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Evaluation of a pilot school programme aimed at the prevention of obesity in children

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SUMMARY

This paper describes the development, implementation and evaluation of a school- and family-based intervention to prevent obesity in children aged 5–7 years. In addition, the efficacy of three different intervention programmes was compared. Children aged 5–7 years (n = 213) were recruited from three primary schools in Oxford and randomly allocated to a control group or one of three intervention groups: nutrition group, physical activity group, and combined nutrition and physical activity group. The setting for the interventions was lunchtime clubs, where an interactive and age-appropriate nutrition and/or physical activity curriculum was delivered. The intervention lasted for 20 weeks over four school terms (~14 months). Children's growth, nutrition knowledge, diet and physical activity were assessed at baseline and at the end of the intervention. Significant improvements in nutrition knowledge were seen in all children ($p < 0.01$) between baseline and post-intervention, and results were highly significant in the nutrition and combined group ($p < 0.001$). Overall, fruit and vegetable intake increased significantly ($p < 0.01$ and <0.05, respectively), with changes seen in fruit consumption in the nutrition group ($p < 0.05$) and the control group ($p < 0.05$) in particular. No significant changes in the rates of overweight and obesity were seen as a result of the intervention. Gender differences were not detected in the majority of assessments and there was no clear effect of programme type per se. This pilot study has demonstrated that school may be a suitable setting for the promotion of healthy lifestyles in children, but requires replication in other social settings. Future initiatives should be long-lasting, multi-faceted and sustainable, involving all children in a school, and should target the whole environment and be behaviourally focused. The ultimate goal of any such programme is to lead to positive behaviour change which will have a beneficial effect on long-term health. Successful targeting of the family remains a challenge to such interventions.

Key words: children; obesity; prevention; school-based intervention

INTRODUCTION

In the UK, the incidence of overweight and obesity among adults and children is increasing at alarming rates (Reilly and Dorosty, 1999; Chinn and Rona, 2001; Rudolf *et al*., 2001). Similar increases are also apparent throughout Europe and globally (WHO, 1998; Livingstone, 2001). Obesity is the result of being in a state of sustained positive energy balance, the causes of which are multi-factorial. Whilst knowledge about the genetic causes and aetiology of obesity is growing, it is likely that changes in lifestyle, particularly the increased consumption of energy-dense food and the marked decline in physical activity, are the major influences. Studies in the UK and the US suggest that childhood obesity appears to account for 33% of adult obesity (Power *et al*., 1997; Dietz, 1998). There is also evidence that intransigent obesity tracks

with age (Guo and Chumlea, 1999). The risks of tracking increase with age of onset and severity of obesity (Edmunds and Walters, 2000). Childhood obesity, as in adults, is difficult to treat successfully in the long-term. A recent critical review of childhood obesity described treatment results as 'equivocal' and 'modest' (Edmunds and Walters, 2000).

The International Obesity Taskforce (IOTF) concluded that prevention of weight gain is easier, less expensive and more effective than treating obesity after it has fully developed (Basdevant *et al*., 1999). Addressing the problem in children who are forming lifestyle habits offers an opportunity for successfully managing and controlling obesity, especially as most adult obesity occurs in later life. A general population approach has been considered more economical and feasible than a targeted approach (Harrell *et al*., 1998). In addition, as the factors that lead to obesity have yet to be fully elucidated, a population-based approach seems judicial (Zwiauer, 2000).

School-based prevention of obesity

Schools provide the ideal vehicle for the delivery of interventions for childhood obesity (Sallis *et al*., 1995; Story, 1999). Most previous school-based interventions have taken place in North America and have been aimed at the promotion of healthy eating or the reduction of cardiovascular risk, rather than the prevention of obesity. Comprehensive reviews of this work have been published (Resnicow and Robinson, 1997; Rowe *et al*., 1997; Lister-Sharp *et al*., 1999; Campbell *et al*., 2001). The reported results from previous work are difficult to compare due to variable study designs and differences in the assessment tools used. Currently there is limited quality data on the effectiveness of obesity programmes and generalizable conclusions cannot be drawn (Campbell *et al*., 2001). Many of the outcomes can be described at best as modest. Two of the more successful North American preventative interventions are the 'Planet Health' and 'Eat Well and Keep Moving' interdisciplinary health behaviour interventions in adolescents and children aged 9–11 years, respectively (Gortmaker *et al*., 1999a; Gortmaker *et al*., 1999b). Both interventions lasted for 2 years and had four specific messages, which were incorporated into several subjects across the curriculum by classroom teachers and were linked to the school food services teacher and other staff wellness programmes. Both programmes resulted in a decrease in television viewing, an increase in fruit and vegetable consumption and, in the case of 'Planet Health', a decrease in the prevalence of obesity in female adolescents. Preliminary results of a German 8-year study targeting 5–7 year olds are encouraging (Muller *et al*., 2001).

Targeting families has been a feature of only a minority of past studies (Rowe *et al*., 1997). Family involvement is logical and has theoretical support (Crockett *et al*., 1989a; Rowe *et al*., 1997), but when the effect of a family component was recently evaluated as part of a programme, it was not found to be of added benefit (Luepker *et al*., 1996). Previous research found poor parental response to meetings and mailed information (Crockett *et al*., 1989b; Lytle *et al*., 1995), but this has not been tested in the UK.

At the inception of this study (1998), there had been no school-based preventive work undertaken in the UK, which made it an important pilot study. Since then, the authors are aware of only one school-based study in the UK: a health authority-funded project in Leeds, known as APPLES. The recently published findings from this study did not show an impact on the incidence of obesity (Sahota *et al*., 2001).

The objective of the present study was to develop, implement and evaluate a school- and family-based intervention to prevent obesity in children aged 5–7 years. Although children at this age do not have responsibility for food purchase or activity choices, food manufacturers in particular are aware of the effectiveness of 'pester power' and specifically target this age group. In addition, the design of this study enabled a comparison of three interventions (nutrition education and/or physical activity); currently there is a need to examine a range of interventions (Campbell *et al*., 2001).

METHODS

Subjects and ethical approval

All children in years 1 and 2 (aged 5–7 years) from three primary schools in Oxford were targeted in January 2000. The primary schools were selected on the basis of previous links to the Nutrition and Food Science Department at Oxford Brookes University and their close proximity to the University. Parents/carers were

sent an invitation letter with a tear-off consent slip and a fact sheet. Canvassing in the school playground during mornings and afternoons was a successful means of enhancing recruitment, along with parent meetings held in the schools. Ethical approval for the study was obtained from the Applied and Qualitative Research Ethics Committee for the Oxford Radcliffe Hospitals, Oxford.

Intervention

The overall intervention programme, known as 'Be Smart', lasted for four school terms (~14 months), and was held over 8 weeks per term, weekly in term 1 and fortnightly in terms 2–4, giving an intervention of 20 weeks in total. Four of the authors were responsible for the delivery of the intervention. A Latin square design was employed for the delivery of the lessons so that each 'teacher' taught a different intervention to different groups of children; the same children always had the same 'teacher' for continuity.

Children were randomly allocated to one of four groups: three intervention groups or a control group. Each intervention group lesson was designed to last for a 25-min period, had an interactive approach and was behaviourally focused. The intervention programme developed was based on Social Learning Theory (Bandura, 1986) and incorporated the following elements:

- Raising the value of the desired behaviour, including the short-term benefits, which are most likely to appeal to children.
- Providing the opportunity to taste healthy foods and undertake non-competitive physical activity.
- Providing incentives to reinforce messages, for example verbal praise and small prizes.
- Developing practical skills and thus self-confidence in the desired behaviour.
- Working with parents (as far as possible) to overcome barriers to the desired health behaviour.

All materials developed were reviewed by experienced primary school teachers and amended on the basis of their recommendations.

A brief outline of the programme per intervention and control group is given below.

Nutrition group ('Eat Smart')

In the first term, children's concepts of health were explored through their drawings and then a link was made to food contributing to health, provided a variety of food was eaten. In the second term, fruit and vegetables were promoted using tasting sessions and games based on the 'Give me 5' [British Dietetic Association (BDA), 2000] message. In the third term, specific positive messages about 'power' foods (high starch foods) were given out, concentrating on breakfast and snacking; quizzes, flash cards and craftwork were used as teaching aids. In the fourth term, tooth-friendly foods were explored, which consolidated the previous term's work.

Physical activity group ('Play Smart')

The physical activity programme was designed to promote activity in daily life rather than the promotion of specific leisure pursuits, which would not be accessible to everyone. Using insects as a theme, the concepts of energy and activity were explored in the first term. The promotion of activity in the playground and a reduction in television viewing were specifically addressed in the second and third terms, using team games, fun physical activities and quizzes. The US recommendations for physical activity in children have been translated into an 'activity pyramid' (Frary and Johnson, 2000), which formed the basis of the fourth term's lessons.

Combined nutrition and physical activity group ('Eat Smart Play Smart')

Children in this group received half of the nutrition and half of the physical activity programme each term.

For all intervention groups, an activity book, designed for use at home, accompanied each term's lessons. Every week in the activity book a related and fun 'homework', such as colouring, quiz or craftwork, was given, concluding with a weekly message for the children and parents. Messages were based on the lesson and were specific and behaviourally focused. Parents were also targeted through a newsletter, which was sent home at the conclusion of each term and gave a résumé of the lessons that term.

Control group ('Be Smart')

For ethical reasons it was considered essential to provide the children in this group with an educational programme. Children learnt about food in a non-nutrition sense. The topics covered

were food traditions, food in different countries and food processing. On alternate weeks, children learnt about the human body, using an interactive CD-Rom. Children had an activity book, which had a related homework, but it did not have weekly messages.

Assessments

All assessments were made at the initial stage and 1 month after the end of the intervention. There were approximately 14–16 months between assessments, depending on the phase of recruitment. Assessments at baseline were made prior to randomization to a group. Assessors were involved in the delivery of the intervention, so knew a small number of the children (approximately one-quarter) at the final assessment stage. Assessments were made in two ways: at school and through postal questionnaires to parents. The same parent/carer was asked to fill in all questionnaires at both the initial and final stages.

Anthropometry

All measurements were taken with children in minimum indoor clothes (shirt/blouse, trousers/skirt, underclothes) and bare feet. Measurements were repeated three times and the mean was calculated. In the main, the same researcher took the same measurements on all occasions to maintain continuity and quality control. Standard methods were used to obtain all measures, as described by Lohman *et al.* (Lohman *et al.*, 1988).

Height was measured using a stadiometer ('Seca' Somatometre, 200 cm × 0.1 cm). Weight was measured using dial scales (Healthometer Professional Scales, 148 kg × 500 g). Body mass index (BMI) was calculated using the standard formula [weight (kg)/height $(m)^2$]. Skinfold measurements were taken at five sites (biceps, triceps, subscapular, supra-iliac and calf) using Holtain skinfold calipers (0.2 mm intervals). Circumferences were taken at four sites (waist, hip, mid-upper arm and head) using a standard tape measure (0.1 mm intervals).

Nutrition knowledge

A nutrition knowledge questionnaire, developed and validated by Calfas *et al.* (Calfas *et al.*, 1991) for use in children aged 4–8 years, was employed. In this assessment, children were shown a series of eight matched photographs of food (e.g. rice and chips) and asked to select the healthiest food. Where appropriate, changes were made to the original foods to ensure all foods would be familiar to children in the UK.

Physical activity

Children were asked basic questions about their school day. This included mode of transport to and from school, and activities at break times. Parents completed a questionnaire which indicated their child's habitual attendance of after-school clubs, outdoor play, television viewing and computer usage; frequency and duration of these activities were specified. Habitual weekend activity was detailed separately: each weekend day was divided into segments and activity per segment was recorded. Duration of television viewing/segment was also recorded.

Dietary assessment

Children's diets were assessed using a combination of two questionnaires completed by parents on their behalf, a 24-h recall questionnaire and a food frequency questionnaire (FFQ). The dietary information was quantified using household measures supplemented by a lunch observation, as described elsewhere (Warren *et al.*, 2003), and analysed using 'Diet 5' (Diet 5 for Windows 1995, Robert Gordon Institute, Aberdeen).

The FFQ was a 42-food item questionnaire that had been validated to rank individuals as high-/low-fat and high-/low-fibre consumers compared with the general population, and was based on current healthy eating recommendations, rather than providing a nutrient analysis (Hammond *et al.*, 1993). Classifications for high-, medium- and low-fat and -fibre were based on the criteria used by Hammond *et al.* (Hammond *et al.*, 1993). Scores were assigned to fat and fibre intake based on consumption of the following foods: red meat, cheese, whole milk, crisps, cakes and biscuits for fat; and vegetarian alternatives, wholemeal bread and breakfast cereals, potatoes, vegetables, salads, fresh fruit and other fruits for fibre. The cumulative scores for fat and fibre were then assigned to 'high', 'medium' or 'low' bands.

Parental questionnaires

Parents provided a social and medical history, dietary assessment (using the FFQ described

above) and physical activity assessment based on the Baecke Activity Questionnaire (Baecke *et al*., 1982) for work-related activity and the Godin Leisure Time Questionnaire (Godin and Shephard, 1985) for activity out of work. Their nutrition knowledge was assessed using a validated nutrition knowledge questionnaire (Parmenter and Wardle, 1999).

Other assessments

As part of the ongoing process evaluation, a log of lesson evaluations, parental phone calls and letters was kept. This process provided help in the development of lessons and the compilation of recommendations for future research. Impact evaluation was undertaken through a quiz based on the main messages of the nutrition and physical activity components of the intervention, completed by all children in the three schools in the relevant year groups. The aim was to assess whether the programme had been comprehensible. Parents and teachers were also asked to complete a satisfaction survey about how they perceived the intervention.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS 10.0.5; SPSS Inc., Chicago, IL, 1999). Data are presented as frequencies, means and standard deviations. Prior to statistical analysis, the normality of the data was tested using the Kolmogorov–Smirnov statistic with a Lilliefors significance level. Between–group comparisons were made using analysis of variance (ANOVA). The independent sample *t*-test and paired *t*-test were used to investigate differences between males and females, and between baseline and final data. The one-sample *t*-test was used to compare nutrient intakes with data from the National Diet and Nutrition Survey (NDNS) of young people aged 4–18 years (Gregory and Lowe, 2000). The Pearson correlation was used to determine associations between selected variables, e.g. weight and television viewing, and parent's and children's diets. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 218 children were recruited in three phases and were randomly allocated to one of three intervention groups or the control group (Table 1). Most of the children were of Caucasian origin (89%). Thirty-nine per cent of their parents had obtained either a degree or a post-graduate qualification. The mean parental BMI was calculated to be 24.5 (SD = 3.8, range = 17.9–38.4) from self-reports of height and weight.

The drop-out rate during the study was 17% ($n = 37$), which made the final number of subjects in the study 181. Of the 37 subjects who left the study, 43% ($n = 16$) moved from the area, 6% ($n = 2$) were discounted because of chronic illness and 51% ($n = 19$) withdrew from the study. The characteristics of the withdrawals were studied. There was no gender bias in the withdrawals. In addition, the drop-out rate was similar between the four intervention groups and the children had a wide range of results from the baseline assessments. This indicated that individuals with the missing data encountered at the final stage did not differ from the remaining subjects. The response rate for the postal questionnaires was approximately 70% at baseline and 45% at the final stage. The fall in returns may be indicative of respondent fatigue.

Anthropometry

Anthropometric data were obtained for 212 children at the initial stage and 172 at the final stage. Using the recent international cut-off values for BMI (Cole *et al*., 2000), the percentage and number of children who were classified as overweight and obese was calculated for all children and per intervention group (Table 2).

Table 1: Subject characteristics at baseline

	All groups	Be Smart	Eat Smart	Play Smart	Eat/Play Smart
n	218	54	56	54	54
Males:females	111:107	29:25	31:25	27:27	24:30
Age in years [mean (SD)]	6.1 (0.6)	6.1 (0.6)	6.1 (0.6)	6.1 (0.6)	6.1 (0.7)
BMI [mean (SD)]	15.9 (2.1)	15.5 (1.6)	16.1 (2.7)	16.0 (2.0)	15.8 (2.0)

Table 2: Percentage of overweight and obese subjects at initial and final stage

	All groups	Be Smart	Eat Smart	Play Smart	Eat/Play Smart
Initial stage					
n	212	50	56	54	52
Percentage overweight	8	8	9	11	2
Percentage obese	4	2	7	6	6
Final stage					
n	172	42	42	46	42
Percentage overweight	8	7	14	11	2
Percentage obese	3	0	7	2	2

Table 3: Nutrition scores at baseline and final stage per intervention group (scored out of 8)

	Be Smart		Eat Smart		Play Smart		Eat/Play Smart	
	Initial ($n = 51$)	Final ($n = 42$)	Initial ($n = 56$)	Final ($n = 40$)	Initial ($n = 53$)	Final ($n = 45$)	Initial ($n = 53$)	Final ($n = 42$)
Mean	5.9	7.3[a]	6.4	7.7[b]	6.2	7.3[a]	6.2	7.4[b]
SD	2.26	1.33	1.95	1.00	2.05	0.95	1.97	0.96
Minimum	1	3	1	2	2	5	1	5
Maximum	8	8	8	8	8	8	8	8

Mean values at the final stage were significantly higher than those at the initial stage: [a]$p < 0.01$, [b]$p < 0.001$.

There were no significant differences in BMI between groups at baseline and overall (Table 2). At the final stage, the incidence of overweightness and obesity was similar to that in the initial stage; small changes in the rates in some of the groups were observed but subject numbers were too small for statistical analysis.

Nutrition knowledge

Nutrition knowledge scores improved in all children between baseline and final stage, particularly in Eat Smart and Eat Smart Play Smart children (Table 3). No significant differences in the scores for males and females were observed.

Physical activity

Most children walked to and from school but a sizeable proportion of children reported travelling by car (32–50%). At the final stage there were small increases in the number of children walking to and from school in all groups. An increase in activity in the playground at morning break was reported in all groups and was higher in all intervention groups (including the nutrition group), compared with the control group, and in the Play Smart and Eat Smart Play Smart groups at lunchtime (Table 4). Overall, there was no notable difference in the playground activities of boys and girls at either baseline or the final stage. From the parental questionnaires, no intervention effect was observed on physical activity patterns out of school.

Dietary assessment

There was no significant difference in fat or fibre scores between the groups or genders at baseline or final stage. At both stages children had scores that were predominately in the low or medium range for fat, and the medium to high range for fibre.

Overall, there was a significant increase in the consumption of vegetables ($p < 0.05$) and fruit ($p < 0.01$). In males there was a significant increase in fresh fruit consumption ($p < 0.01$). When analysing results per group (Table 5), a significant increase in fruit consumption in the Eat Smart ($p < 0.05$) and Be Smart ($p < 0.05$) group was observed. No significant changes in consumption of confectionery or crisps were seen in any of the groups.

From the 24-h recall there were no significant differences in nutrient intake between the groups or genders at baseline or final stage.

Table 4: Percentage of subjects going running during break times at baseline and at final stage

Programme [n (initial stage), n (final stage)]	Morning break		Lunch break	
	Initial	Final	Initial	Final
Be Smart ($n = 50, n = 44$)	80	90	70	66
Eat Smart ($n = 56, n = 40$)	68	88	62	54
Play Smart ($n = 53, n = 46$)	66	85	60	72
Eat/Play Smart ($n = 54, n = 42$)	76	91	60	68

Table 5: Average weekly frequency of consumption of selected foods per intervention group at baseline and final stage

	Be Smart		Eat Smart		Play Smart		Eat/Play Smart	
	Initial ($n = 39$)	Final ($n = 22$)	Initial ($n = 48$)	Final ($n = 20$)	Initial ($n = 33$)	Final ($n = 23$)	Initial ($n = 38$)	Final ($n = 21$)
Vegetables	5.2	5.3	4.4	5.3	5.3	5.5	4.5	5.0
Salads	1.3	2.6	2.1	2.6	1.6	2.0	1.9	2.2
Fresh fruit	5.1	6.6[a]	5.9	6.6[a]	5.9	6.1	5.3	5.9
Other fruit[b]	0.6	1.1	0.7	1.1	0.7	1.1	0.6	1.0
Confectionery	3.6	3.4	3.8	3.4	3.2	3.2	3.6	3.5
Crisps	3.7	3.5	4.0	3.5	4.4	4.0	4.1	4.1

Mean values at the final stage were significantly higher than those at the initial stage: [a]$p < 0.05$.
[b]Included tinned, frozen and cooked fruit.

Parental questionnaires

There was no significant difference in the fat and fibre scores overall or between the groups at baseline or final stage. Parents had scores that were predominately in the low range for fat, and the medium to high range for fibre. There was no difference in the reported consumption of vegetables, salads, fresh fruit, other fruit (tinned, frozen and cooked fruit), confectionery and crisps between groups at baseline and at the final stage. No intervention effects were seen on parents' reports of physical activity or their nutrition knowledge.

Evaluation

Process evaluation

Process evaluation measures the activities of a programme, programme quality and whether it is reaching the target population. It also assesses the degree of programme implementation and participants' satisfaction with it. From the lesson evaluations in term 1 it was clear that children enjoyed practical tasks, quizzes and tasting sessions, and that these were incorporated as far as possible in future lessons.

Outcome evaluation

Three hundred and eleven children completed a children's content questionnaire, divided into two sections—nutrition and physical activity—and a clear intervention effect was seen in the scores for each section. With respect to nutrition questions, children in the Eat Smart group scored significantly higher than children in the Be Smart ($p = 0.004$) and Play Smart groups ($p = 0.002$) and non-study children ($p = 0.002$); children in Eat Smart Play Smart scored significantly better than non-study children ($p = 0.039$). In the physical activity questionnaires, all intervention groups scored better than non-study children, and for Play Smart and Eat Smart Play Smart groups, the differences in scores were highly significant ($p = 0.001$ and $p = 0.000$, respectively). Eighty parents completed a parental survey about their perceptions of the intervention; 93% of parents rated the programme content as average or above and 88% of parents rated their child's enjoyment of the programme as above average.

Eighty-three per cent of parents felt that they had benefited to some extent from the programme. Eleven teachers completed a short teachers' survey to monitor the impact of the programme on school life. All the teachers felt it would be useful to incorporate some of the materials developed in the Be Smart programme into the curriculum, e.g. in Personal Social and Health Education (PSHE).

DISCUSSION

The purpose of a pilot study includes the assessment of feasibility, efficacy and acceptability, which in turn will lead to a decision on whether or not to pursue a particular approach. This is a valuable pilot study for the UK, which has used the school setting in an innovative way to promote diet and/or physical activity. Although a clear intervention programme effect was not apparent as a result of this pilot study, the potential of school as a suitable setting for the promotion of healthy lifestyles in children was demonstrated.

The incidence of overweight and obesity at baseline and final stage was lower than in recent national reports (Reilly and Dorosty, 1999; Chinn and Rona, 2001; Rudolf *et al*., 2001). Given the small numbers of children involved in the study and the short time-span of the intervention, it is unsurprising that changes in the incidence of overweight were not detected. Using anthropometric parameters as measurement outcomes necessitates a study design of sufficient duration and adequate follow-up. Few previous school-based interventions have reported favourable changes in anthropometry. Of the studies reviewed by Rowe *et al.* (Rowe *et al*., 1997) and Resnicow and Robinson (Resnicow and Robinson, 1997), only one showed such a change. Dwyer *et al.* (Dwyer *et al*., 1983) undertook an intervention that focused on physical activity and found a decrease in skinfold measures. One subsequent study has reported a decrease in obesity in adolescent females (Gortmaker *et al*., 1999a). The relatively short time-frame of many previous studies (Cambell *et al*., 2001) may be a reason for this observation.

The baseline level of fruit consumption was higher than that reported in the NDNS (Gregory and Lowe, 2000). The modest rise in fruit and vegetable consumption seen in the group overall, and specifically in the nutrition group (Eat Smart), is encouraging, especially as this occurred independently of a rise in parental consumption. This may also suggest that the change might not be the result of a seasonal effect. The food frequency data was collected in varying months for the different phases of recruitment: January–February, April–May and September–October for baseline data, and April–June for final stage data. Other programmes that have targeted an increase in fruit consumption have found similar levels of increase, ~0.5 portions per day (Niklas *et al*., 1998; Baranowski *et al*., 2000; Reynolds *et al*., 2000).

A rise in fruit consumption was also seen in the control group (Be Smart), which may be the result of contamination between groups (i.e. discussion between children in different groups). It is possible that the children who took part in this intervention discussed their lunchtime club with classmates who had attended a different club. A randomized control trial is considered the least biased estimate of effect size, but its efficacy in lifestyle and behaviour interventions remains controversial (Campbell *et al*., 2001). Randomizing by school rather than within a school may be advantageous, but care needs to be taken to match schools in all aspects.

The measurement of physical activity is problematic, especially in children (Welk *et al*., 2000). Patterns of physical activity rather than actual levels of activity were assessed in the present study, which did not show a response to the intervention, although there was a suggestion that children in the activity groups were more active in the playground after the intervention.

Measurement of knowledge has been used frequently in previous health-promoting, school-based interventions (Rowe *et al*., 1997). However, the link between knowledge and behaviour is not straightforward and it is possible for a dichotomy to exist between the two (Axelson *et al*., 1985). Scores for the children's nutrition knowledge were high, suggesting a 'ceiling' effect whereby it may not be possible to distinguish between children whose knowledge was significantly better (or worse) than others. This phenomenon was noted in the original research among older children (Calfas *et al*., 1991).

The results of the final quiz, which all children in the relevant year groups undertook, indicated that the programme had been delivered and understood in a satisfactory manner. From the parents' survey it appears that parents felt that

this was a worthwhile programme, which was of benefit to the children and was also enjoyable for them. The teachers' appraisal of the study is also valuable when considering research outcomes.

Limitations of, and lessons from, the present study are outlined as follows: (i) the duration of the study was not adequate to see any significant anthropometric changes or changes in the trends of overweightness or obesity; (ii) assessments of diet and physical activity and nutrition knowledge may not have been sensitive enough; (iii) for expediency the four interventions were carried out in each of the three schools, which may have led to contamination between intervention groups; (iv) similar problems in targeting parents were encountered as reported elsewhere; (v) the children recruited to this study were likely to be biased towards those from families of higher socio-economic classes and/or interested in health; and (vi) delivery of an intervention by personnel not employed by the school is likely to be expensive and unsustainable.

CONCLUSION

This pilot study has demonstrated the potential of school as a suitable setting for the promotion of healthy lifestyles in children. The study resulted in knowledge improvements and modest rises in fruit consumption, independent of a rise in parental fruit consumption. There was no clear intervention effect and contamination between the groups was suspected. From outcome evaluation, the programme developed for this research appears to have been comprehensible to the target group. Suitable assessment techniques and ways of targeting families remains a challenge. This intervention, which involved the cooperation of teachers, parents and children, was feasible but not sustainable in the long-term.

This programme has the potential to be modified as part of a future initiative, delivered by teachers, to fulfill existing curriculum criteria, thus providing consistent messages in a range of subjects—science, physical education and social studies. This inter-curricular approach is similar to that of Gortmaker *et al*. (Gortmaker *et al*., 1999a; Gortmaker *et al*., 1999b). Pursuing a separate and combined physical activity and nutrition approach is worthwhile. Any such initiative should focus on the whole school environment and be behaviourally focused, which is the philosophy of the new and innovative Health Promoting Schools initiative (Lister-Sharp *et al*., 1999). Ideally, the wider community should also be targeted. The design of a future study should be randomization at a school level with careful matching of schools, including schools with children from a wider range of ethnic and socio-economic backgrounds.

Future studies of this type should be of sufficient duration to enable changes in anthropometry to be detected, and long-term follow up is vital; grant-awarding bodies must understand the time-scale involved in such research.

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