) scores for psychological measures at baseline for children in intervention and control schools

	Intervention	Control
Self perception (range 0-4):		
Scholastic competence	2.9 (0.7)	2.8 (0.7)
Behavioural conduct	2.9 (0.7)	3.0 (0.7)
Social acceptance	3.0 (0.7)	3.0 (0.7)
Athletic competence	3.0 (0.7)	3.0 (0.7)
Physical appearance	3.1 (0.7)	3.0 (0.7)
Global self-worth	3.2 (0.6)	3.1 (0.7)
Dieting restraint (0-12)*	3.9 (2.8)	4.3 (2.7)
Boys	3.7 (3.1)	3.9 (2.7)
Girls	4.1 (2.5)	5.0 (2.6)
Body shape preference†	0.0 (1.0)	0.0 (1.0)
Boys	0.2 (1.2)	0.2 (1.1)
Girls	–0.2 (0.7)	–0.3 (0.8)

*Derived from six questions measuring dieting.
†Body shape preference is derived by subtracting the rating of preferred from currently perceived body shape. Zero indicates satisfaction, a positive value the desire to be fatter and a negative value the desire to be thinner.

terms of growth measures, diet, and physical activity and table 2 their psychological scores. No significant differences were found between the intervention and comparison pupils for any of the measures.

Completion rate

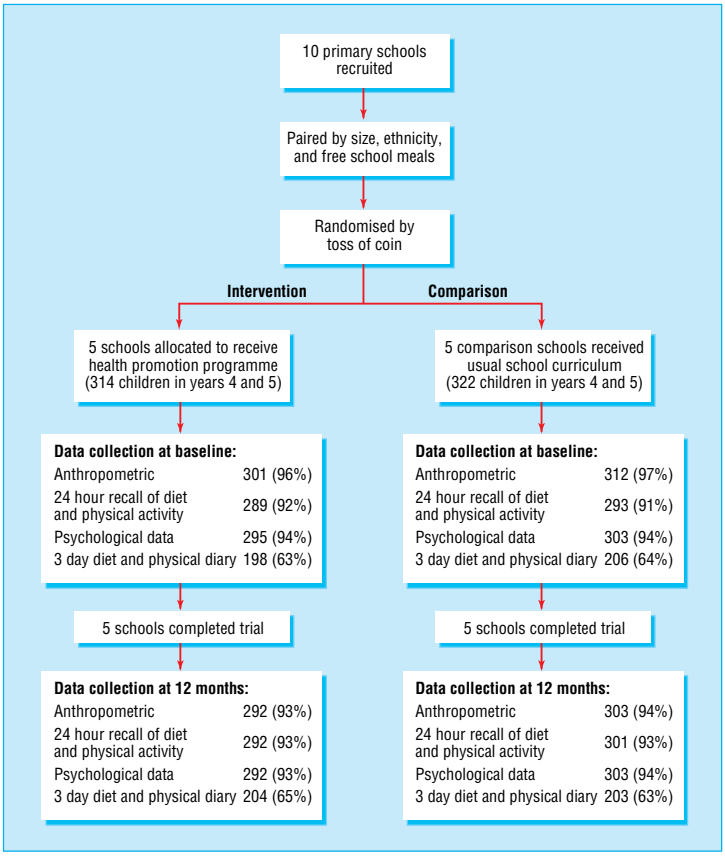
All 10 schools completed the project. The figure shows the progress of the schools through the trial. Only 21 children declined to participate in the data collection. Over the year, 42 children left and 40 new children joined. In all, 613 (97%) children were measured at baseline and 595 (94%) at the end of the intervention period; 404 (63%) completed three day food and physical activity diaries at baseline and 407 (64%) at the end of the study.

Growth

Table 3 shows the weighted mean difference in body mass index standard deviation score for the five pairs of schools. Overall, there was no difference in score between the intervention and control children at the end of the year. There was also no difference for the overweight (weighted mean difference −0.07, 95% confidence interval −0.22 to 0.08) or the obese children (−0.05, −0.22 to 0.11).

Diet

Analysis of 24 hour recall showed that the intervention children had higher vegetable intakes at the end of the study (tables 3 and 4). The weighted mean difference of 0.3 (95% confidence interval 0.2 to 0.4) indicates on average one third of a portion more a day. As the mean baseline was only 0.6 portions/child/day, this difference is equivalent to 50% of baseline intake. The same difference was seen for the overweight (0.3, 0.1 to 0.5) and obese children (0.3, −0.1 to 0.6). The three day



Progress of schools and pupils through trial

Table 3 Weighted mean difference in body mass index standard deviation score and vegetable intake between the five intervention schools and their control schools

	Body mass index SD score		Vegetable intake	
	Weighted mean difference (95% CI)	% weight of school*	Weighted mean difference (95% CI)	% weight of school*
1	0 (–0.2 to 0.1)	25.8	0.2 (–0.1 to 0.4)	25.5
2	0.1 (0 to 0.2)	18.0	0.4 (0.2 to 0.7)	18.2
3	0.1 (–0.1 to 0.2)	22.5	0.3 (0.1 to 0.5)	23.0
4	–0.1 (–0.3 to 0)	19.8	0.4 (0.1 to 0.7)	16.0
5	–0.2 (–0.3 to 0)	13.9	0.1 (–0.1 to 0.4)	17.4
Overall	0 (–0.1 to 0.1)		0.3 (0.2 to 0.4)	

*Statistical weighting.

Table 4 Weighted mean difference (95% confidence interval) in dietary and physical activity levels between intervention and control children according to weight

	All children	Overweight	Obese
24 hr recall:			
Foods high in fat	0.1 (–0.2 to 0.4)	0.4 (–0.0 to 0.9)	0.1 (–0.7 to 0.8)
Foods and drinks high in sugar	–0.5 (–1.1 to 0.1)	0.0 (–0.8 to 0.8)	1.0 (–0.5 to 2.6)
Fruit intake	0.0 (–0.5 to 0.5)	–0.2 (–1.0 to 0.6)	–1.0 (–1.8 to –0.2)
Vegetable intake	0.3 (0.2 to 0.4)	0.3 (0.1 to 0.5)	0.3 (–0.1 to 0.6)
3 day diary:			
Foods high in fat	–0.1 (–0.4 to 0.3)	0.2 (–0.9 to 1.2)	0.0 (–0.8 to 0.8)
Foods and drinks high in sugar	0.1 (–0.4 to 0.5)	0.8 (0.1 to 1.6)	0.3 (–1.8 to 2.3)
Fruit intake	–0.2 (–0.6 to 0.2)	–0.2 (–0.7 to 0.3)	–0.6 (–1.2 to 0.1)
Vegetable intake	0.1 (–0.1 to 0.3)	–0.1 (–0.5 to 0.2)	–0.1 (–0.9 to 0.7)
Physical activity:			
Physical activity	–0.2 (–0.4 to 0.1)	–0.2 (–0.5 to 0.2)	–0.48 (–1.3 to 0.3)
Sedentary behaviour	0.0 (–0.1 to 0.1)	0.3 (0.0 to 0.7)	0.29 (–0.1 to 0.7)

A positive value for weighted mean difference indicates higher food intake or activity levels in the intervention schools than the control schools. A value of zero indicates no difference.

diary (which had a quantitatively and qualitatively lower completion rate) did not show these differences.

Table 4 shows the full dietary assessment. Other significant differences included a lower fruit intake in obese intervention children by 24 hour recall. According to the three day diaries, there was a higher intake of foods and drinks high in sugar in overweight children in the intervention group.

Physical activity and psychological measures

We found no significant difference in physical activity or sedentary behaviour for the sample as a whole. Sedentary behaviour increased by one third in the overweight children in the intervention group compared with overweight control children. The only significant difference in psychological measures was a small increase in global self worth for obese children in the intervention schools (0.32, 0.0 to 0.64).

Focus groups

Compared with children in control schools, children in the intervention schools had higher levels of self reported behaviour change, greater understanding of the health benefits of diet and physical activity, and increased sophistication of ideas and vocabulary, willingness and confidence to share their ideas, and basic knowledge. They were more able to recollect topics learnt and activities undertaken in school linked to diet and physical activity.

Discussion

Implementation of this health promotion programme was highly successful,[9] and it was therefore disappointing that the children showed minimal behavioural changes. The only clinically important positive result was a modest increase in consumption of vegetables. Vegetables are likely to be the most challenging food group to change in children, and a rise of one third of a vegetable portion per child is a huge increase in vegetables consumption across the city per day. Nevertheless, it is a small return for the effort made.

One possible reason for the apparent lack of effectiveness of the intervention could be the alarming increase in the prevalence of overweight and obesity in this entire school population.[3] This rise in body mass index was seen as the children grew older as well as over time. In the face of such an epidemic, a programme with limited resources would be unlikely to have demonstrable effects in countering this increase. Clearly, the social and environmental forces at work require much larger public health counter measures.

Problems of evaluating complex interventions

Lack of evidence of effectiveness does not necessarily mean evidence of ineffectiveness.[16] Inadequate sample size is often an issue in trials, and this is especially the case in studies using group randomisation. Although about 600 children participated, the unit size was only five schools in each arm, which is very small. More schools are needed to achieve a clear result. This would have been more costly and difficult to implement. Several larger health promotion trials have also had results below expectations for the same reason.[17–22]

The outcome measures that we used also presented difficulties. Body mass index is reliably measurable but could not be expected to change significantly over such a short time. Indeed, had body mass index fallen, we would have been concerned that we had induced inappropriate eating behaviour. The other outcome measures were less easy to measure. Although the focus groups indicated a change in self reported behaviour, we had no quantitative evidence of this. Accurate dietary assessment is difficult in any age group, but particularly in children. Few validated instruments are available, and the two methods that we used (24 hour recall and three day diary) could not assess quantities accurately. We therefore relied more on the quality of food reported. The reports of physical activity levels were even harder to quantify.

There is much debate about whether randomised controlled trials are appropriate for evaluating complex interventions, particularly in primary prevention.[23] Our study, with others, raises critical issues for the development of evidence based health promotion and about appropriate measure to determine whether such interventions are effective and worthwhile.

Conclusions

Since the programme was successful in changing the ethos of the schools and the attitudes of the children,[9] it is premature to conclude that it was unsuccessful in reducing risk factors for obesity. The intervention was designed for one academic year only, recognising funding limitations. The intervention might have been strengthened if the families were targeted more directly,[24] while still maintaining the focus on the school community.

Other studies of this type suggest that behaviour change is possible over time.[25 26] Given the problems of evaluating behavioural intervention trials, it has been recommended that funding agencies should consider