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Reducing unhealthy weight gain in Fijian adolescents: results of the Healthy Youth Healthy Communities study

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Summary

Obesity is a significant problem among adolescents in Pacific populations. This paper reports on the outcomes of a 3-year obesity prevention study, Healthy Youth Healthy Communities, which was part of the Pacific Obesity Prevention in Communities project, undertaken with Fijian adolescents. The intervention was developed with schools and comprised social marketing, nutrition and physical activity initiatives and capacity building designed to reduce unhealthy weight, and the individual exposure period was just over 2-year duration. The evaluation incorporated a quasi-experimental, longitudinal design in seven intervention secondary schools near Suva ($n = 874$) and a matched sample of 11 comparison secondary schools from western Viti Levu ($n = 2{,}062$). There were significant differences between groups at baseline; the intervention group was shorter, weighed less, had a higher proportion of underweight and lower proportion of overweight, and better quality of life (Pediatric Quality of Life Inventory only). At follow-up, the intervention group had lower percentage body fat (–1.17) but also a lower increase in quality of life (Assessment of Quality of Life instrument: –0.02; Pediatric Quality of Life Inventory: –1.94) than the comparison group. There were no other differences in anthropometry, and behaviours' changes showed a mixed pattern. In conclusion, this school-based health promotion programme lowered percentage body fat but did not reduce unhealthy weight gain or influence most obesity-promoting behaviours among Fijian adolescents. Despite growing evidence supporting the efficacy of community-based approaches to reduce obesity among children of European descent, findings from this study failed to demonstrate the efficacy of a community capacity-building approach among an adolescent sample drawn from a different sociocultural, economic and geographical context. Additional 'top–down' or other innovative approaches may be needed to reduce adolescent obesity in the Pacific.

Keywords: Adolescents, community, intervention, obesity.

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Introduction

Obesity is a significant health issue among Pacific populations (1). Many Pacific nations have faced rapid nutrition transition from subsistence crops to imported foods and this effect has been compounded by the sedentary behaviours associated with urban lifestyles (2,3). Since the 1990s, the prevalence of obesity among adults from the Pacific region ranked among the highest in the world (4) with only a few countries having rates below 20% (5–8) and with many showing dramatic increases (9). A worrying trend of the 2000s is the emergence of high prevalence rates of

childhood obesity in most Pacific Island communities (1,10). Although few studies have undertaken repeat anthropometric surveying, results from national surveys in Fiji (11) and trends compiled across separate studies in other Pacific nations indicate more than a doubling of prevalence in the last decade.

Like other Pacific nations, Fiji is currently experiencing high rates of obesity with more than one-third of the adult population overweight or obese (6,11–13). These rates vary considerably for the two main ethnic groups with higher rates observed among Indigenous Fijians, and for gender with higher rates observed among women (11,13). Rates for both ethnic groups have also increased over recent years (12). Similar trends are evident among children and adolescents in Fiji. A recent study reported the prevalence of overweight and obesity among Fijian adolescents as 34% with higher rates for Indigenous Fijians and female adolescents (14). Results from national surveys indicate similar findings. The Fiji 2002 STEPS survey reported that among 15- to 24-year-olds, 17% of male and 33% of female adolescents were overweight or obese (13). Findings from the 2004 National Nutrition Survey (NNS) indicated that ~15% of 10- to 17-year-olds were overweight (≥120% weight for age) with similar prevalence rates for ethnic group and gender (11). Comparisons with 1993 NNS data showed that among 10- to 17-year-olds, prevalence of overweight among Indigenous Fijians increased by almost 9% for female and 4% for male adolescents, and among Indo-Fijians by 10% for male and 6% for female adolescents; and that among all children (<18 years), the overweight proportion had tripled (11).

Although numerous surveys have highlighted the problem of overweight among Fijian adolescents, few efforts have been made to address the problem (11). Community-based interventions that promote healthy eating and physical activity are a promising way to reduce overweight among children (15–19). Swinburn and de Silva-Sanigorski (20) identified a need to trial community-based interventions in other, non-Western and multi-ethnic contexts, and more importantly, in contexts where rates of childhood obesity are highest. To date, no community-based approach to reduce childhood obesity has been trialled within the Pacific region.

The Healthy Youth Healthy Communities (HYHC) study was a community-based intervention programme established to address the issue of adolescent obesity in Fiji. It was part of the larger Pacific Obesity Prevention in Communities (OPIC) project which conducted community-based interventions in four countries (Fiji, Tonga, New Zealand and Australia) and sociocultural, policy and economic studies on obesity. This paper reports on the design, intervention and outcomes of the HYHC project.

Methods

The intervention programme was designed to strengthen the community capacity to promote healthy eating and regular physical activity and to reduce overweight and obesity in Fijian adolescents. Community capacity building refers to the development of knowledge, skills, commitment, structures, systems and leadership to enable effective health promotion (21) which may enhance the ability of a community to establish and deliver a programme, to maintain and sustain a programme, or to problem-solve and develop programmes for other health issues (22). The project specifically targeted secondary school students between the ages of 13 and 18 years in forms 3–6. Intervention schools were selected from Nasinu, a relatively large peri-urban area with a population of about 100,000 distributed along the Nausori–Suva corridor on the main Fijian island of Viti Levu. Nasinu was selected as the intervention area based on several criteria (23). During August 2004, an ANGELO (Analysis Grid for Elements Linked to Obesity) workshop (24) was conducted and the subsequent action plan comprised behavioural objectives where children were encouraged to reduce television viewing, reduce sugar drinks and increase water consumption, reduce energy-dense snacks and increase fruit intake, increase active play during and after school and on weekends, and increase walking to/from school (25). Strategic actions under each of the objectives included activities such as empowering parents to support their children's healthy behaviours, social marketing, ensuring that school canteens sold healthy food and drinks, and encouraging members of faith-based organizations to promote healthy eating and physical activities within their respective communities (Waqa, Moodie, Schultz, & Swinburn, Unpublished data) (see Table 1). Six faith-based organizations from about 80 in the intervention area were chosen to participate based on whether the faith-based organization had a major presence in the area, the number of youth groups in them and ease of access.

Study design and participants

The study design was quasi-experimental, with all pupils at all secondary schools ($n = 7$) in the intervention site forming the intervention population. All students in the same forms in selected schools from three areas (Sigatoka, Nadi and Lautoka) on the western side of Viti Levu formed the comparison population. Eleven comparison schools that matched the ethnic profiles of the intervention schools were selected from 35 potential comparison schools.

Methodology

Students were surveyed from August 2005 to April 2006 (baseline) and again during either May to November 2007

Table 1 Overview of the Healthy Youth Healthy Communities behavioural and innovation objectives, key strategies and specific actions

Objective	Key strategies	Specific actions
1. To significantly reduce the proportion of adolescents who skip breakfast on school days	• Promote breakfast with students and parents – pamphlets & school assembly morning talks • School canteen providing breakfast	• Healthy breakfast, pamphlets, assembly talks and linking breakfast with special school events • Canteen opening earlier • Working with business partners to provide breakfast
2. To improve the healthiness of food at school by significantly decreasing the consumption of high-sugar drinks and promoting the consumption of water and by significantly increasing fruit and vegetable consumption	• Develop school policies for canteens to support water, fruit and vegetable consumption • Curriculum development with Home Economics and Agricultural Science	• School audit, food handlers training, distributions of canteen guidelines, awareness programmes • Healthy lunches such as hot soup • School food gardens, world food day celebrations, participation in special subject week • Water bottles with school logos • Assisted with securing of funds for water tanks and extra taps
3. To significantly decrease the consumption of energy-dense snacks and significantly increase consumption of fruit as afternoon snacks	• Social marketing (including fruits [& vegetables] for snacks and benefits of fruits & vegetables, what constitutes healthy snack) • Student information on healthy snacks, fruits & vegetables snacks	• Promoting fruits and vegetables at special events such as athletics week, parents' day, health week, national water and world food day • Posters displayed on health notice board, distribution of pamphlets, information to parents through newsletters and school website, articles published in youth newspaper 'Kaila'
4. To significantly increase the proportion of adolescents living within walking distance to school to walk to and from school with a sense of safety	• 'Walking buddies' • Road safety skills	• Walk to school day • Involvement of road traffic control officers
5. To support physical education teachers to conduct physical education classes effectively	• School policy on physical education classes • Partnership with organizations to provide equipment such as hoops, ropes, other sports equipment	• Training of physical education teachers, provision of physical activity equipment, training of trainers, establishment of aerobics clubs in schools • Acknowledgement of achievements via special award nights
6. To significantly increase the amount of active play after school and on weekends and significantly decrease the time spent watching TV and playing on computers or electronic games	• House rules on screen time and outside play time • School walkathon	• Awareness programmes to students, parents and community • Promote walking by provision of incentives such as fruits, bottled water, T-shirts and pamphlets on physical activity
7. To develop a programme for promoting healthy eating and physical activity within churches, mosques and temples	• Food preparation skills • Budgeting skills	• Training on vegetable gardening, pot plant technology, healthy meal preparation, food display, provision of healthy lunch and snacks, morning walk by church groups

(mostly form 6 students; 37% of baseline cohort) or May to July 2008 (mostly forms 3–5 students; 63% of baseline cohort) (follow-up). The methods used are described in Swinburn *et al*. (26). Briefly, demographic information was collected via paper questionnaires, while Personal Diary Assistants were used for the administration of a knowledge, attitudes and behaviours survey. The survey consisted of items focusing on demography, eating patterns, physical activity and leisure time activities, quality of life, perceptions of and attitudes about body size, family and home environment, school environment and neighbourhood environment. The survey items were piloted in Fiji to ensure clarity and cultural and general relevance. Health-related quality of life was measured using two instruments: the Assessment of Quality of Life instrument (AQoL-6D) developed by Hawthorne *et al*. (27–28) in Australia and the Pediatric Quality of Life Inventory 4.0 (generic module for 13- to 18-year-olds) (PedsQL) developed by Varni and

colleagues (29,30). Anthropometric data (height, weight, bioimpedance) were collected by trained research staff using standardized protocols.

Ethics approvals

Both the pilot and main baseline study were approved by the Deakin University Human Research Ethics Committee, Fiji's National Health Research Committee and the Fiji National Research Ethics Review Committee. The details of the study were provided to parents, students, school principals and teachers. Consent was obtained from schools, parents and students.

Analyses

Analyses for both outcome (anthropometric, quality of life) and impact (obesity-promoting/reducing behaviours) measures were performed. Anthropometric measures included: prevalence of weight status categories (thinness, healthy weight, overweight or obese) using World Health Organization (WHO) cut-off points (31), body mass index (BMI, kg/m^{-2}, weight in kg and height in m^2; and standardized BMI (BMI-z score, calculated using the WHO Reference 2007 Stata macro (http://www.who.int/growthref/tools/en/), and percentage body fat derived from bioelectric impedance measures and equations validated for multi-ethnic adolescent populations (32). Cases with outlying (>3 SD from mean) values on the anthropometric variables at baseline or follow-up were removed from analyses.

Data were analysed as follows:

- Differences in mean baseline anthropometry, weight status classification, quality of life, and personal variables were determined by separate *t*-tests and chi-squared tests.
- Differences in follow-up anthropometry (continuous measures) were determined by separate generalized linear models with group (intervention or comparison) entered into the model with the following covariates: baseline variable, age at follow-up, height at follow-up (models with BMI, BMI-z score, weight), gender, ethnic subgroup (Indigenous Fijian or Indo-Fijian/other) and the duration between measurements.
- Differences in the two quality of life measures (AQoL, PedsQL) were also tested using generalized linear models with group entered into the model along with the baseline measure, age at follow-up, gender, ethnic subgroup and duration between measures.
- Categorical (weight status, behavioural) data were analysed with binary logistic regression; weight status was adjusted for age at follow-up, gender, ethnic subgroup, height at follow-up and duration between measurements.
- Behavioural measures were adjusted for age at follow-up, gender, ethnic subgroup and duration between measurements.

The same methods were used to analyse each of the (seven) outcome variables for separate subsamples for ethnicity with adjustments as appropriate. Change in standardized BMI was also computed and analysed by school. All analyses were conducted using Stata SE 11, with adjustment for clustering by school, and statistical significance set at $P < 0.05$.

Results

The HYHC intervention was applied over three school years (2006–2008). Although preliminary intervention work with the faith-based organizations commenced early 2005, the school-based intervention activities did not commence until July 2006 and these continued through to July 2008, with decreased levels of activity during the annual examination period. The actual individual intervention exposure was just over 2 years because of the time taken to establish interventions and practicalities of undertaking the baseline and follow-up measurements including the resurveying of senior year students who exited the study early. HYHC was delivered to all adolescents in the school communities with consenting adolescents participating in the evaluation study. A flow chart of participating adolescents is shown in Fig. 1. In the intervention group, a response rate of 76% was achieved at baseline, and of those, 33% were followed up yielding a final sample of $n = 879$ for analysis. In the comparison group, a response rate of 73% was achieved at baseline, and of those 45% were followed up yielding a sample of $n = 2{,}069$ for analysis. A higher proportion of adolescents from the comparison group were followed up because just over 50% of adolescents from the intervention group surveyed at baseline had either left school or moved out of the area and 15% were not available for measurement at follow-up. For most variables there was little missing data; however, for the percentage body fat variable, 263 cases at baseline, 350 cases at follow-up and 366 cases across baseline and follow-up were removed on the basis of implausible values (high impedance and/or fat percentage values <5).

Table 2 shows the characteristics of the intervention, comparison and total samples at baseline and follow-up, as well as the original baseline sample that was not followed up. The demographic profiles of the two groups at baseline indicated several important differences. The intervention group was older, had higher proportions of male adolescents and Indo-Fijian/other adolescents than the comparison group. Furthermore, after adjusting for these differences, adolescents from the two groups were different in terms of height, weight and percentage body fat; adolescents from the intervention group were shorter, weighed less and had a higher percentage total fat mass. There was no difference between groups for body size (i.e. BMI and

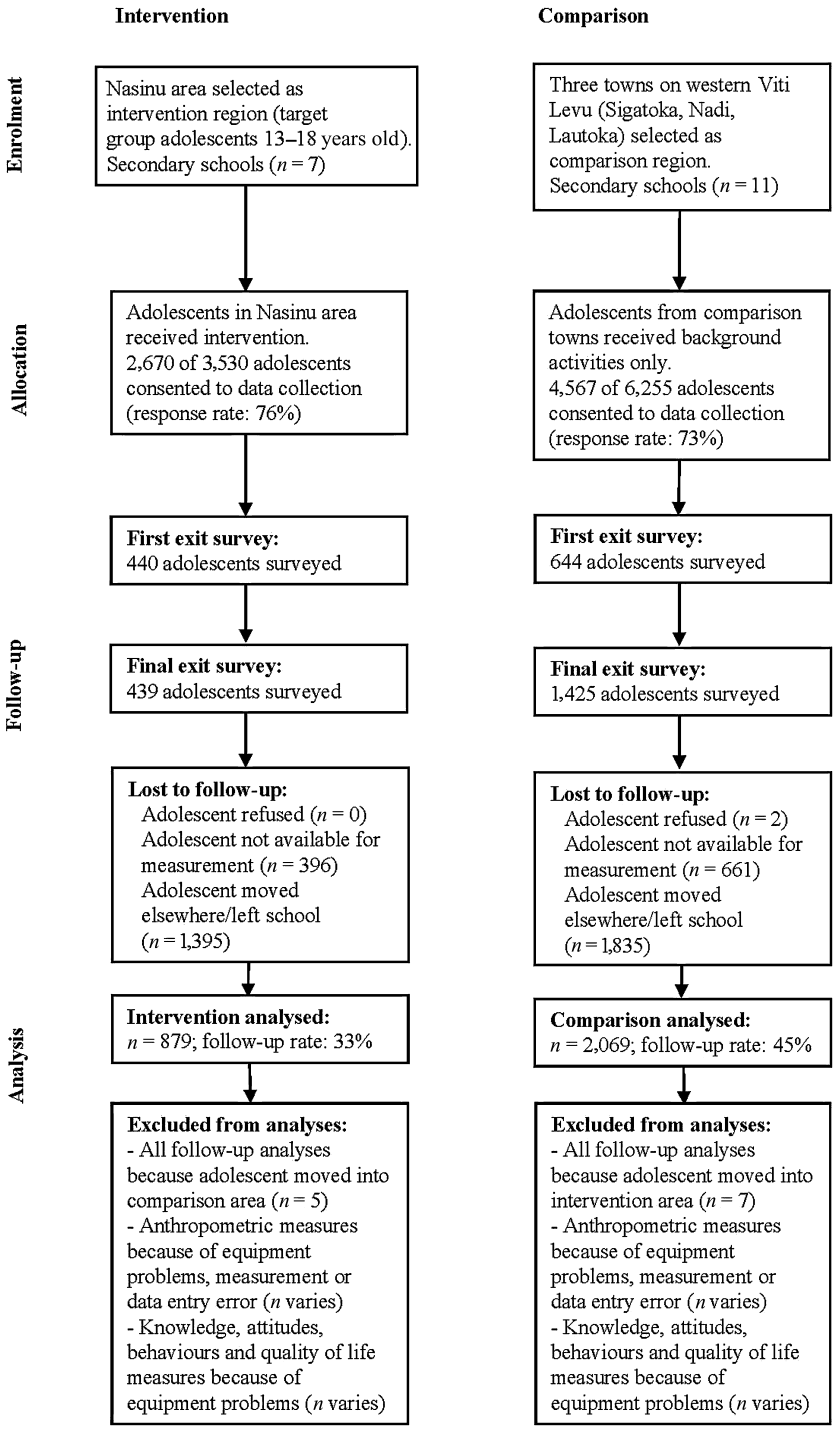

Figure 1 Flow diagram showing participation in the Fiji, Healthy Youth Healthy Communities project evaluation.

BMI-z), but the intervention group had a lower proportion of overweight and higher proportion of underweight adolescents. These observed group differences at baseline are likely to reflect the complex interrelations among these measures for different ethnic groups, since the relationships between bioimpedance analysis and body composition among adolescents (32) and body size and percentage body fat among young men (33) are ethnicity dependent. Results for the two quality of life measures were mixed; at baseline the intervention group had higher quality of life as indicated by the PedsQL but there was no difference between groups on the AQoL measure.

In addition to these demographic and anthropometric differences, the intervention group had a significantly

Table 2 Summary (unadjusted M ± SD or proportions) characteristics of intervention and comparison groups, and total follow-up and non-follow-up samples

Measure	Intervention		Comparison		Total		
	Baseline	Follow-up	Baseline*†	Follow-up	Baseline	Follow-up	Non-follow-up†‡
All, *n*		879		2,069		2,948	4,289
Ethnic subgroup (%)							
Indigenous Fijian		20.2		**37.7**		32.4	**49.5**
Indo-Fijian		77.6		**55.2**		61.9	**45.9**
Other		2.4		**7.1**		5.7	**4.6**
Gender (m, %)		46.1		**43.4**		44.2	**49.6**
Age (years)	15.4, 0.9	17.6, 0.9	**15.2, 1.1**	17.3, 0.9	15.2, 1.1	17.4, 0.9	**15.8, 1.5**
Weight (kg)	53.5, 13.0	58.2, 14.8	**55.8, 13.7**	61.1, 14.5	54.9, 13.4	60.2, 14.6	57.9, 14.0
Height (cm)	162.1, 8.1	165.1, 9.1	**162.9, 8.5**	166.7, 9.1	162.7, 8.4	166.2, 9.2	**163.6, 8.6**
BMI	20.3, 4.2	21.2, 4.6	20.9, 4.2	21.9, 4.3	20.7, 4.2	21.7, 12.7	21.5, 4.3
BMI-z	–0.30, 1.42	–0.34, 1.45	–0.01, 1.35	–0.03, 1.35	–0.10, 1.38	–0.12, 1.39	0.08, 1.36
Percentage body fat	26.2, 9.6	25.5, 11.0	**24.8, 9.5**	26.2, 10.7	25.2, 9.6	26.0, 10.8	24.0, 10.6
Weight status classification (%)							
Obese	5.5	5.3	**6.2**	6.6	6.0	6.2	**6.9**
Overweight	12.7	12.8	**16.5**	15.3	15.3	14.6	**18.9**
Healthy weight	48.6	47.5	**54.5**	54.2	52.8	52.2	**52.9**
Thinness	33.2	34.5	**22.8**	23.8	25.9	27.0	**21.4**
AQoL	0.79, 0.20	0.82, 0.20	0.79, 0.22	0.83, 0.20	0.79, 0.22	0.82, 0.20	**0.71, 0.26**
PedsQL	77.1, 11.9	76.0, 11.0	**74.6, 13.0**	76.5, 11.9	75.3, 12.8	76.3, 11.6	**71.5, 14.1**
Time between measurements (years)	–	2.20, 0.52	–	**2.09, 0.52**	–	–	–

*Test for group differences at baseline.

†Anthropometric and quality of life measures adjusted for age, gender and ethnic subgroup.

‡Test for differences for those who were and were not followed up.

Results significantly different ($P < 0.05$) at baseline are bolded.

AQoL, Assessment of Quality of Life instrument (range: 0–1); BMI, body mass index; BMI-z, standardized body mass index; PedsQL, Pediatric Quality of Life Inventory (range: 0–100).

longer (+0.11 years) re-measurement interval than the comparison group. Due to these group differences, all statistical analyses were conducted on adjusted outcome variables.

Table 2 shows that of all adolescents surveyed at baseline ($n = 7{,}237$), a considerable proportion ($n = 4{,}289$, 59%) were not re-surveyed. Checks for differences on baseline measures showed that the group not available at follow-up was older, and included a higher proportion of male adolescents and Indigenous Fijians. After adjusting for these differences, the non-follow-up group was taller, more likely to be overweight or obese and reported having poorer quality of life.

Outcome analyses

Results of analyses by group for the seven outcome measures are presented in Table 3. At follow-up, the intervention group had a lower percentage body fat relative to the comparison group. There were no differences for weight, body size and weight status classification. The intervention group also reported poorer quality of life at follow-up relative to the comparison group on both the AQoL and PedsQL measures.

Results of similar analyses performed for the ethnic subsamples are also shown in Table 3. For the Indigenous Fijian subsample, the intervention group had lower percentage body fat than the comparison group at follow-up. There were no differences for weight, BMI, BMI-z, weight status classification or quality of life. The same results applied to the Indo-Fijian/other subsample, except that the intervention group reported poorer quality of life at follow-up on both the PedsQL and AQoL.

Outcome analyses for schools

Tests for the effect of clustering by school indicated low intra-class correlations (ICC) for weight (ICC: 0.03) and height (ICC: 0.02) at baseline. There was considerable variation among schools for change in standardized BMI (ΔBMI-z) from baseline to follow-up (see Fig. 2). Five of the seven intervention schools, and seven of the 11 comparison

Table 3 Adjusted differences in outcome measures between comparison (reference) and intervention groups at follow-up for total sample and for Indigenous Fijian and Indo-Fijian/other subsamples

Measure	Difference	Robust SE	*P*	95% CI
All ($n = 2,948$)				
Weight, kg*	0.05	0.21	0.81	–0.37, 0.48
BMI*	0.10	0.07	0.13	–0.03, 0.23
BMI-z*	0.02	0.02	0.33	–0.02, 0.07
Proportion overweight/obese*†	0.34	.19	0.07	–0.03, 0.71
Body fat percentage*	**–1.17**	**0.29**	**<0.001**	**–1.73, –0.60**
Quality of life (AQoL)‡	**–0.02**	**0.01**	**0.02**	**–0.04, –0.00**
Quality of life (PedsQL) (5.7)‡	**–1.94**	**0.43**	**<0.001**	**–2.78, –1.10**
Indigenous Fijian ($n = 956$)§				
Weight (kg)	0.05	0.44	0.90	–0.81, 0.91
BMI	0.02	0.12	0.87	–0.22, 0.26
BMI-z	0.03	0.03	0.31	–0.03, 0.09
Proportion overweight/obese	0.38	0.26	0.15	–0.14, 0.90
Body fat percentage	**–0.93**	**0.31**	**0.003**	**–1.53, –0.32**
Quality of life (AQoL)	–0.02	0.02	0.44	–0.06, 0.03
Quality of life (PedsQL)	–1.22	1.27	0.34	–3.71, 1.27
Indo-Fijian/other ($n = 1,992$)§				
Weight (kg)	0.05	0.23	0.84	–0.40, 0.49
BMI	0.12	0.06	0.07	–0.01, 0.24
BMI-z	0.02	0.03	0.46	–0.03, 0.07
Proportion overweight/obese	0.32	0.26	0.23	–0.19, 0.83
Body fat percentage	**–1.26**	**0.33**	**<0.001**	**–1.90, –0.61**
Quality of life (AQoL)	**–0.02**	**0.01**	**0.02**	**–0.04, –0.00**
Quality of life (PedsQL)	**–2.13**	**0.42**	**<0.001**	**–2.95, –1.30**

*Adjusted for baseline measure, gender, ethnic subgroup, age at follow-up, height at follow-up, duration between measures and clustering by school.
†Weight status classification.
‡Adjusted for baseline measure, gender, ethnic subgroup, age at follow-up, duration between measures and clustering by school.
§Adjusted for baseline measure, gender, age at follow-up, height at follow-up, duration between measures and clustering by school.
Results significantly different ($P < 0.05$) are bolded.
AQoL, Assessment of Quality of Life instrument (range: 0–1); BMI, body mass index; BMI-z, standardized body mass index; PedsQL, Pediatric Quality of Life Inventory (range: 0–100).

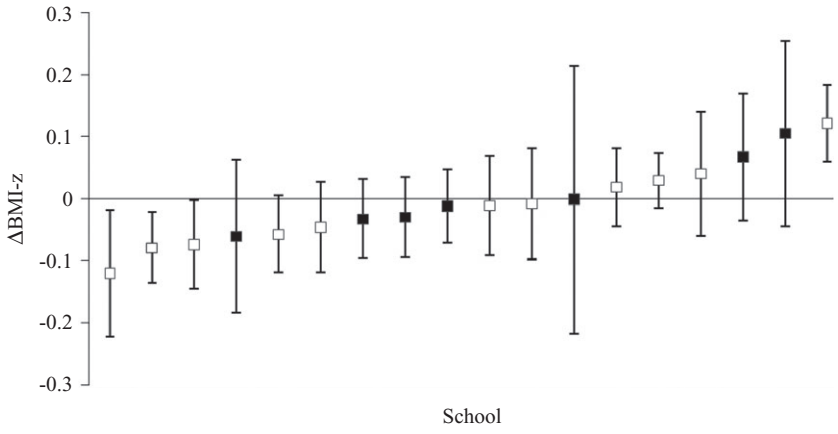

Figure 2 Change in standardized body mass index (ΔBMI-z) by school (filled squares indicate intervention schools, unfilled squares indicate comparison schools) with 95% confidence intervals.

schools showed reductions in BMI-z; however, these reductions were only significant (based on 95% confidence interval) for two of the comparison schools. The remaining two intervention and four comparison schools showed increases for BMI-z; however, only one comparison school increased significantly.

Impacts on behaviours and perceptions of environment

The (unadjusted) proportions of children from the intervention and comparison groups engaging in behaviours or exposed to environments associated with risk for overweight are shown in Table 4. The results indicate some promising shifts for both the intervention and comparison groups on several behaviours. For example, the (unadjusted) proportion of children who reported having snack food every day after school was lower at follow-up for both groups. A positive (healthful) change in time spent watching TV was also observed; the (unadjusted) proportion of children who reported watching TV for 2 h or less each day was higher at follow-up for the intervention group than the comparison group. Results for other variables, however, showed either no change or change in a non-desired direction. Although there was some evidence for overall change, few group differences (after adjusting for relevant covariates) were observed from baseline to follow-up. There was a significant difference between groups in terms of daily intake of vegetables and average time spent watching TV with the comparison group showing more positive health-related behaviour change. Findings were inconsistent for changes in perceptions of household and school environment measures. Overall, trends suggested that perceptions of aspects of the household environment were improved at follow-up; however, the only group difference was that the availability of potato chips and snacks improved more (was significantly lower) for the comparison group. For the school environment, there were improved perceptions for the intervention group on two measures (i.e. school encourages organized sport, school encourages children to be active); however, these differences were not significant.

Discussion

This study reported on the outcomes for a community-based study, HYHC, which focused on obesity prevention in Fijian adolescents in peri-urban Suva. No consistent intervention effect was found across the different outcome measures except for percentage body fat (lowered percentage body fat) and quality of life (poorer quality of life) for the intervention group at follow-up. Findings for the two ethnic subsamples generally showed similar relationships. School-level analyses of changes in (standardized) BMI also failed to show any evidence of an intervention effect. While a number of positive changes were observed from baseline to follow-up, there were few differences between groups on the various behavioural and (perceived) environment measures. Where differences were discerned, these mostly pointed to more positive changes for the comparison group. Overall, the findings indicate that the HYHC study did not achieve the goal of reducing unhealthy weight gain, nor did it achieve most of the behavioural objectives.

Despite previous studies that have reported encouraging effects using a similar health promotion and community capacity-building intervention (16–19), the present findings failed to demonstrate the efficacy of this approach among an adolescent sample drawn from a different sociocultural, economic and geographical context. The study was based in a non-Western country with two main ethnic groups and focused its community-based approach on schools and faith-based organizations. The interpretation of the reduction in percentage of body fat in the intervention group in the absence of other anthropometric changes is uncertain. One possibility is that increased levels of activity can produce these body composition changes (34); however, increased activity was not observed for the intervention group, although our measures may have been too blunt to capture other physical activity-related behaviour change. Since few studies have utilized the same range of measures, it is difficult to ascertain whether this is a plausible explanation for the observed pattern of findings. The equations used to generate the percentages of body fat were developed from a multi-ethnic sample, although Indians and Melanesians (which is the ethnic grouping that most Indigenous Fijians belong to) were under-represented in this calibration study. A number of studies have highlighted higher percentage of body fat for equivalent body size (BMI) for Indo-Fijian samples relative to Caucasian (35) and Pacific samples (33,36,37). Further validation work among a broader range of Asian and Pacific adolescent samples is needed.

Two quality of life measures were also included as supplementary outcome measures. While the raw (unadjusted) values for the baseline and follow-up surveys indicate improvements in quality of life (indicated by both the AQoL and PedsQL measures) for both groups, the magnitude of these increases from baseline to follow-up were lower for the intervention group relative to the comparison group. It is unclear why quality of life scores for the intervention group would be lower at follow-up relative to the comparison group. Group differences in terms of age, gender and ethnicity cannot account for the findings since analyses were adjusted for these differences. One explanation is that the intervention activities did not reach the intended target group; specifically, the intervention may not have reached overweight adolescents from the intervention communities. Another explanation is that at a community level, adolescents in the intervention region (i.e. Nasinu

Table 4 Unadjusted proportions (95% CI) for behaviours and perceptions of household environment at baseline and follow-up for comparison (reference) and intervention groups

Objective/measure	Intervention		Comparison				
	Baseline	Follow-up	Baseline	Follow-up	Direction for positive intervention effect*	Coefficient	*P*-value
Objective 1 (breakfast)							
Breakfast before school (% never)	2.1 (1.0–3.1)	2.9 (2.1–3.8)	3.3 (2.4–4.2)	3.1 (1.8–4.4)	–	0.16	0.58
Objective 2 (school food)							
Vegetables (≤1 serve d^{-1})	**43.9 (40.3–47.4)**	**48.0 (44.4–51.6)**	**44.2 (41.8–46.6)**	**43.0 (40.7–45.4)**	–	**0.22**	**0.02**
Fruit (≤1 serve d^{-1})	71.9 (68.7–75.2)	72.6 (69.4–75.8)	66.8 (64.5–69.0)	68.4 (66.2–70.6)	–	0.13	0.11
Soft drink (% every day)	15.0 (12.5–17.6)	16.4 (14.6–18.2)	20.8 (18.9–22.8)	16.4 (14.6–18.2)	–	0.39	0.20
Fruit drink/cordial (% every day)	6.0 (4.3–7.7)	8.0 (6.0–9.9)	14.2 (12.6–15.7)	9.2 (7.8–10.5)	–	–0.03	0.87
School encourages children to make healthy food choices (% a lot)	53.8 (50.0–57.5)	53.9 (50.2–57.7)	48.9 (46.5–51.3)	41.7 (39.4–44.1)	+	0.51	0.16
Food and drink choices at school canteen (% mostly healthy)	9.6 (7.3–11.8)	11.2 (8.8–13.6)	13.5 (11.9–15.1)	11.2 (8.8–13.6)	+	0.27	0.40
Objective 3 (after school food)							
Snack food after school (% every day)	15.7 (13.1–18.3)	9.9 (7.7–12.0)	12.6 (11.0–14.1)	10.7 (9.2–12.2)	–	–0.18	0.33
Fruit available at home (% every day or almost every day)	32.9 (28.4–37.3)	39.0 (34.3–43.6)	47.7 (45.3–50.1)	40.1 (37.8–42.5)	+	0.27	0.14
Mother encourages eating healthy food (% a lot)	67.2 (62.6–71.7)	74.9 (70.7–79.1)	82.0 (80.1–83.9)	79.3 (77.3–81.3)	+	0.06	0.60
Father encourages eating healthy food (% a lot)	57.3 (52.3–62.2)	66.8 (62.0–71.5)	72.9 (70.6–75.1)	71.6 (69.3–73.8)	+	0.03	0.83
Potato chips/snacks available at home (% every day or almost every day)	**15.3 (11.8–18.7)**	**15.0 (11.6–18.4)**	**18.8 (17.0–20.7)**	**10.9 (9.4–12.4)**	–	**0.43**	**0.03**
Chocolates/sweets available at home (% every day or almost every day)	14.9 (11.5–18.4)	12.7 (9.5–15.9)	9.5 (8.1–10.9)	8.7 (7.3–10.0)	–	0.31	0.25
Objective 4 (school transport)							
Walk/cycle to school (% never)†	17.2 (11.1–23.4)	20.7 (14.1–27.3)	10.4 (7.4–13.5)	12.0 (8.7–15.3)	–	0.52	0.14
Objective 5 (school physical activity)							
School encourages all children to play organized sport (% a lot)	49.5 (45.9–53.0)	57.8 (54.3–61.4)	66.8 (64.5–69.0)	60.3 (57.9–62.6)	+	0.10	0.66
School encourages all children to be physically active (% a lot)	28.3 (25.1–31.5)	31.5 (28.2–34.8)	32.8 (30.6–35.1)	27.4 (25.3–29.6)	+	0.30	0.20
Objective 6 (after school activity and screen time)							
Active after school (% no days)	16.9 (14.1–19.7)	13.1 (10.6–15.6)	11.4 (9.9–12.9)	10.6 (9.1–12.0)	–	0.14	0.66
Mother encourages physical activity or sport (% a lot)	45.3 (40.4–50.2)	48.9 (43.9–53.8)	56.5 (54.1–59.0)	54.7 (52.2–57.1)	+	–0.09	0.30
Father encourages physical activity or sport (% a lot)	55.1 (49.5–60.7)	54.8 (49.2–60.4)	63.9 (61.5–66.3)	62.3 (59.8–64.7)	+	–0.16	0.29
Average TV d^{-1} (% ≤2 h)	**55.5 (50.0, 61.0)**	**60.5 (55.1, 65.9)**	**64.9 (62.5, 67.3)**	**71.2 (68.9–73.4)**	**+**	**–0.42**	**0.02**
Average computer d^{-1} (% ≤1 h)	56.9 (48.6–65.3)	55.5 (47.1–63.8)	70.4 (66.9–73.9)	60.3 (56.6–64.1)	+	0.02	0.94

*Direction for coefficient to indicate positive intervention effect.

†Only those children living within 15-min walking distance from school ($n = 528$).

All models adjusted for baseline measure, age at follow-up, gender, duration and with clustering by school.

Results significantly different ($P < 0.05$) are bolded.

area) were exposed to conditions that may have impacted on their scores at follow-up, and this effect seems to be more salient for Indo-Fijian/other adolescents than for Indigenous Fijian adolescents. For example, just prior to and throughout the intervention period, there was a substantial migration of Indo-Fijian farmers who were removed from their land (when long-term land leases expired) (38) or whose livelihood was impacted (e.g. decreased sugar prices) and whom subsequently relocated to the peri-urban areas around Suva. The Fiji government also recently relocated a number of squatter settlements within the Nausori area. These changes are likely to have impacted on the local environment through increased population density, increased pressure on local infrastructure and transport systems. Increased concerns about political instability may have also exacerbated these matters (39).

Findings for the behavioural and (perceived) environment measures, both of which represent more proximal indicators within the logic pathway for intervention effects, generally indicated no group difference. Although a number of encouraging changes were observed across many of the measures, the magnitude of these changes generally did not differ for the two groups. Also, the (perceived) environmental measures failed to show any conclusive evidence for intervention-based change to either the household or the school environments, an important population level-mediated pathway for behaviour change. In light of this finding, it is not surprising that no intervention effects were determined for the behavioural measures that were directly aligned with the HYHC study objectives. The positive results observed on a number of the behavioural and environmental measures – for both groups – might be accounted for by effects of a number of national strategies occurring in Fiji, and if this is accepted, then reduced effects for the intervention group might be explained by other unmeasured contextual factors associated with the intervention location of the Nasinu district.

Overall, the findings suggest that the HYHC study did not achieve the desired goals of reducing unhealthy weight gain or attenuating some obesity-promoting behaviours. A number of factors may account for these findings. First, the duration may not have been long enough to get the policy, environmental and cultural changes established within schools. Even though a duration of three school years is longer than almost all other interventions of this type, the actual period between baseline and follow-up measurement was just over 2 years. This period is likely to have been insufficient to allow for strategies to gain the desired traction needed for environmental and behavioural change, and more particularly change in weight gain. Second, and related to the first issue, the strength of the intervention may have been insufficient to combat the prevailing physical, economic and sociocultural forces that contribute to unhealthy weight gain among Fijian adolescents. The sociocultural studies within the Pacific OPIC project (40–42) reported that these forces are especially important determinants of adolescent dietary and activity habits and consequently point to a need for more comprehensive strategies to influence cultural values and expectations. Third, design and methodological issues may have compromised the ability to determine any intervention effect. For instance, the intervention group comprised a higher proportion of Indo-Fijian/other ethnic subgroup, which is generally smaller in body size, more likely to be underweight but also having a higher percentage of body fat for equivalent body size. While our analyses accounted for ethnic differences, this characteristic mitigates the opportunity for a fair test of intervention effects given that approximately one-third of the adolescents from the intervention group needed to increase, rather than lose, weight.

The strengths of this study included the large multiethnic sample, duration of the overall intervention period, inclusion of hard outcome measures and the trialling of a community capacity-building approach to reduce unhealthy weight gain among a sample of adolescents from a Pacific context. To date, most previous studies that have utilized a community capacity-building approach have done so with younger samples and in developed Western contexts. The study was limited by a number of factors. First, a purposeful sampling strategy was used where one intervention and three comparison regions were selected. Differences were found among adolescents who were available/not available at follow-up (those who were available were younger, shorter, less likely to be male, Indigenous Fijian, or overweight/obese and reporting better life quality), suggesting a self-selection bias. For these reasons, the findings should not be generalized. Second, the follow-up rate for both groups was generally low since large proportions of adolescents had either left school or were unavailable for re-measurement. Third, while the selection of intervention and comparison communities from geographically disparate locations across Viti Levu minimized contamination risk, it is likely that these communities were different in other ways that may have impacted on the quasi-experimental nature of the study design. Other extraneous social or economic variables peculiar to either the eastern (intervention) or western (comparison) regions of Viti Levu, as well as background health promotion activities predominantly in the western region, may have worked against finding any intervention effect.

Conclusion

This paper reported on the HYHC study which incorporated a health promotion programme and a community

capacity-building approach. The findings indicated that the study did not significantly reduce unhealthy weight gain or influence obesity-promoting behaviours among adolescents in Fiji. Despite strengthening evidence supporting the efficacy of health-promoting approaches to reduce obesity among younger children, it appears that this approach, while probably necessary, is not sufficient to overcome significant economic, physical and social-cultural barriers to healthy weight among Fijian adolescents. To overcome the effect of these barriers, more 'top–down' or other innovative approaches may be needed in addition to community-based programmes to reduce adolescent obesity in Fiji.

Conflict of Interest Statement

P. Kremer, M. Malakellis, H. Mavoa, B. A. Swinburn, M. P. McCabe, M. Moodie and G. Waqa's institutions have received grants from National Health and Medical Research Council. Support was provided to cover the cost of travel to New Zealand and to Investigator meetings. The authors were employed by Deakin University.

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