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PEDIATRIC HIGHLIGHT

Reducing unhealthy weight gain in children through community capacity-building: results of a quasi-experimental intervention program, Be Active Eat Well

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Background: Be Active Eat Well (BAEW) was a multifaceted community capacity-building program promoting healthy eating and physical activity for children (aged 4–12 years) in the Australian town of Colac.
Objective: To evaluate the effects of BAEW on reducing children's unhealthy weight gain.
Methods: BAEW had a quasi-experimental, longitudinal design with anthropometric and demographic data collected on Colac children in four preschools and six primary schools at baseline (2003, $n=1001$, response rate: 58%) and follow-up (2006, $n=839$, follow-up rate: 84%). The comparison sample was a stratified random selection of preschools ($n=4$) and primary schools ($n=12$) from the rest of the Barwon South Western region of Victoria, with baseline assessment in 2003–2004 ($n=1183$, response rate: 44%) and follow-up in 2006 ($n=979$, follow-up rate: 83%).
Results: Colac children had significantly lower increases in body weight (mean: −0.92 kg, 95% CI: −1.74 to −0.11), waist (−3.14 cm, −5.07 to −1.22), waist/height (−0.02, −0.03 to −0.004), and body mass index z-score (−0.11, −0.21 to −0.01) than comparison children, adjusted for baseline variable, age, height, gender, duration between measurements and clustering by school. In Colac, the anthropometric changes were not related to four indicators of socioeconomic status (SES), whereas in the comparison group 19/20 such analyses showed significantly greater gains in anthropometry in children from lower SES families. Changes in underweight and attempted weight loss were no different between the groups.
Conclusions: Building community capacity to promote healthy eating and physical activity appears to be a safe and effective way to reduce unhealthy weight gain in children without increasing health inequalities.
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Keywords: community capacity building; longitudinal; healthy eating; physical activity; children; social gradient

Introduction

Childhood obesity is a global epidemic[1,2] and only population-level prevention strategies can curb this growing problem. In Australia, as in other Western societies, the burden of obesity is greatest among those who are most disadvantaged,[3,4] and the obesity-prevention strategies developed must therefore reach children in these vulnerable families who have an increased risk of obesity from an early age.[5]

There is a broad agreement that, to reduce obesity, priority needs to be given to multistrategy, multisetting prevention efforts, particularly in children and adolescents.[6,7] Controlled obesity prevention trials in childhood are few in number, mostly short term (1 year or less), focused on only a single or a few strategies (education or social marketing only) and settings (school-based only) and largely showed little or no impact.[8–10] Until recently, the studies that did show an impact tended to be high-intensity, less sustainable approaches (for example, extensive classroom time promoting individual behavior change).[8–10] It is clear that innovative approaches that work and are flexible, effective, cost effective, equitable and sustainable are urgently needed, and comprehensive community-wide interventions hold promise as one such option.[6,7,10–12]

We are currently evaluating a capacity-building approach to community-wide interventions aimed at reducing childhood obesity in six controlled intervention demonstration projects in a broad range of contexts, age groups and ethnic groups across four countries (Australia, Fiji, Tonga and

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New Zealand).[13] It is rare that communities have sufficient resources or capacity to promote health, and therefore a process of capacity building is required. Hawe *et al*.[14] have described capacity for health promotion as 'the value added to a system so that it can sustain any particular health promotion or disease prevention program…and [so it can] initiate additional health promotion programs'. In this context, community capacity refers to the community's own ability to bring about change[15] and means enhancing skills, reorienting organizational priorities, creating partnerships and structures, building leadership and community ownership, and finding the resources to promote healthy eating and physical activity in a sustainable way. This capacity-building approach provides the flexibility to account for local contexts of target age groups, ethnicities, socioeconomic backgrounds, rural/urban contexts and existing community activities.[10,11,16]

The aim of this article is to report the results from the first of these demonstration projects, Be Active Eat Well (BAEW), which was situated in Colac, a town of about 11 000 inhabitants in rural Victoria, Australia. The primary outcomes were differences in the increases in anthropometry (weight, waist and body mass index (BMI)-z score) over time and the relationship between baseline indicators of children's household socioeconomic status and changes in children's anthropometry.

Methods

Be Active Eat Well intervention program

Be Active Eat Well was designed to build the community's capacity to create its own solutions to promoting healthy eating, physical activity and healthy weight in children aged 4–12 years and their families. The intervention program was designed, planned and implemented by the key organizations in Colac, particularly Colac Area Health (lead agency), Colac Otway Shire and Colac Neighbourhood Renewal, with Deakin University providing support, training and evaluation. The action plan was developed by the agencies and other stakeholders in 2002 and implemented from 2003 to 2006. It had 10 objectives, with the first three being capacity building, increasing awareness of the project messages and evaluation. The capacity-building objective included broad actions around governance, partnerships, coordination, training and resource allocation. Five objectives targeted evidence-based behavior changes (reducing television viewing, reducing sugar drinks and increasing water consumption, reducing energy dense snacks and increasing fruit intake, increasing active play after school and weekends, increasing active transport to school), and each objective had a variety of strategies (such as social marketing, programs and policies). The two final objectives were intentionally more innovative: a small parent support and education program and a project to improve the deep-frying practices in food outlets (healthier frying oils, wider chips). Table 1 provides an overview of the BAEW intervention strategies. The Victorian Department of Human Services provided the funding for the intervention ($AUD100 000 per year) and most of the funding for the evaluation. Much of the work of the part-time project staff centered on social marketing, coordination and implementation of intervention activities. This also involved reorienting schools and other partners toward providing and promoting healthy food choices and opportunities for physical activity.

Table 1 Overview of the Be Active Eat Well intervention strategies

Nutrition strategies[a]
School-appointed dietitian for support
School nutrition policies (including policies around water, fruit breaks, canteens, fundraising)
Training for canteen staff
Canteen menu changes
Lunch pack (healthy combos in designed packaging; 549 sold during the pilot period and remaining packs, about 4000, provided to schools for ongoing use)
Professional development for teachers about healthy eating curriculum
One-off class sessions conducted by dietitians
Taste tests of new canteen menu items
Fresh taste program (Melbourne Markets)
Healthy breakfast days
Interactive, glossy, children's newsletters (set of four 1600 copies of each newsletter distributed through the schools)
Teacher fliers (linking to children's newsletters)
Promotional materials (for example, balloons, stickers)
Happy healthy families program (small groups, 6 weeks)
Parent tips sheets (set of 10)
Healthy lunchbox tip sheets
Community garden
Choice chips program (7 hot chip outlets in Colac)
Fruit shop displays (3 shops involved)
Physical activity strategies[b]
After-school activities program
Be Active Arts program
Walking school buses
Walk to school days
Promotional materials (for example, balloons, stickers)
Sporting club coach training
Sporting club equipment
Two class sets of pedometers for rotation between schools
Screen time[c]
TV power-down week, including a 2-week curriculum
Interactive, glossy, children's newsletters (series of five 1600 copies of each distributed thorough the schools)
Teacher fliers (linking to children's newsletters)
Across all strategies
Sponsorship of the Colac Kana festival 2004
Sponsorship of kids day out 2003
Broad media coverage over 4 years (57 newspaper articles, 21 paid adverts)
Incorporation of BAEW strategies on Municipal Early Years Plan (Colac Otway Shire)
Incorporation of BAEW strategies into Integrated Health Promotion Plan (Colac Area Health)
Incorporation of BAEW strategies into Municipal Public Health Plan (Colac Otway Shire)
Social marketing training
Obesity-prevention training

[a]Increase water, fruit and vegetables; decrease sweet drinks and energy dense snacks. [b]Increase active transport and time spent being active after school. [c]Limit TV viewing time.

Study design and subjects

The study design was quasi-experimental with nonrandomized intervention and control groups and measures taken pre- and post-intervention in the same children. This design is viewed as useful for community-based interventions where it is not possible for randomization and also for testing the efficacy and feasibility of an intervention, as in this community-based demonstration project. The presence of a comparison group greatly strengthens this experimental design as secular trends can also be accounted for. The town of Colac was the intervention site for the demonstration project with all preschools ($n=4$, age 4 years) and primary schools ($n=6$, age 5–12 years) in Colac with $\geqslant 20$ enrolled students being included in the sample frame. Colac was purposively selected as the intervention site as it had not previously been engaged in similar community-based projects, it was geographically contained and it had good infrastructure and community networks to support the intervention program.

The remainder of the Barwon South Western region of Victoria (population 323 000) was the comparison site. The region (one of eight in Victoria) includes Geelong (population of 199 684 in 2003) as the regional center and covers the south-west coast of Victoria, and it is further divided into eight school networks. It is socioeconomically disadvantaged compared with state-wide averages, and in 2003, 12% of the population were born overseas. The sample frame for the comparison group was a stratified, random sample of the Barwon South Western region, with the Colac school network and any schools within a 30 km radius excluded to avoid possible contamination. The schools and preschools across the remaining seven networks were stratified according to enrollment size (large: $\geqslant 150$; small: $\geqslant 20$; not included: <20) and probability proportional to size sampling was used to select large schools across the seven networks. Small schools and preschools were drawn from one network (simple random sample), and then probability proportional to size was used to select the actual schools.

Survey methodology

Children were measured in 2003/2004 (baseline) and again in 2006 (follow-up). Weight and height were measured in accordance with standard methods for the collection of anthropometric data in children[17] by trained researchers. All measures were taken in light clothing and without shoes. Weight was measured to the nearest 0.05 kg using electronic scales (A&D Personal Precision Scale UC-321) and height was measured to the nearest 0.1 cm using a portable stadiometer (PE87 portable stadiometer). Waist circumference was measured at the level of the umbilicus using a plastic tape measure. Two measurements were recorded for each parameter, and where there was disagreement between these measures (>0.1 kg for weight, >0.5 cm for height, >0.3 cm for waist), a third measure was recorded. The mean of all measures recorded was used for analysis. Self-reported information regarding children's physical activity and nutrition behaviors, dieting practices, episodes of teasing and satisfaction with their body shape and size was captured with a 16-question survey administered to children in grades 5 and 6 only (aged 10–12 years) at baseline and in years 8 and 9 only at follow-up.

A Computer-Assisted Telephone Interview of parents/guardians was used to capture information regarding parents' socio-demographic characteristics, including maternal and paternal education level and household income (AUD). These were categorized as follows: education: has completed a university degree; has a Technical and Further Education (TAFE) qualification (for example, diploma, trade qualification); completed secondary school; did not complete secondary school; household income: \$100 000+, \$75 000–\$99 999, \$50 000–\$74 999, \$30 000–\$49 999, <\$30 000. We also used the 2001 Socioeconomic Index For Areas (SEIFA) (index of advantage/disadvantage), which is an area-level indicator of socioeconomic status (SES). The SEIFA classification used was based on geographic postal area of the child's residential address, and a low score on the SEIFA Index indicates an area of social disadvantage.[18] For analysis, SEIFA scores were classified into high SES and low SES based on the statewide median.[18]

Statistical analysis

BMI (weight in kg/height in m^2), waist/height ratio and BMI-z score (calculated against the 2000 CDC growth reference from the United States using the zanthro module in Stata) were calculated and differences in mean baseline anthropometry were determined by *t*-test. Differences in follow-up anthropometry were determined by univariate regression analysis, with group (intervention or comparison) entered into the model together with the following covariates: baseline variable, age at follow-up, height at follow-up (for models with BMI, BMI-z score and weight only), gender and time between measurements. Incidence rate ratios were used to determine whether the rate of increase of overweight/obesity was different in the intervention and comparison groups (rate of incidence in the intervention group/rate of incidence in the comparison group). The International Obesity Task Force age-specific BMI cut-offs were also used to classify children's weight status as either thinness grades 1–3, healthy weight, overweight or obese[19,20] using the LMS Growth Microsoft Excel module.[20] Analyses were conducted using Stata SE 9.2 (StataCorp, College Station, Texas, USA), with clustering by school at follow-up—therefore, school was the primary sampling unit. In all cases, $P\leqslant 0.05$ was considered statistically significant.

Statement of ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research. This study was approved

by the Deakin University Human Research Ethics Committee, the Victorian Department of Education Employment and Training and the Catholic Education Office. This trial has been registered on the Australian Clinical Trials Registry (ACTRN012607000373471), and the results are presented in line with the revised CONSORT statement.[21] Owing to the nature of the quasi-experimental design, masking of group assignment was not possible.

Results

BAEW program and evaluation participation

The BAEW interventions were applied across the Colac community to all children in the target age range from mid-2003 to mid-2006, and activities were planned with a community engagement and equity focus. Actions occurred for all of the behavioral objectives (Table 1), although the sugar drinks, active play and fruit objectives had a higher intensity of actions than active transport and television viewing. The total person-hours required to deliver the intervention is estimated to be approximately 6,789, and detailed process evaluation reports of the intervention can be found on the BAEW website (www.goforyourlife.vic.gov.au/hav/articles.nsf/pracpages/Be_Active_Eat_Well).

Although the intervention was delivered to all children in the Colac community, only a subset consented to being involved in the evaluation study and the flow chart of these children is shown in Figure 1. The intervention activities were available to all children regardless of their participation or nonparticipation in the evaluation study. In the intervention group, a response rate of 58% was achieved at baseline, and of those, 84% were measured at follow-up. The final analysis sample was 833. In the comparison group, a response rate of 44% was achieved at baseline, and of those, 83% were measured at follow-up—the final analysis sample was 974. In both groups, the sample size for some of the SES indicators was smaller, as data was not available for some measures (see Figure 1).

Table 2 shows the characteristics of the intervention and comparison populations at baseline and follow-up. There were no significant differences in age, weight, waist circumference, BMI, BMI-z score or proportion of overweight and obese children between the two groups at baseline, although height was significantly lower in the intervention group ($P = 0.01$). This baseline difference in height may relate to the lower proportion of males and the children being slightly younger in the intervention group compared to the comparison group (although these were not statistically different).

The proportion of children whose parents were born overseas is higher in the comparison group (12%) than the intervention group (6%), although both groups still have only a low level of cultural diversity and represent a predominately Anglo-Saxon Australian population. The most prevalent countries of birth (if not born in Australia) were New Zealand and countries comprising the United Kingdom. In the comparison group, there were also 16 and 11 families where the mother was born in Croatia and the Philippines, respectively. This level of representation was not seen in the intervention group, and in both groups, all other countries were prevalent at frequencies less than 7 (and generally <3).

The collection of data took substantially longer at baseline than follow-up due to the time needed to recruit schools and obtain parental consent, as well as working around school timetables and vacation periods. This resulted in a longer duration between measurements in the intervention group compared with the comparison group (mean 2.97 years (95% CI: 2.97–2.98) vs 2.11 years (2.10–2.13), respectively). As the children were growing, this had an impact on the raw outcome variables. Owing to the differences in duration of follow-up, statistical analyses were only conducted on the adjusted outcome variables.

Changes in anthropometry

Table 3 shows the differences in outcome measures between comparison (reference) and intervention children at follow-up adjusted for covariates. Children in Colac gained less weight (−0.92 kg), showed significantly lower increases in waist circumference (−3.14 cm), BMI-z score (−0.11) and waist/height ratio (−0.02) compared with the comparison population. The prevalence of overweight and obesity increased in both groups, and the incidence of overweight/obesity was not significantly different between the intervention and comparison group (point estimate of incidence rate ratio: 0.91 (95% CI: 0.65–1.28)). The size of the clustering effect of schools ranged from 0.1 to 0.5 for the anthropometric measures of weight, waist and height.

Associations with socioeconomic status

Associations between the adjusted changes in the five anthropometric measures and the four individual- and area-level indicators of socioeconomic status are shown in Table 4. In the comparison population, all regression coefficients were negative and 19 of 20 analyses were statistically significant (lower SES associated with a greater weight gain). In the intervention group, all coefficients were negative, but none were statistically significant.

Doing no harm

Examination of a number of 'safety' measures showed that the BAEW intervention did not increase the proportion of children participating in behaviors that would put them at increased risk of eating disorders. Specifically, the intervention did not increase the prevalence of thinness/underweight (intervention from 3.1% at baseline to 3.6% at follow-up, comparison 2.2–2.4%, NS) or the self-reported

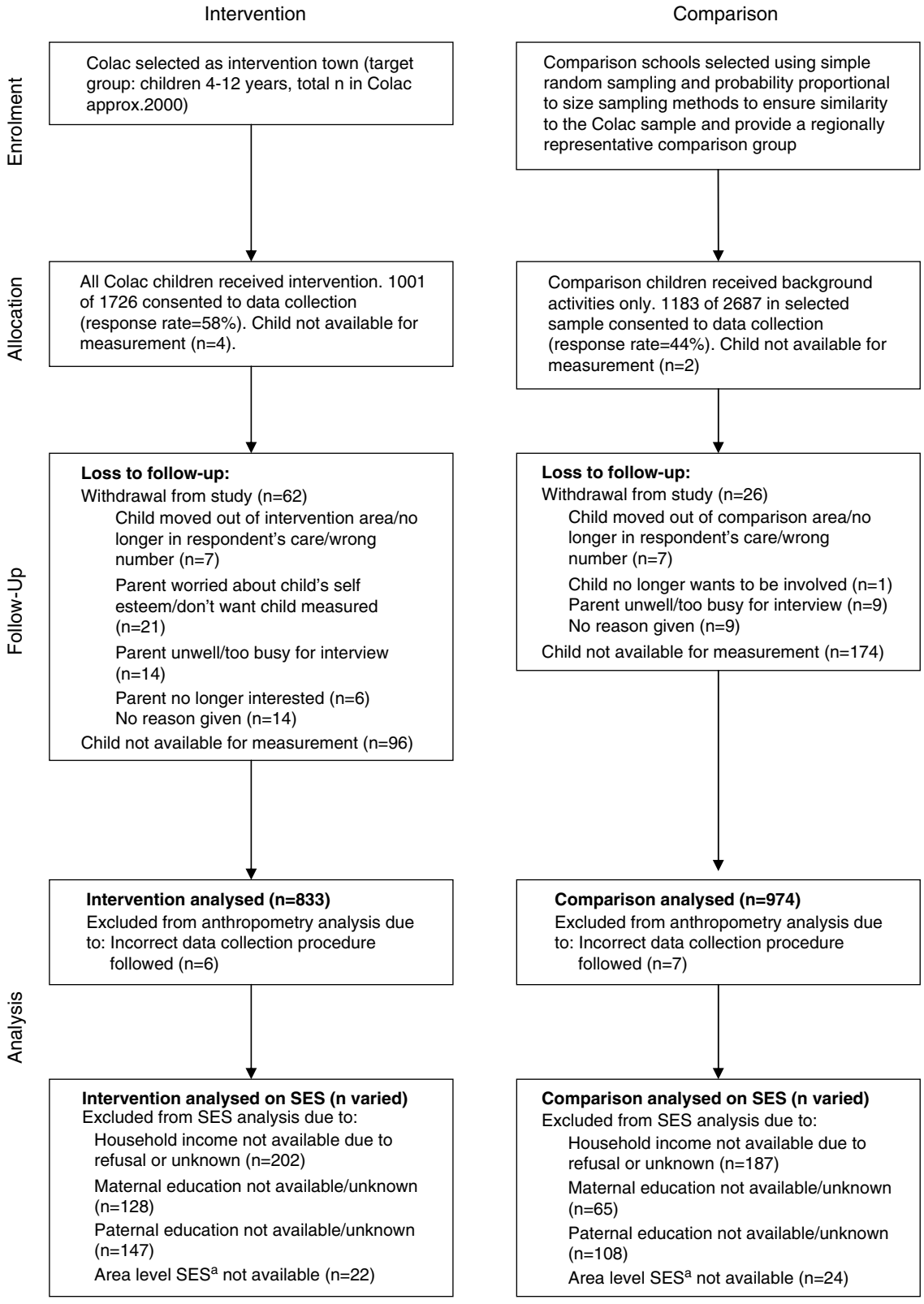

Figure 1 Flow diagram showing participation in an evaluation design of BEAW. [a]SES = SEIFA index of advantage/disadvantage based on residential postcode.[16]

Table 2 Characteristics of the study populations at baseline and follow-up

	Baseline (2003–2004)		*Follow-up (2006)*	
	Intervention	*Comparison*	*Intervention*	*Comparison*
n	1001	1183	833	974
Age, years (s.d.)	8.21 (2.26)	8.34 (2.22)	11.13 (2.27)	10.31 (2.14)
Female (%)	53.6	50.2	53.7	49.1
Height, cm (s.d.)	128.9 (14.2)	130.5 (13.9)[a]	146.2 (14.6)	142.3 (13.7)
Weight, kg (s.d.)	30.7(10.4)	31.4 (10.4)	43.3 (14.7)	39.9 (13.3)
BMI, kg/m^2 (s.d.)	18.0 (3.0)	17.9 (2.9)	19.7 (3.9)	19.2 (3.6)
BMI-*z* score (s.d.)[b]	0.63 (0.93)	0.60 (0.88)	0.54 (0.94)	0.58 (0.88)
Waist circumference, cm (s.d.)	63.4 (8.9)	63.5 (9.1)	70.7 (11.5)	67.7 (10.7)
Waist-for-height (s.d.)	0.49 (0.05)	0.49 (0.05)	0.48 (0.06)	0.48 (0.06)
Thinness, grades1–3 (%)[c]	3.11	2.20	3.60	2.36
Overweight (%)[3]	18.76	19.73	21.61	20.43
Obese (%)[3]	8.53	6.77	8.76	7.91
Time between measures, years (s.d.)			2.97 (0.11)	2.11 (0.25)

[a]Significantly different from baseline intervention group, $P=0.01$. [b]BMI-*z* score calculated against the 2000 CDC growth reference from the United States. [c]Cole *et al*., 2007.[19]

Table 3 Adjusted differences in outcome measures between comparison (reference) and intervention children at follow-up

Variable	*Difference*	*Robust standard error*	P	*95% CI*
Body weight (kg)	−0.92	0.41	0.03	−1.74 to −0.11
Waist circumference (cm)	−3.14	0.96	0.01	−5.07 to −1.22
BMI (kg/m^2)	−0.28	0.21	0.20	−0.7 to 0.15
Waist/height[a]	−0.02	0.01	0.01	−0.03 to −0.004
BMI-*z* score	−0.11	0.05	0.04	−0.21 to −0.01

Abbreviation: CI, Confidence interval. Regression models adjusted for baseline variable, age and height at follow-up, gender, duration between measurements and clustering by school. [a]Height excluded from this model.

Table 4 Adjusted regression coefficients of changes in anthropometric measures for individual- and area-level indicators of SES in the intervention and comparison populations[a]

	Delta waist	*Delta BMI*	*Delta BMI-z score*	Delta weight	*Delta waist/height*
Intervention					
Maternal education	−0.39, NS	−0.12, NS	−0.02, NS	−0.27, NS	−0.002, NS
Paternal education	−0.20, NS	−0.10, NS	−0.003, NS	−0.33, NS	−0.001, NS
Household income	−0.34, NS	−0.11, NS	−0.02, NS	−0.26, NS	−0.002, NS
Area level SES	−0.44, NS	−0.23, NS	−0.04, NS	−0.74, NS	−0.002, NS
Comparison					
Maternal education	−0.50, $P=0.03$	−0.16, $P=0.006$	−0.04, $P<0.001$	−0.38, $P=0.006$	−0.003, $P=0.05$
Paternal education	−0.52, $P=0.008$	−0.17, $P=0.004$	−0.04, $P=0.005$	−0.41, $P=0.003$	−0.004, $P=0.02$
Household income	−0.35, NS	−0.14, $P=0.006$	−0.04, $P=0.006$	−0.27 $P=0.02$	−0.003, $P=0.05$
Area level SES	−1.87, $P=0.006$	−0.46, $P=0.003$	−0.12, $P=0.006$	−1.00, $P=0.002$	−0.01, $P=0.001$

Abbreviation: NS, nonsignificant; SES, socioeconomic status. [a]Models adjusted for baseline variable, age at follow-up and height at baseline and follow-up, gender, duration between measurements and clustering by school.

level of children's (grade 5 and 6 at baseline) 'unhappiness' ('fairly' and 'extremely') with their body size (intervention 6.3–13.4%; comparison 8.2–15.5%; NS); proportion not feeling good about themselves (intervention 2.5–9.8%; comparison 2.3–4.8%, NS); attempts to lose weight in the previous 12 months (intervention 37.6–34.5%; comparison 42.5–45.2%, NS); frequency of teasing about weight (intervention 5.3–5.7%; comparison 4.1–9.5%, NS). Increases in these variables are likely to be due to the children's transition into adolescence where body dissatisfaction is common, particularly for girls.[22]

Discussion

Be Active Eat Well in Colac was a 3-year capacity-building program to increase community promotion of healthy eating and physical activity in a disadvantaged community

in Victoria, Australia. It was effective at slowing the rate of weight gain (by about 1 kg) and waist gain (about 3 cm) in primary school-aged children, in a manner that was safe. Importantly, this is the first obesity prevention program to show significant reductions in the social gradient in weight gain, and therefore this approach may be very valuable for reducing obesity-related health inequalities in children.

Controlled interventions to reduce or prevent childhood obesity have, to date, shown little or no effect. There have been only a small number of studies and they have been relatively short term and tend to be limited to a few strategies and/or settings.[8–10] More recently, however, promising results have emerged from obesity-prevention studies with wider community engagement. The first-year results from the APPLE community-based intervention in New Zealand showed a significant reduction in BMI-z score (−0.12 units), although a reduction in the prevalence of overweight/obesity was not seen.[23] The APPLE intervention had a focus on increasing physical activity outside of school through a community-based activity program. The 'Shape Up Somerville: Eat Smart, Play Hard' intervention engaged the community widely and was specifically focused on changing children's environments. This project achieved a significant reduction in BMI-z score (0.1 units) in the intervention children after 1 year.[24] The design of BAEW and Shape Up Somerville: Eat Smart, Play Hard was similar, and although we did not measure the effect after 1 year, in BAEW, there was a change in BMI-z score of 0.1 units over 3 years. This effect is similar to that seen in APPLE, and together, these three studies demonstrate that community-based interventions are effective and that BMI-z score is sensitive to change in community-level assessments.

The magnitude of the changes in these three studies is of public health significance, indicating that community-wide action can reduce unhealthy weight gain in children; however, the changes were still not of sufficient magnitude to reduce the incidence of overweight or obesity. Although this is the ultimate goal of obesity-prevention interventions, categorical weight status is a blunter measure of changes compared with continuous measures such as BMI-z score or waist circumference. To date, there are no published community-intervention studies that have demonstrated a reduction in the prevalence of childhood obesity. The challenges ahead, therefore, are to determine the level of intervention required to achieve a reduction in childhood overweight and obesity prevalence, how to ensure sustainability of the successful intervention strategies within the community and to assess the longitudinal effects of the reductions in unhealthy weight gain as children become adolescents and then adults.

We recognize that this is a demonstration project and the potential biases involved in evaluating complex community-based interventions under real world conditions and have attempted to minimize these or statistically adjust for them. The Colac community was purposively selected for the BAEW intervention, and the results may not apply in other communities. We believe that the use of a capacity-building approach has built in flexibility by design and should overcome this, and the intervention activities are designed to be transferable to other communities as they have been delivered through fairly standard settings/services. However, as the Colac community is fairly homogeneous in terms of ethnicity, applying the intervention activities to communities with high levels of ethnic diversity may require further adaptation. Additionally, a quasi-experimental design has more risk of bias than individual or setting-based randomization (however, having the regional population as the comparison group reduces this potential bias); the differences in duration of follow-up between the intervention and comparison groups occurred for logistical reasons (this was adjusted for in the analyses); the nonblinding of group allocation during testing; response rates of about 50% (although, if more overweight children were not included in the evaluation, the bias may contribute to an underestimate of the impact of the intervention).

The BAEW project employed a community capacity-building approach to the intervention, rather than using a predeveloped program to apply to the community. The main characteristics of this approach are as follows: to enhance the skills of health professionals and stakeholders, to reorient organizational priorities, to develop networks and partnerships, to build leadership and community ownership and to develop sustainable health-promotion strategies. These characteristics are appealing for a number of reasons: (1) they allow flexibility and so are adaptable to varying local contexts (for example, age of target group, locality, ethnicity, existing capacity, resources), (2) they promote sustainability as they are community owned and operated, and involve reorienting existing resources, (3) they can be scaled up with an injection of external funds for a defined period of time (for example, 3–4 years) to enable the organizational, training and resources issues oriented toward promoting healthy eating and physical activity, which is then followed by increased internal organization funding for these initiatives and reduced external resources and (4) a community capacity-building approach has the potential to build the policies, environments and community ethos over time, more than externally designed and applied programs or campaigns.

A community-wide, capacity-building approach has the potential to influence the underlying social and economic determinants of health. We saw some evidence of this upstream impact through reduction in the social gradient with weight gain, and this implies that community-wide interventions should not increase health inequalities in relation to child overweight.

Conclusion

A capacity-building approach to reducing childhood obesity is flexible, cost effective, sustainable, equitable and safe. BAEW has shown that this approach can effectively prevent

unhealthy weight gain in children and has given it sufficient credentials to warrant implementation and evaluation (including cost-effectiveness) in other communities. In addition, efforts to determine the long-term maintenance of anthropometric changes in those exposed to the interventions and community sustainability beyond the initial period of external funding are required.

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References

1 Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004; **5**: 4–104.
2 Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006; **1**: 11–25.
3 Ball K, Crawford D. Socioeconomic status and weight change in adults: a review. *Soc Sci Med* 2005; **60**: 1987–2010.
4 Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychol Bull* 1989; **105**: 260–275.
5 Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Relat Metab Disord* 1999; **23**: S1–S107.
6 Position of the American Dietetic Association. Individual-, family-, school-, and community-based interventions for pediatric overweight. *J Am Diet Assoc* 2006; **106**: 925–945.
7 Kumanyika S, Jeffery RW, Morabia A, Ritenbaugh C, Antipatis VJ. Obesity prevention: the case for action. *Int J Obes Relat Metab Disord* 2002; **26**: 425–436.
8 Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005; (2): CD001871.
9 Doak CM, Visscher TL, Renders CM, Seidell JC. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obes Rev* 2006; **7**: 111–136.
10 Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C *et al*. Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* 2006; **7**: 7–66.
11 Sorensen G, Emmons K, Hunt MK, Johnston D. Implications of the results of community intervention trials. *Annu Rev Public Health* 1998; **19**: 379–416.
12 French SA, Story M, Jeffery RW. Environmental influences on eating and physical activity. *Annu Rev Public Health* 2001; **22**: 309–335.
13 Schultz J, Utter J, Mathews L, Cama T, Mavoa H, Swinburn B. Action plans and interventions—The Pacific OPIC Project (Obesity Prevention in Communities). *Pacific Health Dialog* 2007; **14**(2): (in press).
14 Hawe P, Noort M, King L, Jordens C. Multiplying health gains: the critical role of capacity-building within health promotion programs. *Health Policy* 1997; **39**: 29–42.
15 Rogers T, Howard-Pitney B, Lee H. *An Operational Definition of Local Community Capacity for Tobacco Prevention and Education*. Stanford Center for Research in Disease Prevention: Stanford, 1995.
16 Economos CD, Irish-Hauser S. Community interventions: a brief overview and their application to the obesity epidemic. *J Law Med Ethics* 2007; **35**: 131–137.
17 Davies P, Roodvelt R, Marks G. *Standard Methods for the Collection and Collation of Anthropometric Data in Children*. National Food and Nutrition monitoring and surveillance project: Commonwealth of Australia, 2001.
18 Australian Bureau of Statistics. *Information Paper: Census of Population and Housing—Socio-Economic Indexes for Areas, Australia*. Canberra: The Australian Bureau of Statistics, 2001. Report No.: 9039.0.
19 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**: 1240–1243.
20 Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007; **335**: 194.
21 Mohor D, Schultz KF, Altman DG. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *Clin Oral Invest* 2003; **7**: 2–7.
22 Hill AJ. Motivation for eating behaviour in adolescent girls: the body beautiful. *Proc Nutr Soc* 2006; **65**: 376–384.
23 Taylor RW, Mcauley KA, Williams SM, Barbezat W, Nielsen G, Mann JI. Reducing weight gain in children through enhancing physical activity and nutrition: the APPLE project. *Int J Pediatr Obes* 2006; **1**: 146–152.
24 Economos CD, Hyatt RR, Goldberg JP, Must A, Naumova EN, Collins JJ *et al*. A community intervention reduces BMI z-score in children: Shape Up Somerville first year results. *Obesity* 2007; **15**: 1325–1336.