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Program Obesity Zero (POZ) – a community-based intervention to address overweight primary-school children from five Portuguese municipalities

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Abstract

Objective: Results of the WHO European Childhood Obesity Surveillance Initiative indicated that on average one out of four primary-school children is overweight or obese. Portugal presented one of the highest prevalences of obesity. Childhood obesity prevention and treatment should be a top priority. The aim of the present study was to evaluate the effectiveness of Program Obesity Zero (POZ), a multi-component, community-, family- and school-based childhood obesity intervention.
Design: Parents and children attended four individual nutrition and physical activity counselling sessions, a one-day healthy cooking workshop and two school extracurricular sessions of nutrition education. Waist circumference, BMI, physical activity level, sedentary behaviours, and nutrition and physical activity knowledge, attitudes and behaviour were assessed at baseline and after 6 months. Diet was assessed using two 24 h recalls, at baseline and at 6 months.
Setting: Five Portuguese municipalities and local communities.
Subjects: Two hundred and sixty-six overweight children (BMI ≥ 85th percentile) aged 6–10 years, from low-income families in five Portuguese municipalities, were assigned to the intervention.
Results: Children showed reductions in waist circumference (−2·0 cm; $P < 0{\cdot}0001$), mean BMI (−0·7 kg/m^2; $P < 0{\cdot}0001$) and BMI-for-age percentile (−1·7; $P < 0{\cdot}0001$) at 6 months. Overall, children's intake of fruit and vegetables was <400 g/d throughout the intervention. After 6 months, higher fibre consumption and an apparent decrease in sugary soft drinks intake to a quarter of that observed at baseline (mean intake: 198 ml/d at baseline), with improvements in physical activity levels and screen time <2 h/d, were also observed.
Conclusions: The findings suggested that POZ is a promising intervention programme, at municipality level, to tackle childhood overweight and obesity.

Keywords
Children
Primary schools
Overweight
Municipalities
Family

The prevalence of overweight and obesity has been increasing consistently throughout the WHO European Region. Preliminary results of the first round of the European Childhood Obesity Surveillance Initiative from WHO European Region indicated that on average 24 % of children aged 6–9 years are overweight or obese[1], with Portugal (8·9 %)[2] and Italy (12·3 %)[3] presenting the highest prevalences of obesity. Childhood obesity prevention and treatment should be a top priority. Following the WHO European Charter on Counteracting Obesity and the European Commission White Paper entitled *A Strategy for Europe on Nutrition, Overweight and Obesity related Health Issues*[4,5], it is essential to build partnerships between stakeholders across all levels (national, sub-national and local) highlighting the role of local authorities, which have great potential in creating the environments and opportunities for healthy living. Action should be taken at both micro and macro levels and in different settings such as home and families, communities and schools[6]. Increasing evidence shows that the most successful interventions are multi-component, adapted to the local context, using the existing local structures of a community and involving the participants in the planning and implementation stages[7]. Using this sort of approach and involving multiple partners contributes to community empowerment and affords the opportunity to reach a large number of people[8]. International recommendations agree that interventions used within a childhood obesity approach should essentially rely upon behaviour modification regarding diet and physical activity[9,10]. The aim of the present study was to

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evaluate the effectiveness of Program Obesity Zero (POZ), a multi-component, community-, family- and school-based intervention at municipality level, which targeted low-income families with overweight and obese children.

Methods

POZ was implemented during the year 2009 in five municipalities from the five Portuguese regions that applied to the programme – Melgaço (North), Cascais (Lisbon and Tagus Valley), Mealhada (Centre), Beja (Alentejo) and Silves (Algarve) – in partnership with the local health centre. In line with recommendations from the National Health Plan 2011–2016[11], POZ prioritized low-income families, acknowledging that counteracting childhood obesity should be particularly oriented for the less affluent groups of the population. POZ was an integrated, multi-component healthy lifestyle programme based on the principles of nutrition and physical activity from psychology, learning and social cognitive theories and the study of therapeutic processes.

The goal was then to target low-income families with overweight children (6–10 years old) through a set of activities in order to reverse the trend. This project was the first in Portugal to put forward an approach to treat obesity in children with the involvement of community players.

The programme engaged families in the process of childhood obesity management (decreasing adiposity and BMI) by addressing components necessary for individual-level behavioural change. The intervention targeted five behavioural changes: (i) decreasing the consumption of foods high in fat, salt and sugar; (ii) increasing the consumption of fruits and vegetables and wholegrain products; (iii) decreasing television viewing; (iv) increasing physical activity levels; (v) and increasing knowledge, positive attitudes about nutrition and healthy diet, and related behaviour change.

Participant selection

Each municipality and health centre conducted an initial childhood nutritional status survey targeting all primary-school children (6–10 years old) registered in the school year 2008/2009. Potential participants (with overweight or obesity) were recruited and an invitation was forwarded to the families through the local health authorities following advice from the family doctor regarding income status and eligibility of the family. In order to have homogeneous guidance of the project, the national team developed several training sessions for the local stakeholders about anthropometric measurements and nutritional counselling. In addition, each municipality had the help of a nutritionist who was responsible for coordinating the activities. From the 2226 children measured, 482 were eligible since these children were overweight (BMI $\geq$ 85th percentile)[12], enrolled in a primary school and had no apparent clinical problems, co-morbidities, physical disabilities or learning difficulties. Most of the measurements (97 %) were performed in schools and the rest at the health centres. Informed consent was obtained from the parents after provision of explanation of the study objectives and methods in several local meetings conducted by nutritionists. Two hundred and sixty-six (55·1 %) families accepted to participate.

The intervention

The programme consisted of three different types of intervention delivered over a 6-month period in different settings.

Health centres – individual counselling sessions

Each child, and at least one parent, were invited to participate in four individual counselling sessions performed by trained nutritionists (two days of training), who were provided with identical materials and manuals which contained detailed methods for the delivery of all sessions. These sessions (each individual counselling session lasting 60 min) consisted of nutrition education with healthy eating advice customized for overweight and obese children. The traffic light diet method was followed[13]. The sessions also included healthy eating tips in the form of achievable weekly and monthly targets. A 'non-dieting' philosophy was advocated throughout the intervention; therefore children were discouraged from weighing themselves and encouraged to make small lifestyle changes to improve health rather than achieve rapid weight loss. A behavioural approach was adopted, focused on teaching parents and children to apply different techniques such as stimulus control, goal setting, reinforcement and response prevention to establish a health-promoting home environment[14]. All children were encouraged to undertake at least 1 h of physical activity daily.

Family 'healthy cooking' workshops

In order to actively involve families and the school environment, in each municipality children and families were invited to participate in a one-day healthy cooking workshop (each healthy cooking workshop lasting 3 h), performed by a certified and renowned 'chef' in a school kitchen. The workshop was under the guidance of a nutritionist where nutrition education focused not only on the provision of nutrition information, but also on the development of skills and behaviours related to areas such as food preparation, food preservation and storage, social and cultural aspects of food and eating, and other consumer aspects. All of these areas are conducive to healthier food choices[15]. A 'healthy meals/recipes POZ book', developed particularly to achieve children's dietary needs, was provided to families where they learnt how to prepare low-budget healthy meals and how to prepare these recipes at home.

School intervention

All school classes that had children enrolled in POZ were selected. Two intervention initiatives were developed at school level, one oriented to children in the classroom (each lasting 6 h) and another one targeting parents (each lasting 3 h). The focus of the intervention was on encouraging healthy eating and increased levels of physical activity in all children rather than highlighting weight or obesity as issues, although participants (children, families and schools) were not blinded to the fact that it was an obesity prevention initiative. In the classroom, each nutritionist encouraged all children (the participants and non-participants from each class) to be more physically active every day by increasing the variety and opportunities for physical activity beyond those which were currently provided in each school, i.e. to increase non-curricular activity at recess, lunchtimes and after school, with a particular focus on less traditional sports and more lifestyle-based activities such as outdoor games, cycling, beach hikes and children's games. Another intervention initiative included the development of a resource called 'nutrition and physical activity sheets' for teachers to facilitate additional initiatives in classrooms. These activities were predominantly nutrition based and focused on reducing the intake of sugary drinks and on increasing fruit and vegetable consumption. Objectives for the parents' component focused on stimulating awareness and gaining parental support to encourage variety in the diet and availability of healthy foods at home. Methods used included a presentation, discussion and brochures given in one session meeting.

Outcome measurements

Data were collected at baseline and 6 months thereafter, i.e. at the first and fourth individual counselling session and visit to the health centre, respectively, by a trained nutritionist in each municipality.

Nutritional status

Body weight, height and waist circumference were obtained for every child, following standardized procedures[16]. BMI was subsequently calculated. The 2000 growth reference of the Centers for Disease Control and Prevention[12] was used to describe children's nutritional status. Children were classified as overweight if their BMI-for-age was ≥85th percentile, pre-obese and obese if their BMI-for-age was ≥85th and <95th and ≥95th percentile, respectively. The 75th percentile was used as the cut-off point for risk of abdominal obesity using Fernandez *et al.*'s reference[17].

Socio-economic classification

Social class was based on the occupation of the parents in accordance with the Standard Occupational Classification from the National Institute of Statistics[18]. Mothers' and fathers' socio-occupational status was then categorized into three groups. The 'high' category included women or men in management positions (Class I); only 7·8 % of men and 6·2 % of women were from this class. Office workers, service workers and skilled manual workers constituted the 'middle' category (Class II and III). The majority of the parents were from the 'low' category, i.e. 61·2 % of men and 55·4 % of women were unskilled workers or unemployed (Class IV and V).

Dietary intake – 24 h recall

From the age of about 7–8 years there is a fairly rapid increase in the ability of children to participate in unassisted recall, but only for food eaten in the immediate past and for no longer than the previous 24 h[19]. For Andersen *et al.*[20], the 24 h recall would be the first choice of method for children as is logistically simple, applicable for cross-cultural surveys and less burdensome for the respondents. Furthermore, the 24 h recall method has been shown to be reliable and valid in children as young as 7–8 years old[21]. Two 24 h dietary recalls (at baseline and after 6 months) were administered to children and assisted by parents and trained nutritionists in each municipality. Recall records were reviewed by nutritionists from the national programme team before analysis of food and nutrient data. The 20- to 30-min interview was conducted privately and focused on food and beverage intake during the previous 24 h period. Information on macro- and micronutrients was obtained using the software Food Processor SQL®, version 9·7·0.

Physical activity and sedentary behaviours

Habitual free-living physical activity was measured with the use of a pedometer (vertical impact measure only) worn around the waist, which provided an assessment of the daily number of steps. Children were instructed to put on the pedometer as soon as they woke up and to take it off just before bed. Physical activity and the amount of sedentary behaviours were also assessed using a non-validated questionnaire administered by the nutritionist to parents and children. The questionnaire included the number and duration of physical vigorous activities (e.g. sports) and the time spent on sedentary activities (television watching, video games/computer use), which was assessed separately for weekdays and weekend days. It also evaluated the number of hours of sleep.

Nutrition and physical activity knowledge, attitudes and behaviour

A validated questionnaire[22] for Portuguese children that included questions regarding nutrition knowledge, attitudes and behaviours was completed by the children with the help of the nutritionists. The final instrument comprised thirteen questions. A score system gave one point to each correct answer, positive attitude and behaviour.

Statistical analysis

All analyses were conducted using the statistical software package SPSS 20·0 for Windows. Descriptive analyses

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(mean values, standard deviations and percentages) of child characteristics and 95 % confidence intervals were calculated.

The paired-samples *t* test was calculated after testing for normality and the Wilcoxon test was used as a non-parametric alternative. The McNemar test was used for categorical variables. Statistical significance was set at $P < 0{\cdot}05$.

Results

Of the 266 participating children, 199 completed the intervention (41 % of the original sample). Major reasons for dropping out were absence or parental refusal to the pre-scheduled sessions.

Effects on nutritional status

The characteristics of the study population at baseline and 6 months after are shown in Table 1. The effect on outcome variables after 6 months of intervention is also shown in Table 1. Mean height and weight were significantly higher by respectively 2·6 (95 % CI 2·3, 2·9) cm and 0·8 (95 % CI 0·5, 0·1) kg (both $P < 0{\cdot}001$) after 6 months. Changes in BMI did not result from variation in weight but rather from differences in relative height over time. Waist circumference, mean BMI and BMI-for-age percentile were significantly lower at 6 months: by −2·0 cm; −1·7 kg/m^2 and −1·7, respectively (all $P < 0{\cdot}001$). After 6 months, 9·1 % of the children moved out of the obese category (59·4 % to 50·3 %), 1·6 % (40·6 % to 42·2 %) moved into the pre-obese category and 7·5 % moved into the healthy weight category (Table 1).

Effects on dietary intake

Analysis of data from repeated 24 h recalls indicated significantly higher fibre consumption (2·5 g; 95 % CI 0·7, 4·2 g; $P = 0{\cdot}005$; Table 2) after 6 months of intervention. Although total energy, protein, carbohydrate, sugar and total fat consumption showed lower values, these differences were not statistically significant (Table 2).

Analyses of children's food intake reported in the 24 h recall showed that, at baseline, 'semi-skimmed milk' (14·2 %),

Table 1 Descriptive characteristics of the study population at baseline and after 6 months of intervention: overweight children aged 6–10 years from low-income families in five Portuguese municipalities, 2009

	Characteristic							
	Baseline		6 months		Difference			
	Mean	SD	Mean	SD	*n*	Mean	95 % CI	*P* value
n	266		199		NA	NA		NA
Age (years)	8·6	1·4	8·9	1·3	NA	NA		NA
Sex								
Male	126		96		NA	NA		NA
Female	140		103		NA	NA		NA
Height (cm)	137·3	9·9	139·5	9·8	199	2·6	2·3, 2·9	<0·001*
Weight (kg)	43·3	1·0	44·1	10·1	199	0·8	0·5, 1·1	<0·001†
BMI (kg/m^2)	22·8	3·0	22·4	2·9	199	−0·4	−0·6, −0·2	<0·001†
Waist circumference (cm)	75·1	8·4	73·1	8·9	198	−2·0	−2·7, −1·3	<0·001†
BMI-for-age percentile	95·0	3·8	93·4	5·5	199	−1·7	−2·2, −1·3	<0·001†
Normal weight (%)	NA		7·5		NA	NA		NA
Pre-obesity (%)	40·6		42·2		NA	NA		NA
Obesity (%)	59·4		50·3		NA	NA		NA

NA, not applicable.
Data are presented as number, mean and standard deviation, or percentage.
*Paired-samples *t* test.
†Wilcoxon test.

Table 2 Estimated differences in daily dietary intake at baseline and after 6 months of intervention: overweight children aged 6–10 years from low-income families in five Portuguese municipalities, 2009

			Difference		
	Baseline	6 months	Mean	95 % CI	*P* value
Total energy intake (kJ)	6908	6738	−171	−227, 569	0·397*
Total energy intake (kcal)	1651·0	1610·5	−40·9	−54·2, 136·1	0·397*
Protein (g)	81·2	71·0	−10·2	−28·7, 8·3	0·674†
Carbohydrates (g)	244·2	236·5	−7·7	−24·4, 9·1	0·368*
Sugar (g)	90·2	82·8	−7·4	−16·4, 1·7	0·233†
Total fat (g)	51·9	50·8	−1·1	−5·9, 3·7	0·485†
Fibre (g)	16·7	19·2	2·5	0·7, 4·2	0·005†

*Unpaired *t* test.
†Mann–Whitney test.

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Table 3 Estimated differences in physical activity and sedentary behaviours, nutrition knowledge and attitudes at baseline and after 6 months of intervention: overweight children aged 6–10 years from low-income families in five Portuguese municipalities, 2009

			Difference		
	Baseline	6 months	Mean	95 % CI	*P*-value
Physical activity and sedentary behaviours					
Vigorous activity (d/week)	2·2	2·5	0·3	0·1, 0·5	0·008*
Television viewing and video games/computer use (%)					
<2 h/d, weekdays	84·0	92·8	8·8		0·001†
≥2 h/d, weekdays	16·0	7·2	−8·8		
<2 h/d, weekend days	49·4	51·4	2·0		0·324†
≥2 h/d, weekend days	50·6	48·6	−2·0		
Hours of sleep					
Weekdays	9·9	9·8	−0·1	−0·2, −0·05	0·005*
Weekend days	10·4	10·7	0·3	0·2, 0·4	<0·001*
Nutrition knowledge and attitudes					
Food and nutrition knowledge	51·8	57·6	5·8	4·6, 7·1	<0·001*
Food attitudes to healthy foods	9·1	10·4	1·3	0·9, 1·6	<0·001*

*Wilcoxon test.
†McNemar test.

'vegetable soup' (8·4 %) and soft dinks such as 'ice tea' (5·3 %), 'tropical fruit flavour soda' (3·3 %) and 'coke' (1·6 %) were the foods/beverages that contributed most to total daily energy intake. On average, at baseline, children reported an intake of 286·7 g of fruit and vegetables (fruit, 153·7 g; vegetables, 133·0 g) and consumption of 198 ml of sugar-rich drinks on the previous day, with 'ice tea' accounting for 53·0 % and coke for 14·7 % of total soft drinks consumption reported. After 6 months of intervention, milk was the item that contributed most to total energy intake (semi-skimmed milk, 19·3 %; skimmed milk, 5·1 %) on the previous day. Regarding wholegrain products, there was a ten times higher reported consumption of whole-wheat bread after 6 months of intervention (from 1 % to 10 % of children consuming 50 g/d). The reported consumption of sugary soft drinks on the previous day was 44 ml per child, on average, after the intervention (data not shown).

Effects on physical activity and sedentary behaviours

Habitual free-living physical activity was not measured because the daily number of steps was not recorded by the families. The majority of children were not registered in a sports club (71·2 %) at baseline. After the intervention, 5·0 % of these children registered in a sports club. Data indicated an increase in vigorous activity (0·3 d/week, 95 % CI 0·1, 0·5 d/week; $P = 0·008$) and an improvement in screen time, i.e. the percentage of children reporting television viewing and video games/computer use for <2 h/d (8·8 % more during weekdays from baseline to 6 months after; $P = 0·001$; Table 3). Children slept for more hours during the weekend than during the week (10·7 and 9·8 h at 6 months, respectively). The number of hours of sleep during the weekend increased from baseline to 6 months (0·3 h, 95 % CI 0·2, 0·4 h) and this difference was statistically significant ($P < 0·001$; Table 3).

Effects on nutrition knowledge and attitudes

Analysis of the children's knowledge concerning healthy diet and nutrition indicated that, from baseline measures, dietary knowledge increased (+5·8 scale points, 95 % CI 4·6, 7·1 scale points; $P < 0·001$) after 6 months. There was also an improvement in children's attitudes regarding healthy foods such as brown bread, vegetable soup, lettuce, tomato, apple, carrot, orange, broccoli, milk, fish yoghurt and fruit (+1·3 scale points, 95 % CI 0·9, 1·6 scale points; $P < 0·001$; Table 3).

Discussion

POZ was developed as a multi-component intervention in overweight children from families of low socio-economic status, in school and family settings, focusing mainly on the promotion of healthy lifestyles. Participation in POZ was associated with significant improvements in the degree of adiposity which was examined by waist circumference and BMI. Waist circumference was designated as an outcome measure since BMI does not distinguish between fat and lean mass and waist circumference is not susceptible to this effect, as it does not depend on lean mass. We felt that this advantage outweighed the known disadvantages of waist circumference of greater measurement error and variability over time compared with BMI[23]. Excess abdominal fat in children has been associated with several CVD risk factors[24,25]. The present findings are therefore encouraging since POZ resulted in decreased waist circumference (–2·0 cm) in the children at 6 months and furthermore significant differences were observed in both mean BMI ($-1·7$ kg/m^2) and BMI-for-age percentile (−1·7; Table 1). This agrees with results from other studies[26–32] where community-based programmes proved to be effective and successful in the prevention and/or reduction of overweight and/or obesity in children at local or municipality

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level in the WHO European Region. Consistent with POZ, most of these multi-component programmes aimed to improve food habits and physical activity levels in the target groups.

Despite the methodological constraints, analysis of the 24 h recall measures indicated that POZ seems to have improved dietary intake in children. After 6 months of intervention, we observed lower intakes of total energy, total fat and sugar and a significantly higher intake of dietary fibre. Many studies have shown an inverse association between fibre intake and weight gain and an assistance in losing weight[33]. Moreover, consumption of whole-wheat bread was reported in 10 % more children after the intervention, while in contrast our results also showed a lower reported consumption of sugary soft drinks after 6 months. Although sometimes controversial, other studies, particularly short-term interventions studies, have shown that energy consumed in liquid form appears to supplement habitual food intake, leading to increase of body weight[34,35]. Mrdjenovic and Levitsky[36] suggested that sugar-sweetened beverages may displace more nutritious fluids such as milk in children's diet; this is apparently is consistent with our results, since our children reported a lower intake of sugary beverages and a higher intake of milk products after the intervention.

Physical activity and sedentary behaviours are an essential focus for a successful obesity intervention. Our findings among children from families with low socio-professional status, where there is some evidence that aerobic fitness is worse[37], showed that, after the intervention, children were more physically active with an increase in vigorous activity and a reduction in their sedentary activities such as television viewing and video game/computer use time (<2 h/d; Table 3). This result concurs with other community-, family- and school-based interventions, particularly the ones addressed to children from primary schools[27,33,38,39]. In fact, Brown and Summerbell's[40] review of school-based lifestyle interventions to prevent childhood obesity concluded that physical activity interventions may be more successful in younger children (<9 years old). Despite the different methodologies used, Jansen *et al.*[33] showed increased physical activity levels in children particularly from schools with low socio-economic status in a 1-year intervention. Other researchers[26,38] have also shown a decrease in television viewing among primary-school children although their findings were not so encouraging as ours since the differences were not statistically significant; nevertheless, the intervention period was over 1 year.

Schools have been a popular setting for implementation of interventions, as they offer continuous, intensive contact with children[15]. School infrastructure and physical environment, policies, curricula and staff have the potential to positively influence child health[40]. Whereas some school-based interventions have predominantly targeted improvements in healthy eating and physical activity by curriculum initiatives[41], POZ offered the opportunity to enhance non-curricular education on nutrition and physical activity, involving children and families in extracurricular sessions. Studies in school-aged children which used multi-faceted approaches to improving physical activity and nutrition education provided encouragement. One study reported significant effects on BMI[42], while another study showed a reduction in obesity prevalence[43]. Few studies have evaluated the effectiveness of non-curricular approaches for obesity prevention[44,45]. A 1-year project[45] showed that higher attendance at an after-school activity programme was associated with favourable changes in percentage body fat and fat-free mass but not in BMI. Another 2-year project[26] observed a significant benefit on BMI after only 1 year of extracurricular school-based intervention, which was considerably enhanced at 2 years. Although it remains unclear which components are crucial for the observed effects, POZ also had significant benefits on children's BMI using a similar methodology. Moreover, the POZ school intervention was designed to concentrate on approaches that would not involve an increased workload for teachers and to use the schools as a physical base for community intervention, focusing on lifestyle-based activity introducing several simple messages that highlighted healthy eating.

Furthermore, in a recent review Nixon *et al.*[46] found that multi-component interventions that combine high levels of parental involvement and interactive school-based learning targeting physical activity and dietary change appeared most effective. It was suggested that interventions should also be focused on developing children's (and parents') perceived competence at making dietary and physical changes[47]. In POZ there was an improvement in dietary knowledge and children's attitudes regarding healthy foods such as brown bread, fruits and vegetables, milk and fish (Table 3). Nevertheless, although family involvement enhances the effectiveness of programmes for younger children[15], in POZ we found a high parental involvement only in the one-day healthy cooking workshop; as reported in many other studies, school-based activities in POZ had difficulty in invoking parental involvement[48–50]. More suitable intervention strategies and opportunities should be explored to improve participation rates.

POZ has three main strengths: (i) it was the first multi-component programme targeting overweight children in Portugal from families with low socio-economic status in different settings, (ii) with a standardized intervention protocol for consistent delivery across settings; and (iii) it established and promoted a real partnership between health centres and local governments. On the other hand, it has several limitations. First is the lack of longer-term follow-up. Second is the initial non-acceptability of participating in POZ from families with overweight children, which represented 55·1 % less attendance. Third, the programme did not have a control group and because children were not randomized to intervention and control conditions, there is the possibility that the intervention and control

would differ in ways that may or may not be measurable. Fourth is the limited validity of measures of dietary intake and physical activity based on child report. The methodological constraints of 24 h recalls, particularly for children[51], are well discussed and because it was only possible to apply one 24 h recall, it does not report the habitual food intake of these children. However, we cannot dismiss the possibility that children may have biased their recalls of dietary intake and physical activity as a consequence of the intervention, although we have no evidence to support this hypothesis. Fifth is the probability of misreporting in children, either by the participants themselves and/or by obese or weight-conscious parents who report their children's food intake[19]. Finally, although the drop-out rate was low (7·5 %) it may have influenced the results.

Conclusions

The prevalence of overweight and obesity is increasing in many countries and regions each year and has become an international public health priority, with a concomitant demand to create and implement effective interventions to prevent this global trend[52]. The importance of effective interventions to reduce obesity and related health risks has increased in recent decades due to obesity's epidemic proportions[53]. There are many challenges in executing and evaluating the effects of comprehensive school- and community-based interventions. Nevertheless, participation in POZ was effective in reducing adiposity and BMI in children, with an apparent significantly higher fibre consumption and a decreased intake of sugary soft drinks. Improvements in physical activity levels and screen time <2 h/d were also observed, adding to the growing body of evidence of the effectiveness of multi-component comprehensive approaches. The funding for the project came from the municipalities and a grant from the Ministry of Health. The estimated cost per child was €373 for the entire programme. This cost would represent an average investment per municipality within reasonable limits, of slightly above €30 000 per financial year. Therefore, POZ is expected to provide useful guidance to researchers, public health professionals, health professionals and school administrators seeking to develop similar intervention programmes. Although it has several limitations, the findings suggest that POZ is a promising intervention, at municipality level, to tackle childhood overweight and obesity.

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