doi: 10.1111/j.1467-789X.2011.00921.x

The Pacific Obesity Prevention in Communities project: project overview and methods

B. A. Swinburn[1], L. Millar[1]*, J. Utter[2], P. Kremer[3]*, M. Moodie[4], H. Mavoa[1], W. Snowdon[5], M. P. McCabe[3], M. Malakellis[1]*, M. de Courten[6], G. Waqa[7], K. F. Fotu[8], G. Roberts[7] and R. Scragg[2]

[1]WHO Collaborating Centre for Obesity Prevention, Deakin University, Burwood, Victoria, Australia; [2]Epidemiology and Biostatistics, School of Population Health, University of Auckland, Auckland, New Zealand; [3]School of Psychology, Deakin University, Burwood, Victoria, Australia; [4]Deakin Health Economics, Deakin University, Burwood, Victoria, Australia; [5]Pacific Research Centre for the Prevention of Obesity and Non-Communicable Diseases (C-POND), Research Unit, Fiji School of Medicine, College of Medicine, Nursing & Health Sciences, Fiji National University, Suva, Fiji; [6]Copenhagen School of Global Health, University of Copenhagen, Copenhagen, Denmark; [7]Fiji School of Medicine, Fiji National University, Suva, Fiji; [8]Fiji School of Medicine, Fiji National University, Nuku'alofa, Tonga; *These authors are at the Geelong campus

Received 18 April 2011; revised 23 June 2011; accepted 23 June 2011

Address for correspondence: Professor BA Swinburn, WHO Collaborating Centre for Obesity Prevention Population Health Strategic Research Centre, Deakin University, 221 Burwood Highway, Melbourne, Victoria 3125, Australia. E-mail: boyd.swinburn@deakin.edu.au

Summary

Obesity is increasing worldwide with the Pacific region having the highest prevalence among adults. The most common precursor of adult obesity is adolescent obesity making this a critical period for prevention. The Pacific Obesity Prevention in Communities project was a four-country project (Fiji, Tonga, New Zealand and Australia) designed to prevent adolescent obesity. This paper overviews the project and the methods common to the four countries. Each country implemented a community-based intervention programme promoting healthy eating, physical activity and healthy weight in adolescents. A community capacity-building approach was used, with common processes employed but with contextualized interventions within each country. Changes in anthropometric, behavioural and perception outcomes were evaluated at the individual level and school environments and community capacity at the settings level. The evaluation tools common to each are described. Additional analytical studies included economic, socio-cultural and policy studies. The project pioneered many areas of obesity prevention research: using multi-country collaboration to build research capacity; testing a capacity-building approach in ethnic groups with very high obesity prevalence; costing complex, long-term community intervention programmes; systematically studying the powerful socio-cultural influences on weight gain; and undertaking a participatory, national, priority-setting process for policy interventions using simulation modelling of cost-effectiveness of interventions.

Keywords: Economic, obesity, policy, socio-cultural.

obesity reviews (2011) **12 (Suppl. 2)**, 3–11

Introduction

The obesity epidemic is rapidly increasing in high-, middle- and many low-income countries (1). The countries in the Pacific region are largely of low income and have the highest rates of adult obesity in the world (2,3). The prevalence of adult overweight/obesity (body mass index, BMI > 25 kg m^{-2}) is over 75% in Nauru, Samoa, American Samoa, Cook Islands, Tonga and French Polynesia (1,2). The adult Pacific populations living in New Zealand also have an extremely high prevalence of overweight/obesity at 88%, while among the country's European/other population it is approximately 60% (4). Adolescent obesity is the most important precursor to adult obesity so it is important to prevent unhealthy weight gain during adolescence.

The prevalence of child and adolescent obesity has been increasing globally. Countries such as Australia, Canada and the USA have recorded marked increases in the prevalence of overweight and obesity among children and adolescents since the 1970s (5,6). Similarly, increases in childhood and adolescent obesity have been reported for New Zealand (7) and some Pacific nations (8,9). Utter *et al.* (10) reported the prevalence of overweight/obesity (using WHO definitions (11)) among adolescents participating in the baseline Pacific Obesity Prevention in Communities (OPIC) project (10) and the results are shown in Fig. 1. The combined prevalence of overweight/obesity ranged from 15% in the Indo-Fijian male/female adolescents to 71% in Pacific Island male/female adolescents in New Zealand. The rapid rise in unhealthy weight gain among the New Zealand Pacific population occurs at a very early age with approximately 50% of 5- to 6-year-old children already being overweight or obese (12). The latter figure was calculated using the International Obesity Taskforce definitions (13) which give lower prevalence estimates than the more recent WHO definitions (11); nevertheless, New Zealand Pacific children appear to have one of the highest prevalence levels of overweight and obesity in the world. Polynesian children and adolescents living in the Pacific Islands, such as Tonga, have a lower prevalence than their New Zealand counterparts (Fig. 1), yet the adult prevalence figures are similar (>80%) whether they are living in New Zealand (4) or the Pacific Islands (2,14). Thus, the unhealthy weight gain among Pacific populations occurs much earlier in New Zealand (childhood and early adolescence) than in the Pacific Islands (adolescence and early adulthood).

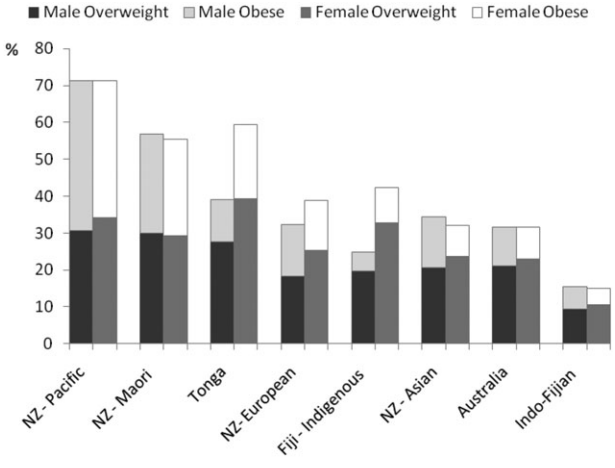

Figure 1 Prevalence of overweight and obesity (WHO definitions) among adolescents in the eight cultural groups in four countries of the Pacific Obesity Prevention in Communities project.

The impact of obesity on non-communicable diseases, especially diabetes, is substantial (1), and this places an extremely high healthcare cost burden on low-income Pacific countries (15). Obesity prevention has been recognized as a high priority by the WHO and health authorities in New Zealand, Australia and the Pacific for at least the last 15 years (16–21). However, effectiveness evidence for obesity prevention is very limited with studies mostly being short-term, conducted in primary schools and showing modest results at best (22,23). Recent whole-of-community interventions are more promising in the prevention of obesity in primary school aged children (24,25) but there are very few published studies that capture the critical period from 12 to 18 years. Several studies that have focused on the reduction of cardiovascular risk factors (26) were single-sex or single-strategy (27) or were conducted over a short timeframe with small samples (28). No long-term, large-scale, multi-strategy, community-based, adolescent obesity interventions have been reported in the literature. Consequently, intervention studies utilizing the recommended, sustainable, multi-strategy, multi-setting health promotion approaches are urgently needed (29,30). Children and adolescents are obvious priority groups to target because they are still growing in height, are responsive to environmental changes and are developing skills and behaviours around food and activity that will persist through adulthood.

The Pacific OPIC project was funded for 5 years through the International Collaborative Research Grants Scheme, a one-off funding round from a collaboration of the Wellcome Trust (UK), the National Health and Medical Research Council (Australia) and the Health Research Council (New Zealand). The purpose of the scheme was to link research groups in Australia and New Zealand with others in the Pacific or South East Asia as a way of increasing research capacity in those developing countries around important health priorities. The Pacific OPIC project targeted obesity prevention in adolescents in four countries: Fiji, Tonga, New Zealand and Australia from 2004 to 2009 (31). This paper provides an overview of the Pacific OPIC project and describes the common methods used in the four intervention sub-studies.

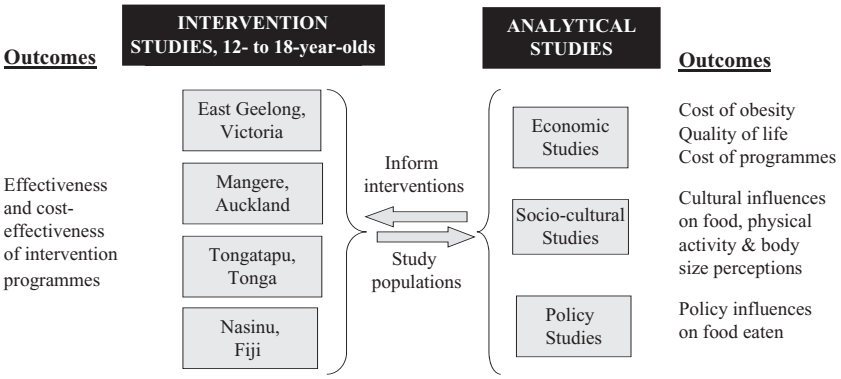

Figure 2 Overall design of the Pacific Obesity Prevention in Communities project (31).

Pacific Obesity Prevention in Communities project overview

The structure of the Pacific OPIC project is shown in Fig. 2. The whole-of-community intervention studies targeting youth (ages 12–18 years) in each of the four countries were conducted in parallel with a series of analytical studies: economic, socio-cultural and policy.

Ethics

Each of the programmes received within-country ethics approval and each was registered as a trial (see individual papers for full details (32–35)).

The Pacific Obesity Prevention in Communities intervention studies

The primary aim of the intervention studies was to determine the effectiveness of whole-of-community intervention programmes for obesity prevention in youth. A description of the early consultative approach that was implemented in each country to determine intervention objectives and action plans can be found elsewhere (36–38). Governance of the intervention programmes at each site involved a steering group of stakeholders from universities, government bodies and community bodies and is described elsewhere (39–42). The role of the universities was predominantly training, evaluation and support, aimed at building the communities' and the schools' capacity to implement obesity prevention interventions.

Evaluation designs

The study designs balanced scientific rigour, resource capacity and local feasibility and were adapted to each site. The overall design of the intervention studies was quasi-experimental with intervention and comparison groups. Intervention sites were chosen using site-specific community, geographic and access criteria (31). The comparison populations were selected to minimize contamination from the intervention programmes, maximize comparability with the intervention group and manage local contexts. The full details of the designs are included in the four outcome papers in this supplement and elsewhere (31–35).

The primary intervention sites in Australia were five secondary schools in the East Geelong/Bellarine region and the seven comparison schools were randomly selected from the rest of the Barwon South-Western region of Victoria (34). In Fiji, the peri-urban area of Nasinu near Suva was chosen as the intervention site (seven schools) with the comparison population being drawn from towns on the west side of the main island of Viti Levu (11 schools) (33). In Tonga, school students from three districts on the main island of Tongatapu comprised the intervention group and all students of the same age on the island of Vava'u comprised the comparison population (32). In New Zealand, the four intervention and two comparison schools were all situated in South Auckland and were matched for similar demographic characteristics (35).

A quasi-experimental design was used because of limitations of the sites and restrictions on funding. A cluster randomized controlled trial design would have been technically ideal, but it was not possible. The intervention was intended to be across the whole of community which encompassed several secondary schools so recruiting 20–30 such whole communities and randomizing them into a controlled trial was neither affordable nor feasible. In Tonga, e.g. the main island of Tongatapu, where 72% of the country's 101,000 population live, has a land area of only 260 m^2. Secondary schools draw pupils from all over the island and contamination across intervention and comparison sites would have been inevitable if multiple intervention and comparison sites were on the same small island. The selected study design imposed some methodological limitations, particular accounting for the effects of clustering, which means that the key findings of the four intervention studies should be interpreted in this light.

Intervention programmes were conducted over a period of three school years. The true length of the school year

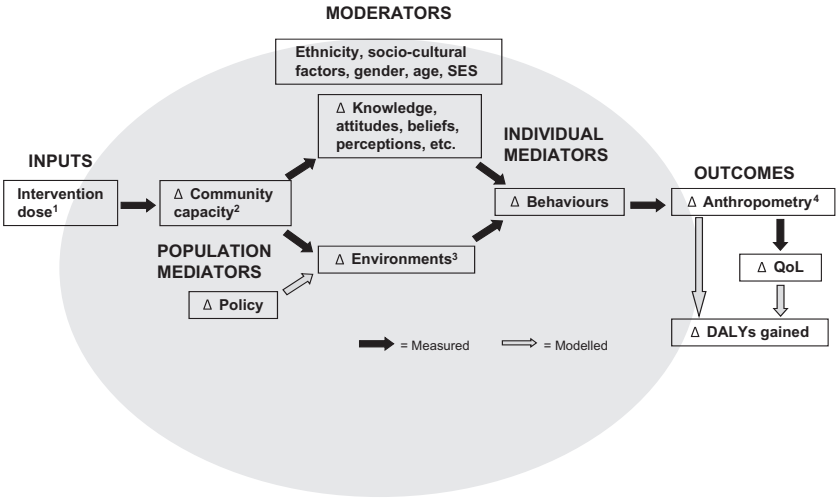

Figure 3 Logic model for the interventions. The measured links are shown in the dark arrows and non-measured (modelled) links in the light arrows. Δ means 'change in'; [1]Intervention dose is either 1 or 0 (intervention, control) or dollars (for those with economic evaluations); [2]Capacity is leadership, partnerships, resources, workforce and organizational development; [3]Relevant environments are schools, homes, neighbourhoods, churches; [4]Weight, body mass index, standardized body mass index, %fat, prevalence of overweight and obesity. DALYs, disability-adjusted life years saved; QoL, quality of life; SES, socioeconomic status.

combined with the logistics of the baseline and follow-up surveys meant that the intervention duration was less than three calendar years. In addition, there were more than two waves of measurements to capture new students entering schools (making baseline assessments from 2005 to 2007) and to capture school leavers (making follow-up assessments from 2006 to 2008). This meant that the mean duration between measurements for students was about 2.5 calendar years. The intervention studies were designed to be longitudinal follow-up studies and this remained the case for Australia, Fiji and Tonga. For New Zealand, the unexpectedly high transition of students in the intervention schools meant that analyses using serial cross-sectional designs probably had less bias than the original intended longitudinal approach because of the higher response rates (66% for each cross-sectional wave versus 40% for the longitudinal follow-up).

Interventions

The processes to develop action plans for each intervention programme were the same across all intervention sites and are detailed elsewhere (36–38). In brief, situation analyses were conducted with local stakeholders at each site to gain an understanding of the important contextual factors, relevant organizations and existing activities. In Fiji and Tonga, this included one-on-one interviews with adolescents to gain a preliminary understanding of the major socio-cultural barriers to healthy eating and physical activity. Analysis Grids for Elements Related to Obesity (ANGELO) workshops with stakeholders comprised a guided process by which communities developed agreed action plans to address priority obesogenic behaviours and build community capacity to promote healthy eating and physical activity (38). While the interventions that arose from the action plans varied somewhat across sites, there were many commonalities such as targeting reductions in sweet drink and energy-dense snack consumption and increasing structured and unstructured physical activity (39–41) (Waqa G, Moodie M, Schultz JT, Swinburn BA, Unpublished data).

The logic model for the interventions (42) is shown in Fig. 3. The intervention dose was considered as intervention versus the comparison of usual practice, although the economic evaluation also allowed for a dollar dose to be estimated. The intervention targeted an increase in community capacity which was envisaged to influence local environments and individual knowledge and attitudes. These in turn were postulated to influence diet and physical activity patterns and changes in BMI and quality of life which could then be modelled to changes in quality-adjusted life years gained. Variables such as gender, ethnicity and age were considered moderators in that they could have interactive effect with the intervention producing differential impacts on the outcome variables.

Measures

The outcome measures were uniform across each intervention site. The main primary outcome measures were changes in anthropometry and body composition. The secondary outcomes were changes in behaviours, knowledge, perceptions of environments, quality of life, body size perceptions and community capacity.

Anthropometry and body composition

Students were measured by trained research staff using standardized methods and protocols (43). Height was measured using portable stadiometers (Surgical and Medical PE87 or Leicester Height Measure, Seca Model 214) to the nearest 0.1 cm. Bioelectrical impedance and weight were measured with a segmental body composition analyser

(Tanita Corporation, Model BC 418). BMI was calculated as kg m^{-2} (weight in kg, height in m). Weight classification (thinness, healthy weight, overweight, obese) used the 2007 WHO Reference age-specific BMI cut-offs for children and adolescents (11,44). Estimated percentage body fat was derived using equations validated for young people aged 12 to 19 of different ethnicities using input variables of bioelectrical impedance, age, gender, weight, height and ethnicity (45). Waist circumference was measured at the level of the umbilicus with a plastic tape measure with an in-built tension indicator (Novel; Novel Products Inc., Rockton, IL, USA). Only a single waist measurement was possible within the timeframe of the single classroom period (about 40 min) allocated for all questionnaires and all measurements. Due to a number of issues associated with the waist circumference measurement (e.g. lack of precision due to a single measurement only, stretching of some tapes due to the tropical heat, and the known problems of inter- and intra-observer error (46)) across baseline and follow-up, the waist circumference variables were excluded from the outcome analyses.

Student questionnaire

All students completed a questionnaire on their behaviours, attitudes and knowledge related to nutrition and physical activity at both baseline and follow-up. The questionnaire included items relating to students' demographic background, eating and physical activity patterns, perceptions of their school, home, and neighbourhood environments, nutrition-related knowledge, perceptions of body size and weight loss behaviours. Students completed the questionnaires on Personal Digital Assistants (hand-held computers, Hewlett Packard iPAC Pocket PC).

The questionnaire comprised approximately 83 questions (plus two quality of life questionnaires – 43 items) and took an average of 30–40 min to complete. Some questions in the survey were specific to each site to address local contexts, such as the role of the church or cultural food practices. The questionnaires were completed in English except in Tonga where they were completed in Tongan. The questionnaire was initially piloted in each country with 95 students in Australia, 60 in Tonga, 100 in Fiji and 85 in New Zealand. The feedback from the students about the wording and comprehensibility of the questions plus the range of responses were used to further modify the questionnaire thus ensuring ease of completion in the wider sample.

Other measures

The Community Readiness to Change (CRTC) assessment (48) was used to rank the capacity of the schools and communities to combat obesity. This instrument has six domains of CRTC in relation to the issue of adolescent obesity (leadership, resources, community attitudes, community efforts, and community knowledge about both the issue and existing efforts) and provided a quantitative estimate of community capacity which was a key part of the logic model of action (Fig. 3). The CRTC was administered at baseline and follow-up through interviewing of key informants such as school principals, teachers, parents and students. The School Environmental Audit was administered within schools to gain an understanding of potential barriers and enablers to healthy practices (e.g. policies relating to nutrition and physical activity, food and water availability/accessibility, and opportunities for physical activity). The Audit was completed by a minimum of three people (two teachers and one other such as canteen manager, administrator or parent) per school. The tool, which was based on the ANGELO framework (48) and adapted from similar tools which have been used in childhood settings (49,50), was modified to each country's cultural context.

Economic studies

One aim of the economic studies was to determine the cost-effectiveness of the four intervention programmes in order to inform decisions about the optimal allocation of resources for obesity prevention. The economic dimension of obesity is extremely important to governments, particularly in the Pacific where the expensive treatment of the complications of obesity, such as diabetes and cardiovascular diseases, comprises a large component of the health budget (51). Resource use associated with all intervention activities was documented through a diary approach, and supplemented by records such as invoices, minutes of meetings and staff notes. Current practice as reflected by obesity prevention activities in the comparison schools was also costed. Costs were analysed by expenditure category and key intervention features to identify cost drivers (31).

Two quality of life instruments were administered at baseline and follow-up to facilitate description of the health burden of adolescent overweight and obesity and as an outcome measure in a cost-utility analysis of the interventions. The Assessment of Quality of Life (AQoL) was based on the WHO's definition of health and the assessment was designed to measure health-related quality of life (52). The AQoL is a multi-attribute utility instrument that was selected because of its suitability for use in economic evaluation (39). Use of the AQoL instrument allowed comparison of the efficiency of the Pacific OPIC interventions with a broader range of healthcare interventions. The AQoL was originally developed by Hawthorne *et al*. (53) in Australia for use with adults and it was recalibrated for use with adolescents in each of the four countries (54). The AQoL provides a good coverage of health-related quality of life, with 20 items across six dimensions (physical ability; social and family relationships; mental health; coping; pain; vision, hearing and communication).

Given the absence of a suitable condition-specific instrument, the AQoL was coupled with a second general health-related quality of life instrument used in children and adolescents. The 23-item Pediatric Quality of Life Inventory (PedsQL) 4.0 (generic module for 13- to 18-year-olds) developed by Varni, covers four dimensions: physical, psychological, social and school functioning (55). Both quality of life instruments were scored in accordance with guidelines for their use (56,57).

In the final component of the economic studies, the cost and outcome datasets were compiled with local data on the prevalence of obesity-related diseases and their costs in an economic model to describe the disease burden and health-care cost implications of adolescent obesity. This model can also be used to predict the costs and benefits downstream as a result of the interventions through their capacity to reduce obesity-related disease.

Socio-cultural studies

The aim of the socio-cultural studies was to describe the social structures, values, beliefs, perceptions, attitudes and expectations which have a significant influence on individual behaviours related to eating, activity and body image (see McCabe *et al.* (58)). The socio-cultural component of the Pacific OPIC project was conducted in five cultural groups: Tongans in Tonga and New Zealand, Indigenous Fijians and Indo-Fijians in Fiji, and Australian Europeans. Three study methods were used: one-on-one interviews (n = 240; 48 per group), questionnaires (n = 3,000; 600 per group) and body size perception measures using digital image distortions (58) (n = 100, in Fiji and Australia only). Participants were 12- to 19-year-old male/female adolescents recruited separately from the intervention studies although they were usually from the same areas as the intervention sites. The socio-cultural studies informed the intervention components of the Pacific OPIC project. Specifically, preliminary interviews informed the ANGELO workshops with participating communities in Fiji, Tonga and New Zealand, the subsequent in-depth interviews, and the socio-cultural indicator questions for the intervention questionnaire (baseline and follow-up) and the socio-cultural questionnaire. The in-depth interviews also informed the specific action plans in Fiji and Tonga, e.g. highlighting adolescents' rationale for skipping breakfast. The complementary nature of the interviews, questionnaires and body size perception distortion studies enabled a mixed-methods approach to interpreting overall data.

Policy studies

The food supply in the Pacific Islands has undergone extremely rapid transition since the late 19th century (59), moving from one that was largely self-sufficient to one which is very reliant on food imports. This rapid change has limited the ability of Pacific Island governments to ensure that the regulatory environment is sufficiently developed to protect local health. There are potential problems with food insecurity, food safety, food quality, labelling and food marketing practices. Trade and agriculture policies can have a significant effect on the food supply and there is great potential for domestic laws to be used to improve the healthiness of the food supply in Pacific countries (59,60). The Pacific OPIC project food policy component focused on two major areas (see the paper by Thow *et al.* in this supplement (61)). One set of studies examined existing policies, including trade-related policies, in the Pacific Islands and analysed their rationales, implementation and impacts (59,61–63). The other set of studies worked with cross-sectoral stakeholders within Fiji and Tonga to identify and prioritize promising food policies for implementation and then modelled their impact on health outcomes (64–66).

Contributions to obesity prevention research

The papers in this supplement and the other papers, published and planned, from the Pacific OPIC project will add a substantial amount of new knowledge to the field of obesity prevention in areas where the evidence is currently sparse. The project has pioneered many areas for obesity prevention research, including using a multi-country collaborative approach to build research capacity, especially in low-income countries (see the paper by Schultz *et al.* (67) in this supplement). Internationally, the Pacific OPIC project has been the largest, longest, most comprehensive obesity prevention project among adolescents. The experiences and findings of the four intervention studies will inform future work within this area. The economic studies are providing much-needed information on the costs and cost-effectiveness of long-term community interventions. The socio-cultural studies provide some of the first systematic insights into the powerful socio-cultural influences on weight gain. The policy studies have highlighted the unique challenges facing the food environment of the Pacific and have provided a model approach for a participatory, national priority-setting process for policy interventions.

Conclusions

The Pacific OPIC project was a large, innovative, multi-site and multi-setting approach to the very difficult problem of adolescent obesity. The project involved approximately 18,000 adolescents over four countries, over almost 3 years of intervention. In addition to the participating adolescents, communities were also involved in the planning and execution of the interventions. Although the project objectives were similar across the sites, the interventions were tailored to each site by the relevant stakeholders. This ensured that

the interventions were relevant and increased the likelihood that the interventions would be well received. The socio-cultural, policy and economic studies provided valuable information to complement obesity prevention efforts.

Conflict of Interest Statement

M. de Courten, M. P. McCabe, B. A. Swinburn, H. Mavoa, L. Millar, P. Kremer, M. Malakellis and M. Moodie's institutions have received grants from the National Health and Medical Research Council. Support was provided to cover costs for travelling to New Zealand and Investigator meetings. The authors mentioned above were employed by Deakin University.

J. Utter's institution has received grants from the Health Research Council of New Zealand.

G. Waqa's institution has received grants and support to cover costs of travel to Investigator meetings from the Wellcome Trust. Support in kind such as writing, provision of medicines or equipment, or administrative support was also provided to Waqa's institution from Secretariat of the Pacific Community grants for school-based interventions. The author was employed by Fiji School of Medicine, Fiji National University.

R. Scragg's institution has received grants from Health Research Council of New Zealand.

W. Snowdon's institution has received grants from Wellcome Trust for funding the entire OPIC project. The author also received consulting fee or honorarium, for the concept paper on food policy options for the region, and support for travel to attend meetings to discuss actions to control NCDs in the region, both funded by the World Health Organisation.

G. Roberts and K. F. Fotu declared no conflict of interests.

Acknowledgements

The authors would like to thank the many people involved in the Pacific OPIC project including other co-investigators, other staff and postgraduate students, partner organizations, and especially the schools, students, parents and communities. The funding for the project was from the Wellcome Trust (UK) (grant reference number 071637/Z/03/Z), the National Health and Medical Research Council (Australia) and the Health Research Council (New Zealand) through their innovative International Collaborative Research Grant Scheme.

References

1. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. WHO Technical Report Series: 894. WHO: Geneva, 253 pp, 2000.
2. Coyne T. *Lifestyle Diseases in Pacific Communities*. Secretariat of the Pacific Community: Noumea, 2000.
3. Hodge AM, Dowse GK, Zimmet PZ, Collins VR. Prevalence and secular trends in obesity in Pacific and Indian Ocean island populations. *Obes Res* 1995; **3**: 77s–87s.
4. Ministry of Health. *A Portrait of Health: Key Results of the 2006/07 New Zealand Health Survey*. Ministry of Health: Wellington, 2008.
5. Magarey A, Daniels L, Boulton T. Prevalence of overweight and obesity in Australian children and adolescents: reassessment of 1985 and 1995 data against new standard international definitions. *Med J Aust* 2001; **174**: 561–564.
6. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006; **1**: 11–25.
7. Utter J, Denny S, Crengle S, Ameratunga S, Robinson E, Clark T *et al*. Overweight among New Zealand adolescents: associations with ethnicity and deprivation. *Int J Pediatr Obes* 2010; **5**: 461–466.
8. Khan N, Cigljarevic M, Schultz JT, Dyer E. Evidence for a curriculum review for secondary schools in Fiji. *Pac Health Dialog* 2006; **13**: 97–102.
9. Smith BJ, Phongsavan P, Havea D, Halavatau V, Chey T, Members of the Health Behaviour and Lifestyle of Pacific Youth Survey Collaborating Group, Tonga Core Survey Team. Body mass index, physical activity and dietary behaviours among adolescents in the Kingdom of Tonga. *Public Health Nutr* 2007; **10**: 137–144.
10. Utter J, Faeamani G, Malakellis M, Vanualailai V, Kremer P, Scragg R *et al*. *Lifestyle and Obesity in South Pacific Youth: Baseline Results from the Pacific Obesity Prevention in Communities (OPIC) Project in New Zealand, Fiji, Tonga and Australia*. University of Auckland: Auckland, 2008.
11. World Health Organization. *WHO Reference 2007; Growth Reference Data for 5–19 Years*. WHO: Geneva, 2010.
12. Parnell W, Scragg R, Wilson N, Schaaf D, Fitzgerald E. *New Zealand Food, New Zealand Children: Key Results of the 2002 National Nutrition Survey*. Ministry of Health: Wellington, 2003.
13. 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.
14. Ministry of Health. *Fiji Non-Communicable Diseases (NCD) STEPS Survey 2002*. Ministry of Health: Suva, 2002.
15. Khaleghian P. Noncommunicable diseases in Pacific Island countries: disease burden, economic costs and policy options. A report prepared for the South Pacific Commission and the World Bank South Pacific Commission, Noumea, 2003.
16. Dewe S. *Healthy Action – Healthy Eating. Oranga Pumau – Oranga Kai. Towards an Integrated Approach to Physical Activity, Nutrition and Healthy Weight for New Zealand*. Ministry of Health: Wellington, 2002.
17. Moodie AR. Australia: the healthiest country by 2020. *Med J Aust* 2008; **189**: 588–590.
18. World Health Organization. *Workshop on Obesity Prevention and Control Strategies in the Pacific*. WHO, Regional Office for the Western Pacific: Manila, 2000.
19. World Health Organization. *Plan of Action for the Western Pacific Declaration on Diabetes 2000–2005*. WHO, Western Pacific Region: Manila, 2001.
20. World Health Organization. *World Health Report 2002: Reducing Risks, Promoting Healthy Life*. WHO: Geneva, 2002.
21. National Health and Medical Research Council. *Acting on Australia's Weight*. NHMRC, Commonwealth of Australia: Canberra, 1997.

22. Summerbell C, Waters E, Edmunds L, Kelly S, Brown T, Campbell K. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005; **3**: 1–70.
23. 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.
24. de Silva-Sanigorski AM, Bell AC, Kremer P, Nichols M, Crellin M, Smith M *et al*. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. *Am J Clin Nutr* 2010; **91**: 831–840.
25. Sanigorski AM, Bell AC, Kremer PJ, Cuttler R, Swinburn BA. Reducing unhealthy weight gain in children through community capacity-building: results of a quasi-experimental intervention program, be active eat well. *Int J Obes* 2008; **32**: 1060–1067.
26. Luepker RV, Perry CL, McKinlay SM, Nader PR, Parcel GS, Stone EJ *et al*. Outcomes of a field trial to improve children's dietary patterns and physical activity – the Child and Adolescent Trial for Cardiovascular Health (CATCH). *JAMA* 1996; **275**: 768–776.
27. Neumark-Sztainer D, Story M, Hannan PJ, Rex J. New moves: a school-based obesity prevention program for adolescent girls. *Prev Med* 2003; **37**: 41–51.
28. Frenn M, Malin S, Bansal NK. Stage-based interventions for low-fat diet with middle school students. *J Pediatr Nurs* 2003; **18**: 36–45.
29. Swinburn B, Egger G. Preventive strategies against weight gain and obesity. *Obes Rev* 2002; **3**: 289–301.
30. Doak C, Adair LS, Monteiro C, Popkin BM. Overweight and underweight coexist within households in Brazil, China and Russia. *J Nutr* 2000; **130**: 2965–2971.
31. Swinburn B, Pryor J, McCabe MP, Carter R, de Courten M, Schaaf D *et al*. The Pacific OPIC project (Obesity Prevention in Communities) – objectives and designs. *Pac Health Dialog* 2007; **14**: 139–146.
32. Fotu KF, Millar L, Mavoa H, Kremer P, Vivili P, Snowdon W *et al*. Outcome results for the Ma'alahi Youth Project, a Tongan community-based obesity prevention programme for adolescents. *Obes Rev* 2011; **12**(Suppl. 2): 41–50.
33. Kremer P, Waqa G, Vanualailai N, Schultz JT, Roberts G, Moodie M *et al*. Reducing unhealthy weight gain in Fijian adolescents: results of the Healthy Youth Healthy Communities study. *Obes Rev* 2011; **12**(Suppl. 2): 29–40.
34. Millar L, Kremer P, de Silva-Sanigorski A, McCabe M, Mavoa H, Moodie M *et al*. Reduction in overweight and obesity from a 3 year community-based intervention in Australia: the 'It's Your Move!' project. *Obes Rev* 2011; **12**(Suppl. 2): 20–28.
35. Utter J, Scragg R, Robinson E, Warbrick J, Faeamani G, Foroughian S *et al*. Evaluation of the Living 4 Life project: a youth-led, school-based obesity prevention study. *Obes Rev* 2011; **12**(Suppl. 2): 51–60.
36. Bell AC, Simmons A, Sanigorski AM, Kremer PJ, Swinburn BA. Preventing childhood obesity: the sentinel site for obesity prevention in Victoria, Australia. *Health Promot Int* 2008; **23**: 328–336.
37. Schultz J, Utter J, Mathews L, Cama T, Mavoa H, Swinburn B. The Pacific OPIC project (Obesity Prevention In Communities): action plans and interventions. *Pac Health Dialog* 2007; **14**: 147–154.
38. Simmons A, Mavoa HM, Bell AC, De Courten M, Schaaf D, Schultz J *et al*. Creating community action plans for obesity prevention using the ANGELO (Analysis Grid for Elements Linked to Obesity) Framework. *Health Promot Int* 2009; **24**: 311–324.
39. Mathews L, Moodie M, Simmons A, Swinburn B. The process evaluation of It's Your Move!, an Australian adolescent community-based obesity prevention project. *BMC Public Health* 2010. doi: 10.1186/1471-2458-10-448
40. Utter J, Warbrick J, Scragg R, Denny S, Schaaf D. The design, development and achievements of a youth-led nutrition and physical activity intervention in a Pacific Community in New Zealand. *J Am Diet Assoc* 2010; **11**: 1634–1637.
41. Fotu K, Moodie M, Mavoa H, Pomana S, Schultz J, Swinburn BA. Process evaluation of a community-based intervention: an adolescent obesity prevention project in Tonga. *BMC Public Health* 2011. doi: 10.1186/1471-2458-11-284
42. Waters E, Swinburn B, Seidell J, Uauy R (eds). *Preventing Childhood Obesity – Evidence, Policy and Practice*. Wiley-Blackwell, BMJ Books: West Sussex, 2010.
43. Mathews L, Kremer P, Sanigorski A, Simmons A, Nichols M, Moodie M *et al*. Nutrition and physical activity in children and adolescents: Report 1: methods and tools. In: (Victoria) DoHS (ed.). *Sentinel Site Series*. Deakin University: Geelong, 2009. [WWW document]. URL http://www.deakin.edu.au/dro/view/DU:30023891 (accessed February 2010).
44. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ* 2007; **85**: 660–667.
45. Sluyter JD, Schaaf D, Scragg RKR, Plank LD. Prediction of Fatness by Standing 8-Electrode Bioimpedance: a Multiethnic Adolescent Population. *Obesity* 2010; **18**: 183–189.
46. Ulijaszek SJ, Kerr DA. Anthropometric measurement error and the assessment of nutritional status. *Br J Nutr* 1999; **82**: 165–177.
47. Edwards RW, Jumper-Thurman P, Plested BA, Oetting ER, Swanson L. Community readiness: research to practice. *J Community Psychol* 2000; **28**: 291–307.
48. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med* 1999; **29**: 563–570.
49. Carter M-A, Swinburn B. Measuring the 'obesogenic' food environment in New Zealand primary schools. *Health Promot Int* 2004; **19**: 15–20.
50. de Silva-Sanigorski A, Elea D, Bell C, Kremer P, Carpenter L, Nichols M *et al*. Obesity prevention in the family day care setting: impact of the Romp & Chomp intervention on opportunities for children's physical activity and healthy eating. *Child Care Health Dev* 2011; **37**: 385–393.
51. World Health Organization. Health care decision-making in the Western Pacific Region. Diabetes and the care continuum in the Pacific Island countries. WHO, Regional Office for the Western Pacific, 2003.
52. Hawthorne G, Richardson J, Osborne R. The Assessment of Quality of Life (AQoL) instrument: a psychometric measure of health-related quality of life. *Qual Life Res* 1999; **8**: 209–224.
53. Hawthorne G, Richardson J, Day NA. Using the Assessment of Quality of Life (AQoL) – Version 1. *Technical Report 12*. Centre for Health Program Evaluation: Melbourne, 2001.
54. Moodie M, Richardson J, Rankin B, Sinha K, Iezzi A. Predicting time trade-off health state valuations of adolescents in four Pacific countries using the AQoL-6D instrument. *Value Health* 2010; **43**: 1014–1027.
55. Varni JW, Seid M, Rode CA. The PedsQL: measurement model for the Pediatric Quality of Life Inventory. *Med Care* 1999; **37**: 126–139.
56. Varni JW, Seid M, Kurtin PS. PedsQL 4.0: reliability and validity of the Pediatric Quality of Life Inventory version 4.0 generic core scales in healthy and patient populations. *Med Care* 2001; **39**: 800–812.

57. Varni J, Seid M, Knight T, Uzark K, Szer I. The PedsQL 4.0 Generic Core Scales: sensitivity, responsiveness, and impact on clinical decision-making. *J Behav Med* 2002; **25**: 175–193.
58. McCabe MP, Mavoa H, Ricciardelli L, Schultz JT, Waqa G, Fotu KF. Socio-cultural agents and their impact on body image and body change strategies among adolescents in Fiji, Tonga, Tongans in New Zealand and Australia. *Obes Rev* 2011; **12**(Suppl. 2): 61–67.
59. Thow AM, Snowdon W. The effect of trade and trade policy on diet and health in the Pacific Islands. In: Hawkes C, Blouin C, Henson S, Drager N, Dubé L (eds). *Trade, Food, Diet and Health: Perspectives and Policy Options*. Wiley-Blackwell: Oxford, 2010, pp. 147–168.
60. Lawrence M. Using domestic law in the fight against obesity: an introductory guide for the Pacific Geneva. 2003.
61. Thow A, Snowdon W, Schultz JT, Leeder S, Vivili P, Swinburn BA. The role of policy in improving diets: experiences from the Pacific Obesity Prevention in Communities food policy project. *Obes Rev* 2011; **12**(Suppl. 2): 68–74.
62. Thow AM, Quested C, Juventin L, Kun R, Khan AN, Swinburn B. Taxing soft drinks in the Pacific: implementation lessons for improving health. *Health Promot Int* 2011; **26**: 55–64.
63. Thow AM, Swinburn B, Colagiuri S, Diligolevu M, Quested C, Vivili P *et al*. Trade and food policy: case studies from three Pacific Island Countries. *Food Policy* 2010; **35**: 556–564.
64. Snowdon W, Moodie M, Schultz J, Swinburn B. Modelling of potential food policy interventions in Fiji and Tonga and their impacts on noncommunicable disease mortality. 2011. doi: 10.1016/j.foodpol.2011.06.001
65. Snowdon W, Lawrence M, Schultz J, Vivili P, Swinburn B. Evidence-based policy solutions to promote a healthy food environment for the Pacific Islands. *Public Health Nutr* 2010; **13**: 886–892.
66. Snowdon W, Potter J-L, Swinburn B, Schultz J, Lawrence M. Prioritizing policy interventions to improve diets? Will it work, can it happen, will it do harm? *Health Promot Int* 2010; **25**: 123–133.
67. Schultz JT, Moodie M, Mavoa H, Utter J, Snowdon W, McCabe MP *et al*. Experiences and challenges in implementing complex community-based research project: the Pacific Obesity Prevention in Communities project. *Obes Rev* 2011; **12**(Suppl. 2): 12–19.