

Interventions to prevent childhood obesity

Literature review



Canterbury
District Health Board
Te Pori Hauora o Waitaha

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Executive summary

Background

Maintenance of a healthy body weight in childhood is important for good short- and long-term health and wellbeing. Being overweight or obese in childhood is associated with a variety of physical, social and mental health problems. In addition, overweight or obese children are more likely to become obese adults and develop noncommunicable diseases such as type 2 diabetes, cancer and cardiovascular diseases (Chan & Woo, 2010; Lobstein, Baur, Uauy, & IASO International Obesity TaskForce, 2004; Ministry of Health, 2012; World Health Organization, 2012).

In New Zealand, 31% of children aged 2-14 years are classified as overweight/obese (Ministry of Health, 2012). Following the global trend (World Health Organization, 2010), the prevalence of obesity in New Zealand children has increased from 8% in 2006/2007 to 10% in 2011/2012 (Ministry of Health, 2012).

The prevalence of obesity is unequally distributed within populations. In New Zealand, obesity rates are higher among Māori and Pacific children, and those who live in the most deprived areas (Ministry of Health, 2012).

Quality evidence on the most effective strategies for obesity prevention in children is urgently needed to address the rising prevalence and very serious health consequences.

Methods

To investigate the effectiveness of interventions to prevent obesity in children aged up to 12 years, several recently-published systematic reviews and meta-analyses were sourced to provide an evidence-based overview. To evaluate the use of childhood obesity prevention interventions in a New Zealand context, a specific search of New Zealand-based studies was also included.

Findings

The interventions included in 15 systematic reviews to prevent obesity in children focused on increasing physical activity, reducing sedentary behaviours, and promoting healthy eating habits.

Generally, interventions tended to result in no change or a modest (and sometimes significant) reduction in adiposity. Due to the wide variety of interventions administered it is not possible to identify exactly which specific strategies (or combinations of strategies) are the most effective. However, multicomponent interventions which combined both diet and physical activities, involved other family members, included multiple settings, and were of longer duration, tended to be most effective. Some strategies that were included in the more beneficial interventions included nutrition and physical education integrated into the curriculum, more physical activity sessions, more nutritious food available in schools, an environment that supported healthful behaviours, and training for teachers and staff.

Interventions with minimal personal contact or that focussed on modifying behaviour using education alone were typically not effective.

Despite the majority of studies being conducted in the USA or Europe, these general characteristics of effective interventions appear generalisable to a New Zealand setting. This was demonstrated in two New Zealand-based interventions that employed specialised co-ordinators to work with schools and communities to increase physical activity and promote simple healthy eating messages using a variety of strategies. Both interventions resulted in some positive effects on the adiposity and health of primary school-age children.

There is some concern that participating in an obesity prevention intervention may result in adverse outcomes for children, for example, disordered eating behaviours, stigmatisation of obese individuals, and impaired growth. In spite of this, few studies measured psychosocial outcomes or negative physical effects. On the whole, those that did collect this information did not find that adverse outcomes were experienced more often by children receiving an intervention.

Conclusions

Overall, it appears that obesity prevention interventions for children can be both safe and effective when multicomponent strategies focussed on both diet and physical activity are used. While the effects on adiposity tended to be small, even modest effects can have a significant impact on population health when the interventions are sustained long-term.

The modest overall effect of education interventions highlights the fact that changes to an individual's behaviour require support from health-promoting environments. Enhanced effects are likely to occur when other factors which have been shown to be related to obesity (such as built environments, food quality, availability and pricing, government policy, and advertising) are also incorporated into population-based strategies.

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Introduction

This paper has been prepared in response to a request from the Communities Team at Community & Public Health, and presents the findings of a literature review focused on the effectiveness of interventions to prevent obesity in children up to 12 years of age. The evidence in this paper will inform Community & Public Health and the Child and Youth Workstream of the Canterbury Clinical Network.

Methodology

Due to the limited timeframe, wide scope of the topic, and the large number of publications in this area, recently-published systematic reviews and meta-analyses were identified to provide a brief evidence-based overview of the topic. A literature search to identify reviews was conducted in PubMed (NLM), using the search terms: child*, obes*, intervention, review, from 2010-present.

As it was assumed that very few of the studies included in the reviews would have been conducted in New Zealand, a separate search for interventions implemented in New Zealand was also included. A search was conducted in both PubMed (NLM) using the search terms: child*, obes*, intervention, New Zealand, from 2003-present, and in the Kiwi Research Information Service (<http://nzresearch.org.nz/>), using the search terms: child and obesity or overweight or intervention. The reference lists of relevant articles as well as university, district health board, and government department websites were also investigated.

A broad search was also conducted using Google Scholar and various combinations of the search terms: child, obesity, overweight, review, meta-analy*, intervention, New Zealand.

Titles and abstracts of publications (articles, reports, and theses) extracted from the search strategies above were assessed for relevance. Brief summaries of the most relevant publications are included in the Findings section.

Limitations of the evidence base

Some systematic reviews combined the findings of studies of both children (up to 12 years) and adolescents (13-18 years) and/or included studies to treat overweight/obesity – all of which represent data beyond the scope of this review. In some instances, the data was presented or analysed separately so that just the findings relating to prevention studies for children up to 12 years of age could be presented. However, this was not the case in all reviews and several with potentially relevant findings could not be included in the current literature review (Branscum & Sharma, 2011; Ciampa et al., 2010; da Silveira, Taddei, Guerra, & Nobre, 2013; Gerards, Sleddens, Dagnelie, de Vries, & Kremers, 2011; Golley, Hendrie, Slater, & Corsini, 2011; Krishnaswami, Martinson, Wakimoto, & Anglemeyer, 2012; Metcalf, Henley, & Wilkin, 2012; Seo & Sa, 2010; Silveira, Taddei, Guerra, & Nobre, 2011; van Stralen et al., 2011; Wahi, Parkin, Beyene, Uleryk, & Birken, 2011; Wang et al., 2013). Though not included in this literature review, these reviews tended to have similar conclusions to those summarised.

Within each systematic review, there are many differences between studies in terms of settings, design, sample size, participant characteristics, intervention approaches, duration, outcome measures used to

assess the intervention effects, and statistical analyses. This heterogeneity makes it difficult to make conclusions about the overall effect of interventions as a group.

The individual studies included in the reviews often have limitations which are inevitable due to the fact that interventions are implemented in community-based settings of free-living populations. For example, strict double-blind randomisation is often not possible, contamination may occur between the group receiving the intervention and the control group, compliance and level of participation of each individual will be variable, and loss to follow-up is expected. These limitations may impact on the accuracy, precision and size of the effect of the intervention described; however they do reflect the application of obesity prevention interventions in a real-world setting.

Most of the studies included in the systematic reviews were conducted in the USA and Europe, and only two published interventions conducted in New Zealand were sourced. It can be difficult to extrapolate the findings of individual studies to a New Zealand context due to the environmental and sociocultural differences between countries. Therefore, the conclusions made must be interpreted acknowledging that the intervention effects may not be entirely comparable if undertaken in New Zealand.

Limitations of this review

This review has been carried out in a short time frame and has accessed literature using databases readily available to the Canterbury District Health Board. It is not, and does not claim to be comprehensive or systematic.

Background

Maintenance of a healthy body weight in childhood is important for good short- and long-term health and wellbeing. Overweight and obese children are more likely to have abnormal cholesterol, blood glucose and blood pressure levels compared to children who are within the normal weight range. In addition, being overweight or obese in childhood is also associated with a variety of physical, social and mental health problems, including low self-esteem and quality of life, and increased risk of teasing, bullying and social isolation. Overweight and obese children are also more likely to become obese adults and develop noncommunicable diseases such as type 2 diabetes, cancer and cardiovascular diseases at a younger age (Chan & Woo, 2010; Lobstein, et al., 2004; Ministry of Health, 2012; World Health Organization, 2012).

The prevalence of childhood obesity is increasing at a serious rate, and the World Health Organization (2012) states that it is one of the most serious public health challenges of the 21st century.

In New Zealand, 21% of children aged 2-14 years are classified as overweight, and a further 10% are classified as being obese (a total of approximately 275,000 children) (Ministry of Health, 2012). Following the global trend (World Health Organization, 2010), the prevalence of obesity in New Zealand is increasing; the percentage of obese children has increased from 8% in 2006/2007 to 10% in 2011/2012 (Ministry of Health, 2012).

The prevalence of obesity is unequally distributed within populations and in New Zealand obesity rates are higher among Māori (17%) and Pacific (23%) children than New Zealand European/Other (6%) or Asian (7%) children. Additionally, children who live in the most deprived areas of New Zealand are more than twice (2.3 times) as likely to be obese than those who live in the least deprived areas (Ministry of Health, 2012).

The development of overweight and obesity is due to the complex interaction of multiple factors – biological, behavioural (including diet and physical activity), cultural, social, environmental and economic (Chan & Woo, 2010; Lobstein, et al., 2004). Therefore, strategies to prevent overweight and obesity in children require a multifaceted approach. As the high prevalence of overweight/obesity in children has very serious health consequences, it is very important to be informed by quality evidence regarding the most effective strategies for prevention.

Findings

Interventions to prevent obesity in childhood are most often designed to encourage healthy eating habits and regular physical activity, not to promote weight loss. Therefore it is important to note that the primary goal of interventions to prevent obesity is not necessarily to *reduce* adiposity (body fatness), but instead to *prevent an increase* in adiposity, between baseline and the end of the intervention.

International systematic reviews and meta-analyses of interventions to prevent obesity in children

The findings of 15 systematic reviews published since 2010 which describe interventions to prevent obesity in children up to 12 years of age are described below (and in Tables 1 and 2 of the Appendix). Each review has a slightly different focus in terms of setting (eg. school, community, home) or participant characteristics (eg. ethnicity, sex, age), and so all are summarised separately. The summaries include discussion of outcomes related to adiposity (eg. BMI, prevalence of overweight), health (eg. blood pressure), and/or healthful behaviours (eg. vegetable intake, amount of physical activity).

Findings from individual systematic reviews

Family-focused physical activity, diet and obesity interventions in African-American girls: a systematic review (Barr-Anderson, Adams-Wynn, DiSantis, & Kumanyika, 2013)

A systematic review of studies published up to 2012 investigating the effectiveness of family involvement in obesity interventions among African-American girls identified fifteen studies of 5-12 year olds which focused on obesity prevention. Interventions varied widely in the type and level of family involvement – many included parents and/or other family members, but none included the whole family. Many studies culturally tailored the content of the materials and messages, and several were brief or pilot-type studies. There was also a wide variety in the types of behaviour change strategies utilised, which included knowledge and skills-based education sessions (eg. group, individual, theatre-based), active games, newsletters, resources, family events, food preparation classes, and aerobics/dance classes. The majority of the interventions were based in the school or community (eg. community centre, camp), and the remainder were implemented either at home, or in multiple settings. Intervention duration ranged from 3 weeks to 2 years. All studies indicated at least some positive influence on physical activity and dietary behaviours, though for some studies, results were mixed. Six studies were randomised controlled trials that measured weight-related outcomes (eg. BMI, percentage body fat, waist circumference). Four of these studies showed positive effects of the intervention (though findings were not always statistically significant, and numerical data was not provided), and the remaining two (high quality) studies showed mixed or negative findings. Overall, the authors were unable to make clear-cut conclusions on the most effective ways of involving family members in obesity prevention interventions for African-American girls.

Systematic review of community-based childhood obesity prevention studies (Bleich, Segal, Wu, Wilson, & Wang, 2013)

A systematic review investigating the effectiveness of community-based interventions to prevent obesity/excessive weight gain in high-income countries identified five studies of children up to 12 years of

age published up to 2012. Four of these studies took place in the USA, and one in Australia. Most studies were conducted in a community setting as well as in the home or school environment, and all interventions were 1-4 years in duration. Interventions used multiple strategies to modify diet or physical activity or both. These included group counselling, school food service changes, health education, city policies, community awareness campaigns, physical education enhancements (eg. dance classes, active play), family outreach, and social marketing. Three of the five studies reported significantly lower adiposity in intervention children compared with controls (difference in change from baseline between control and intervention for standardised BMI (zBMI) of -0.04 or -0.1, or BMI of -0.02 or -0.06). In the other two studies there was no significant effect of the intervention; however the children in the control group also received some general health education (not specifically related to nutrition or physical activity). There is moderate strength of evidence that interventions of greater duration that had multiple intervention components (focusing on both diet and physical activity) administered in multiple settings (in particular, both community and school) were most effective.

Educational interventions in childhood obesity: a systematic review with meta-analysis of randomised clinical trials (Sbruzzi et al., 2013)

Twenty six randomised clinical trials of children 6-12 years of age published up to 2012 were found in a systematic review to assess the effectiveness of educational interventions to prevent or treat obesity. Of these, 18 studies were designed to prevent obesity using behavioural modification, nutrition and/or physical activity. The educational interventions lasted from 6-72 months, and included one or more of the following: dietary counselling/education sessions for children and/or parents, classroom curricula, more physical activity sessions or activity of greater intensity, activities to complete in the home, school nutrition policy, and canteen changes. There were non-significant decreases in waist circumference, BMI, zBMI, blood pressure, cholesterol and HDL cholesterol in the intervention compared to the control groups. The studies included in the meta-analyses were heterogeneous in terms of many factors (particularly the intervention strategies and duration), and the quality of the evidence was deemed to be low by the authors, so results should be interpreted with caution. Overall, the findings in this review state that educational interventions alone are not effective in preventing childhood obesity and its physiological consequences.

A systematic review of home-based childhood obesity prevention studies (Showell et al., 2013)

Four studies of children up to 12 years of age were included in a systematic review of the effectiveness of home-based interventions to prevent obesity. Interventions were 1-24 months in duration, and all had a follow-up period of at least 1 year. The behavioural interventions aimed to modify diet (eg. to increase fruit and vegetable consumption, increase calcium intake, decrease high fat/high sugar consumption) aimed at the child, parent or family, physical activity, sedentary behaviours (to reduce screen time), or a combination of these. All included studies were randomised controlled trials conducted in the USA and published up to 2012. None of the four studies reported a consistent significant effect of the intervention on BMI, prevalence of overweight/obesity, fruit and vegetable intake, energy intake, physical activity or sedentary behaviour. The authors concluded that the strength of evidence was insufficient to support the effectiveness of home-based interventions alone to prevent childhood obesity.

Combined home and school obesity prevention interventions for children: what behaviour change strategies and intervention characteristics are associated with effectiveness? (Hendrie et al., 2012)

In a systematic review to examine the effectiveness of combined-setting interventions targeting children's obesity and weight-related nutrition and physical activity behaviours, 15 studies were identified. All studies were controlled trials of pre- or primary school-aged children published between 1998 and 2010. Most studies evaluated interventions of relatively short duration (5-20 weeks). The intervention settings were schools, after school programs, childcare centres, home, summer day camp, or a combination of these settings. All interventions included a group session with the children, usually administered by a teacher or carer, and typically incorporated some level of family participation. Little other detail of intervention strategies was provided in the review. Of the eleven studies that collected weight-related data, three showed significantly lower BMI or zBMI in the intervention group compared to the control group, by a small amount. Eight studies were shown to be effective in improving reported dietary behaviours (ie. greater fruit and vegetable, and reduced fat intakes). Two studies were effective in increasing physical activity, and one study resulted in decreased television viewing. In total, seven studies were considered to be effective. The effective studies used more behaviour change techniques, and six of the seven effective interventions used the following techniques: providing general information about the behaviour-health link, prompting practice, and planning for social support/change. Studies which used theoretical models of behaviour change (eg, Social Cognitive Theory) to develop the intervention were also more effective. This review provides evidence that theory-based interventions utilising multiple behaviour change techniques and family involvement in a combined setting can be effective at reducing children's risk of obesity.

Parent participation in weight-related health interventions for children and adolescents: a systematic review and meta-analysis (Niemeier, Hektner, & Enger, 2012)

A systematic review investigating the impact of parental influence on child and adolescent interventions to either prevent or treat overweight/obesity identified 42 studies published between 2004 and 2010. Intervention activities consisted of nutrition and/or physical activity-related education, physical activity sessions, behaviour therapy, or a combination of these activities. Duration ranged from 9 weeks to 4 years. The level of parental involvement in each intervention was variable, and was defined as either optional, required or none. Of the 42 studies identified, eleven had the aim of preventing overweight/obesity in children aged 2-12 years. When these eleven studies were combined in a meta-analysis, there was no significant difference in the change in BMI between baseline and the end of the study for children in the intervention versus control groups ($p=0.0983$). This is in spite of several of the studies showing a larger decrease in BMI in the intervention compared to the control group. To determine the influence of parental involvement on outcomes, data for both children and adolescents (up to 19 years old) was combined. This analysis found that interventions that required parental involvement had significantly higher success rates than interventions with no parent involvement ($p=0.027$). This review indicates that parental involvement increases the effectiveness of interventions to prevent an increase in BMI, however the relevance specifically to children up to 12 years old is unclear since data from adolescents was also included in the analysis.

Identifying effective behavioural models and behaviour change strategies underpinning preschool and school-based obesity prevention interventions aimed at 4-6-year-olds: a systematic review (Nixon et al., 2012)

To identify the most effective behavioural models and strategies used in preschool and school-based obesity prevention interventions of children 4-6 years of age, a systematic review was conducted of studies published between 1995 and 2010. Of the 12 studies identified, all used behaviour change strategies to target physical activity, healthy eating, sedentary behaviour, or a combination of these behaviours, with nine using various psychological theories (eg, Social Cognitive Theory). Interventions varied in length from up to 6 months to over 12 months. Four of the 12 studies reported a significant favourable effect on weight status, and seven reported significant positive changes in physical activity and/or dietary behaviours (actual data not presented). The remaining studies showed no significant effect on one or more of these outcomes. The most effective interventions featured a moderate or high level of parental involvement, increased compulsory physical activity in school, modified dietary intake through changes to the school environment (eg. canteen), and included at least some of the following behaviour change strategies: developing skills and behavioural capability, developing self-efficacy, educating parents and children about the benefits of healthful dietary and physical activity behaviours (the behaviour-health link), and modelling healthful eating and physical activity.

Systematic review of effective strategies for reducing screen time among young children (Schmidt et al., 2012)

A systemic review identified 47 studies published between 1947 and 2011 which aimed to reduce screen time (eg. television, computer, video game) in children up to 12 years old. Most studies took place in multiple settings, and almost all had a home component. Many different strategies were used in the interventions, including educational and/or physical activity sessions, resources for teachers and/or parents, television time monitors, contingent feedback systems (eg. screen time is “earned” through time spent doing physical activity), incentives, and advertising. Approximately 19 of the 47 studies were primary prevention interventions measuring weight-related outcomes. Five of those studies reported significantly lower BMI in the intervention compared to the control groups. The strategies employed in those studies included nutrition and physical activity education for children, physical activity sessions, coupon incentives for parents, teacher training, home visits, community-wide programs, and TV monitors.

Effectiveness of preventive school-based obesity interventions in low- and middle-income countries: a systematic review (Verstraeten et al., 2012)

Twenty two controlled trials published between 1990 and 2011 were identified in a systematic review to assess the effectiveness of school-based interventions for the primary prevention of obesity in low- and middle-income countries. The quality of reporting of most of the studies was determined by the authors to be low-to-moderate. Interventions focused on either diet, physical activity, or both, and lasted 6 months to 4 years. Strategies were incorporated into the existing school environment, and included nutrition education, group counselling, breakfast programs, additional physical education sessions, and environmental or organisational changes. Of the ten studies of children 6-12 years of age that provided weight-related data, six reported a statistically significant reduction in BMI or zBMI in the intervention group. Three of the four studies that provided dietary data indicated at least some significant positive effect on behaviours such as reduced sweetened beverage intake. Four of the five studies that provided

activity data indicated some significant positive effect of the intervention, such as faster performance on a shuttle run test. Three studies collected data on adverse effects, however, the review did not discuss these findings. The most effective interventions targeted both diet and physical activity, involved multiple stakeholders, and integrated educational activities into the school curriculum.

Systematic review of the effectiveness of weight management schemes for the under fives (Bond, Wyatt, Lloyd, & Taylor, 2011)

Four studies published between 1990 and 2009 were identified in a systematic review to assess the effectiveness and cost-effectiveness of weight management interventions for children less than five years of age. These randomised controlled trials took place in the UK, USA and Thailand, and were 14-24 weeks in duration. The studies took place either at home, preschool, or in both settings, and included strategies such as additional physical activity sessions and nutrition-related activities for children, and health-focussed education, newsletters, voucher incentives, and aerobics classes for parents. One study showed that the BMI and zBMI of African-American (but not Latino) children in the intervention group was significantly lower than those in the control group 1 and 2 years after the intervention began (difference in the adjusted change from baseline ≈ 0.5 BMI points). This intervention employed three 20-minute physical activity sessions and three nutrition activities in the weekly preschool curriculum. Financial incentives were also provided to parents on completion of homework. There was no statistically significant effect on weight-related outcomes in other studies, however most outcomes tended to be in a more positive direction for the intervention group. In the two studies that assessed physical activity, no significant differences were observed between the objective activity levels of children in the intervention and control groups. The authors state that no adverse effects were reported in any of the studies, however, no further detail was provided. Due to the small number of studies and the variability in their populations, design and interventions, no firm conclusions on the effectiveness of interventions for young children could be drawn.

School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project (De Bourdeaudhuij et al., 2011)

A systematic review to evaluate school-based interventions that combined both nutrition and physical activity approaches in Europe was conducted. Six studies published in 1990-2007 which targeted children 6-12 years of age were identified. Intervention duration ranged from 6 weeks to 6 years. Five of the studies were determined to be of moderate quality, and one of low quality. The interventions either focussed on education alone (curriculum-based lessons and/or games), or a combination of education and environmental factors (including curriculum-based lessons, modifying food available at school, increasing physical activity, providing more play equipment, and meetings with parents/community members). Two multicomponent studies showed a significant improvement in weight-related outcomes (BMI, skin-folds, and percentage overweight). In one study the positive effect was only observed in girls, and in the other, differences between the BMI of intervention and control groups persisted even after 3 and 10 years. These interventions included workbooks and classroom modules, exercise sessions, teacher training, and meetings with parents. Some positive effects on physical activity and diet-related behaviours were found, however not in all studies. Multicomponent studies tended to be more effective than education alone. Overall, there was inconclusive evidence from these few studies that interventions have a definite positive impact on child obesity prevention in the European context.

Interventions for the prevention of overweight and obesity in preschool children: a systematic review of randomized controlled trials (Monasta et al., 2011)

To assess the effectiveness of interventions for the prevention of overweight and obesity in children less than 5 years old, a systematic review was conducted which identified seven randomised controlled trials published between 1997 and 2008. All interventions were 10 weeks – 16 months in duration, except one which lasted 13 years. The interventions were administered in a variety of settings, including preschools, homes, and hospitals/clinics. They all included one or more strategies, for example education and/or physical activity sessions, resources and support for staff and parents, individual counselling, and promotion of breastfeeding. There was a tendency towards positive effects of the interventions on weight-related outcomes (eg. BMI, weight-for-age z-scores, and percentage overweight), and diet and physical activity-related behaviour, however these differences were not often statistically significant. Overall, the review indicated that no single or combined intervention provides evidence of a significant effect on limiting weight gain in preschool children.

A review of electronic interventions for prevention and treatment of overweight and obesity in young people (Nguyen, Kornman, & Baur, 2011)

A systematic review summarising interactive electronic media interventions for the treatment or prevention of obesity in children and adolescents identified 24 studies published between 1998 and 2008. Of those, three studies specifically focussed on obesity prevention and included children 8-11 years of age. All three studies were based in the USA and took place either at home, school, or both day camp and home. Duration of the interventions was brief at just 8-12 weeks. Interventions included internet-based modules (for children and parents), or an interactive CD-ROM game/lesson based on Social Cognitive Theory, and some monetary incentives. One study showed significantly lower zBMI (by 0.07 points) and percentage body fat (by 1.4%) in the intervention group, however the other two smaller studies showed no significant effects. Some diet and physical activity-related behaviours were improved to a small extent as a result of the intervention. Due to the small number of relevant studies and the variability in the interventions, there is insufficient evidence to state the effectiveness of electronic interventions alone to prevent obesity in children.

Interventions for preventing obesity in children (Waters et al., 2011)

A systematic review by The Cochrane Collaboration assessed the effectiveness of interventions intended to prevent obesity in children under 18 years published until 2010. This review included only evaluated interventions that were in place for 12 weeks or more. Fifty five controlled trials (with or without randomisation) were identified from 16 middle- and high-income countries which compared diet or physical activity interventions (or both) with a non-intervention control group who received usual care or another active intervention. Interventions were conducted within the community, school, out-of-school hours care, home, childcare or preschool. Parental/family involvement was incorporated in some interventions, and several included training for teachers/staff/carers. The interventions varied widely and strategies included physical activity sessions, food service/policy modifications, enhanced classroom curriculum (eg. education and activities to increase fruit, vegetable and water intake), additional classroom and playground equipment, devices to monitor screen time, newsletters and resources, and social marketing.

Of the 55 studies, eight recruited children aged up to 5 years, and 39 recruited children aged 6-12 years. A meta-analysis was conducted to investigate the effectiveness of the interventions on zBMI, which was the most commonly reported measure of adiposity. Children up to 5 years of age participating in an intervention tended to have a change in zBMI from pre- to post-intervention that was 0.26 units less than that observed in the control group (95% CI: 0.00, 0.52, $p=0.05$). To illustrate this change in zBMI in terms of BMI, for a child aged 3.7 years with a BMI of 16.3, this would represent a reduction in BMI of 1.6%. Results suggest that home or healthcare setting-based interventions were most effective for this age group. For children 6-12 years of age, the zBMI of children in the intervention group was on average 0.15 units lower (95% CI: 0.08, 0.23) than those in the control group. To illustrate, for a child aged 9.5 years with a BMI of 18.2, this would represent a reduction in BMI of 0.8%.

Of the 47 studies in the Cochrane review, 20 also reported a significant positive effect of the intervention on other measures of adiposity (eg. BMI, weight, skinfold thickness, percentage body fat, percentage overweight). In most of the intervention groups, some modest changes on diet- and physical-activity related behaviours were also achieved. These included increased fruit and vegetable consumption; reduced intake of sweetened beverages, snacks or fats; improved cardiovascular fitness; more time spent in physical activity; and decreased sedentary behaviours.

None of the eight studies of children up to 5 years of age explicitly provided data on any measures of harm or unintended consequences as a result of the intervention. Only eight studies of children 6-12 years of age collected data on adverse outcomes (including prevalence of underweight, unhealthy eating practices, stigmatisation, teasing, body image perceptions, satisfaction, and self-worth). In these studies, either very few or no adverse effects were reported.

Overall, interventions in children up to 12 years of age indicated a positive effect on adiposity. The authors stated that due to the wide variety of approaches and measures used in the interventions included in the review, the ability to make firm conclusions about the best interventions for effective behaviour change was limited. However, the following elements were included in the more beneficial interventions:

- integration of nutrition and physical education in to the standard curriculum,
- more physical activity sessions,
- improvement of the nutritional quality of food available in schools,
- an environment and culture that supports healthful behaviours,
- providing support and training for teachers and staff to implement health promotion activities, and
- engaging with parents to encourage children to be more active, eat more nutritious foods and spend less time doing screen-based activities.

Objectively measured physical activity and obesity prevention in children, adolescents and adults: a systematic review of prospective studies (Wilks, Besson, Lindroos, & Ekelund, 2011)

Nine prospective and four randomised controlled trials of children 3-12 years of age were identified in a systematic review to investigate the association between objectively measured physical activity and change in adiposity. The review was a systematic update of two previous reviews, and included studies published between 1999 and 2009. The physical activity interventions took place in a preschool, school, or community setting, and incorporated additional activity opportunities with health education programmes for the children and often parents/families as well. Interventions lasted between 4 months and 2 years. A

significant effect of the intervention on adiposity (ie. smaller increase in skinfolds) was noted in only one of the randomised controlled trials. Not all of the interventions were successful at increasing physical activity levels of children significantly. This review states that there is insufficient evidence on which to base conclusions for using physical activity alone to prevent obesity in children.

Conclusions

Overall, the systematic reviews and meta-analyses indicated no change or a modest (and sometimes significant) reduction in adiposity resulting from obesity prevention interventions for children. The studies included in the reviews were heterogeneous in terms of study design, location, duration, population, and intervention strategy. These differences mean that it is difficult to identify specific strategies (or combinations of strategies) that are the most effective. Broadly, however, the most effective interventions had the following features:

- being multicomponent interventions focussed on both diet and physical activity,
- including multiple settings,
- involving other family members, and
- being of longer duration.

Some strategies that were included in the more beneficial interventions were nutrition and physical education integrated within the school curriculum, more physical activity sessions, more nutritious food available in schools, an environment that supports healthful behaviours, and support and training for teachers and staff. Interventions with minimal personal contact or that focussed on providing education alone were typically not effective.

Interventions to prevent obesity in children conducted in Aotearoa New Zealand

Most of the studies included in the reviews described above were based in the USA or Europe. Therefore, to gain an understanding of interventions designed and undertaken specifically in the New Zealand context, findings of these interventions are discussed separately here.

Findings from individual interventions

Three published intervention studies were identified that were designed to prevent obesity/excessive weight gain in New Zealand children.

A Pilot Programme for Lifestyle and Exercise (APPLE) Project (Taylor et al., 2008; Taylor et al., 2007; Taylor et al., 2006)

The APPLE Project was a 2-year obesity prevention intervention for 5-12 year old children, starting in 2003. Seven primary schools in two semirural Otago communities participated, with the intervention implemented in one community (250 participating children) and no intervention in the other (219 participating children). The majority of participants identified as being New Zealand European (83%), with 17% identifying as Māori, and <1% Pacific.

Co-ordinators worked with each intervention school for 20 hours per week. In the first year, they focussed on increasing non-curricular activity during school breaks and after school, facilitating activity programs

involving parents and other community members, and encouraging short bursts of activity in class. In the second year, the co-ordinators focussed on reducing sugary beverage intake and increasing fruit and vegetable intake. Free fruit was supplied for 6 months, cooled water filters were provided, and a wider variety of sport and play equipment was made available.

Mean zBMI of intervention children was significantly lower than control children after 1 year (0.09 points, 95% CI: -0.01, -0.18) and 2 years (0.26 points, 95% CI: -0.21, -0.32). After 2 years, this change in zBMI would equate roughly to a difference of ≈ 0.5 BMI points for a 7-year-old and ≈ 0.7 BMI points for an 11-year-old. This difference was attributable to a difference in weight, rather than height. When only those children who provided data at all three time points (baseline, 1 and 2 years) were included in the analysis, there was no significant effect of the intervention after 1 or 2 years on zBMI for overweight children, whereas there was a significant effect for normal-weight children. The percentage of children categorised as overweight was not significantly different between the intervention and control groups after either 1 or 2 years. Two years after completing the intervention (ie. 4 years after baseline), the zBMI of children in the intervention group was significantly lower than controls (by 0.17 points, 95% CI: -0.08, -0.25), and the effect was greater in children who had been involved in the intervention for longer. The percentage of children categorised as overweight was not significantly different between the intervention and control groups, except when only those children who completed the full 2-year intervention were included in the analysis (19% lower, 95% CI: -6, -31). These analyses were adjusted for multiple factors, as children in the intervention group were significantly leaner (ie. lower zBMI), with smaller waist circumferences at baseline.

Systolic blood pressure was significantly lower in intervention children after 1 (2.9mmHg, 95% CI: -0.6, -5.2) and 2 (4.8mmHg, 95% CI: -0.8, -0.4) years, and after 2 years waist circumference was significantly lower in intervention children (1cm, 95% CI: 0.0, -2.0). There were no statistically significant differences between groups for diastolic blood pressure or pulse rate. At the end of the 2-year intervention, children in the intervention group reported consuming significantly fewer servings of sweetened drinks (1.2 fewer servings, 95% CI: -0.2, -2.3), and more servings of fruit (0.8 more servings, 95% CI: -0.5, -1.1) than children in the control group. There were no significant differences in water or vegetable intake between groups.

There was no significant effect of the intervention on the amount of time children spent watching television. Objective activity (measured using an accelerometer) was significantly higher in the intervention group after 1 year of the intervention, however was not different after 2 years. Conversely, subjective activity (summed from a questionnaire to provide a rating from 1=low to 5=high) was significantly lower in the intervention group after both 1 (0.2 rating points, 95% CI: -0.1, -0.4) and 2 (0.2 rating points, 95% CI: 0.0, -0.4) years of the intervention.

Several changes to policies and procedures surrounding healthy eating and physical activity were implemented by the intervention schools. These included changing the types of food available for purchase, and prohibiting the use of physical activity as punishment.

This study indicated that providing co-ordinators to encourage additional physical activity and reinforce simple dietary messages in school and the community was effective at preventing excessive weight gain in primary school-age children. A decrease in adiposity was most apparent in children who were normal-weight at baseline, and the adiposity of overweight children was stable over the 2-year period.

Project Energize (Rush et al., 2013; Rush et al., 2012)

Project Energize was a longitudinal controlled study designed to prevent childhood obesity, implemented from 2004-2006. A total of 124 primary schools in the Waikato Region were stratified by rurality and social deprivation, and randomly assigned to the intervention (n=692) or control (n=660).

Each intervention school was assigned a co-ordinator, who worked with the school to achieve goals based on healthier eating and quality physical activity. Examples of initiatives included promoting active transport and lunchtime games, supporting class teachers, assisting schools with canteen “makeovers”, providing nutrition information sessions for parents, and facilitating community events.

The majority of participants identified as being New Zealand European (66%), with 26% identifying as Māori, and the remainder (8%) were categorised as “other ethnicity”. At the end of the 2-year intervention, the percentage body fat (of younger children) and blood pressure (of older children) tended to be lower in the intervention compared to the control group. However, there were no statistically significant differences in BMI, percentage body fat, blood pressure, or prevalence of overweight/obesity between the intervention and control groups after adjusting for baseline measures, rurality, social decile and clustering.

Project Energize was introduced to all of the Waikato regional schools from 2006. In 2011, the BMI of 2,474 younger (aged 7 years) and 2,330 older (aged 10 years) children attending 193 of the 235 primary schools were compared with data collected from control schools at the end of the study in 2006. After adjusting for age, sex, ethnicity, socio-economic position and school cluster effects, the combined prevalence of overweight/obesity among younger and older children in 2011 was lower by 31 and 15%, respectively, than among children in the control schools in 2006. The prevalence of thinness was not different between the two time points. Similarly, BMI was lower by 3.0% (95% CI: -5.8, -1.3) and 2.4% (95% CI: -4.3, -0.5). These effects were observed for both boys and girls, both Māori and non-Māori children, and across socioeconomic position. Although limited by the fact that the comparisons were not made between children at the same time point, these findings indicate that the introduction of this multicomponent project has likely resulted in a lower prevalence of overweight/obesity in Waikato schoolchildren.

Project Energize is now being introduced to clusters of schools in Franklin and Northland, and the Ministry of Health recently announced that it is to be expanded to over 100 preschools in the Waikato region (Waikato District Health Board).

Prevention of Overweight in Infancy study (POI.nz) (Taylor et al., 2011)

The POI.nz study is a randomised controlled trial being undertaken with 800 families in Dunedin. The aim of this study is to evaluate the effect on weight velocity and BMI of early childhood obesity prevention interventions delivered to parents in late pregnancy and the first 2 years of their infant’s life compared to standard Well Child care. The three interventions include anticipatory guidance, extra education, and support to encourage (a) positive diet and physical activity behaviours, or (b) appropriate sleeping patterns, or (c) both interventions combined. This study is currently underway and post-intervention results have not yet been published.

Conclusions

The findings from two studies with published results indicate that the provision of a dedicated co-ordinator to increase physical activity and promote simple healthy eating messages can have some modest positive effects on the adiposity and health of primary school-age children. These interventions used multiple strategies to engage with children, family members, schools and the wider community to influence both children's behaviour and their environment. Conducted in Otago and Waikato, these interventions are directly relevant to the New Zealand setting and could be implemented in other regions with any necessary community-specific modifications.

Reviews specifically investigating psychosocial and adverse physical outcomes of interventions to prevent obesity in children

There is some concern that interventions which aim to prevent overweight/obesity in children have the potential to cause unintended adverse effects (Doak, Visscher, Renders, & Seidell, 2006) by contributing to problems such as body image dissatisfaction, low self-esteem, disordered eating behaviours and attitudes, social stigmatisation, discrimination against obese individuals, impaired growth and development, and injury.

Findings from individual reviews

The following two reviews focussed specifically on investigating potential psychosocial and adverse physical outcomes of obesity prevention programs for children.

The impact of school-based prevention of overweight on psychosocial well-being of children (van Wijnen, Wendel-Vos, Wammes, & Bemelmans, 2009)

Of the 53 studies included in a review of school-based obesity prevention interventions published between 1990 and 2008, only five studies of children under 12 years old measured psychosocial variables. The interventions focused on physical activity, sedentary behaviour, or both diet and physical activity. The interventions used several different instruments to measure multiple psychosocial variables, including general self-worth, dietary restraint, body image perception, disordered eating, physical and verbal aggression, and self perception. There were no significant differences between intervention and control groups in psychosocial outcomes in most of the studies. However, one study reported a significantly larger decrease in peer-rated aggression (-2.4%, 95% CI: -4.6, -0.2) and observed verbal aggression (-0.10 acts per minute, 95% CI: -0.18, -0.03) in children in the intervention group. This review highlights that there is a paucity of data on psychosocial outcomes in childhood obesity prevention studies, and from the small number of studies included in this review there is little evidence of a significant effect of these interventions on psychosocial outcomes.

Childhood obesity prevention programs: how do they affect eating pathology and other psychological measures? (Carter & Bulik, 2008)

A review to evaluate the impact of childhood obesity prevention programs on eating pathology and other psychological measures assessed the studies extracted in an earlier systematic review completed by the Cochrane Collaboration (Summerbell et al., 2005). Outcome measures of interest included underweight, excessive weight loss, binge eating, weight control behaviours, dietary restraint, excessive exercise, over-

concern with weight and shape, body image, and self-esteem. Of the 22 studies included in the original review, only six studies of children less than 12 years old were identified that included any of these measures. Many studies found no significant differences between the intervention and control groups in terms of eating pathology and other psychological outcomes. One study reported that children in the intervention group were significantly more likely to be engaging in unhealthy weight control behaviours. Some studies showed positive outcomes in the intervention groups, including significantly less over-concern with weight and shape, increased self-worth (in obese children), and greater healthy food and behaviour intentions. Whilst acknowledging the limited data available, the review concluded that the existing evidence does not support the view that childhood obesity prevention interventions are associated with unintended psychological harm.

Conclusions

Despite some concern that interventions to prevent obesity in children may result in adverse psychosocial and/or physical outcomes, very few studies have collected this type of data. Of the limited number of studies reporting on adverse effects, there is little evidence to suggest that these interventions have a negative impact on the physical and psychological wellbeing of those involved. However, because most studies are not likely to be sufficiently powered to detect infrequent adverse outcomes, and these measures are also collected infrequently, decisive conclusions about the potential for adverse outcomes are not possible.

Programs to promote child health in Aotearoa New Zealand

There are several programs that have been undertaken or are currently underway in New Zealand that promote healthy lifestyles for children. These programs are not obesity prevention interventions, but do include health-promoting initiatives related to nutrition and physical activity. These include Health Promoting Schools (hps.tki.org.nz/), Fruit in Schools (Boyd, Dingle, Hodgen, King, & Moss, 2009), Well-being and Vitality in Education (wavesouthcanterbury.co.nz/index.html), and Healthy Eating Healthy Action (Ministry of Health, 2008).

Conclusions

Overall, findings from the systematic reviews and meta-analyses investigating the effectiveness of obesity prevention interventions for children indicate a modest positive effect on adiposity (ie. prevention of excessive weight gain or modest weight reduction) and other health-related outcomes. The studies included in this literature review were heterogeneous in terms of study design, duration, participant characteristics, and intervention strategy. These differences mean that it is difficult to identify specific interventions that were the most effective. On the whole however, interventions with the following characteristics tended to be more effective:

- used a multi-component design (eg. health-related education sessions integrated into the current school curriculum, policies for changes to the school environment to improve the quality of food available)
- focussed on both diet (increased fruit, vegetable and water intake, and decreased sweetened beverage intake) and physical activity (increased opportunities for activity),
- involved parents and/or family members (to support activities in the home relating to diet, physical activity and screen time),
- took place in multiple settings (most often preschool or school was the primary setting)
- used strong community engagement (involved the input of leaders from a range of sectors), and
- were of longer duration (at least 1 year).

Despite the majority of studies being conducted in the USA or Europe, these general characteristics of effective interventions appear generalisable to a New Zealand setting, even if the specific resources or activities within each intervention may require tailoring.

The effectiveness of longer duration multi-component interventions in school settings with family and community involvement was demonstrated in two New Zealand-based interventions. These interventions were tailored to the communities in which they were conducted, and employed dedicated co-ordinators to increase physical activity and promote simple healthy eating messages. Both interventions resulted in modest but positive effects on the adiposity and health of primary school-age children.

While the effects on adiposity tended to be small, this is to be expected. As these prevention studies include all children, irrespective of body composition, the effects are smaller than if only obese children were included. At a population level, even modest effects can have a significant impact on health when the interventions are sustainable.

There is little evidence to suggest that obesity prevention interventions have a negative impact on the psychosocial or physical health of those involved. However, given that this evidence is based on the limited number of studies reporting these outcomes in the short-term, it is essential that potential adverse effects are monitored as part of any intervention.

Interventions that used minimal contact or aimed solely to modify diet or physical activity-related behaviours through education alone were largely ineffective. The small overall effect of education interventions highlights the fact that changes to individuals' behaviours require support from healthful

environments. Other factors which have been shown to be related to obesity (such as built environments, food quality, availability and price, government policy, and advertising) are difficult to manipulate in an intervention study-type setting, but their importance in programs to prevent obesity must not be underestimated. Enhanced effects are likely to occur when these factors are also incorporated into population-based strategies.

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Appendix

Table 1. Summary of systematic reviews and meta-analyses of interventions to prevent obesity in children with more conclusive findings

Reference	n ^a	Population	Settings (duration)	Main interventions	Findings ^b	Conclusions
(Waters, et al., 2011)	47	Children ≤12 years old	Home, school, community, clinic or multi-setting (≥12 weeks)	Education, activities, policy, and environmental change to modify diet and/or increase physical activity and/or decrease sedentary behaviours	Significant positive effect on adiposity (meta-analysis). Most reported positive effect on dietary and physical activity behaviours (some NS).	Positive effect of interventions. Most effective interventions integrated health education into the school curriculum, increased activity sessions, improved food quality, provided training for staff, and involved parents
(Sbruzzi, et al., 2013)	18	Children 6-12 years old	School or both school and home (6-72 months)	Education, activities, policy, and environmental change to modify diet and/or increase physical activity	Interventions reported lower adiposity, blood pressure, cholesterol (NS, meta-analysis).	Low quality evidence suggests that educational interventions alone are not effective
(Hendrie, et al., 2012)	15	Children ≤12 years old	School and home (5-20 weeks)	Education and activities to modify diet and/or increase physical activity and/or decrease sedentary behaviours	3/11 interventions reported significantly lower adiposity. Some reported a significant positive effect on dietary, physical activity and sedentary behaviours.	Most effective interventions used multiple behaviour change strategies and family involvement in a combined setting
(Nixon, et al., 2012)	12	Children 4-6 years old	School and/or home (<6->12 months)	Education, activities and environmental change to modify diet and/or increase physical activity and/or decrease sedentary behaviours	4/12 interventions reported significantly lower adiposity. 7/12 reported significant positive effect on dietary and physical activity behaviours.	Most effective interventions featured moderate-high level of parental involvement, focused on both diet and physical activity, and used several specific behaviour change strategies
(Niemeier, et al., 2012)	11	Children 2-12 years old	School, community, home, or multi-setting (9 weeks-4 years)	Education and activities to modify diet and/or increase physical activity and/or decrease sedentary behaviours	Several interventions reported lower adiposity (some NS). However, no significant overall effect on adiposity (meta-analysis).	No significant effect of interventions

Reference	n ^a	Population	Settings (duration)	Main interventions	Findings ^b	Conclusions
(Verstraeten, et al., 2012)	10	Children 6-12 years old in low- and middle-income countries	School (6-48 months)	Education, activities and environmental changes to modify diet and/or increase physical activity.	6/10 interventions reported significantly lower adiposity. Most reported some significant positive effect on dietary behaviours and physical activity levels.	Most effective interventions focused on both diet and physical activity, involved multiple stakeholders and integrated educational activities into the school curriculum
(Monasta, et al., 2011)	7	Children <5 years old	Preschool, home, clinic (10 weeks-13 years)	Education and activities to modify diet and/or increase physical activity	Some interventions reported lower adiposity (some NS). Some reported positive effect on dietary and physical activity behaviours (some NS).	No significant effect of interventions for young children
(Bleich, et al., 2013)	5	Children ≤12 years old in high-income countries	Community plus either home or school (1-4 years)	Education, activities, policy, and environmental change to modify diet and/or increase physical activity	3/5 interventions reported significantly lower adiposity.	Moderate strength of evidence that multicomponent interventions of longer duration in multiple settings are most effective

^a Number of intervention studies that aimed to prevent obesity in children up to 12 years of age included in the systematic review

^b Results of intervention compared to control group

NS, statistically non-significant

Table 2. Summary of systematic reviews and meta-analyses of interventions to prevent obesity in children with less conclusive findings

Reference	n ^a	Population	Settings (duration)	Main interventions	Findings ^b	Conclusions ^c
(Schmidt, et al., 2012)	19	Children ≤12 years old	Home, school, community, clinic or multi-setting (most <1 year)	Education, activities and environmental changes to decrease screen time	5/19 interventions reported significantly lower adiposity. Most reported less screen time (some NS).	Inconclusive effect of screen time-focused interventions
(Barr-Anderson, et al., 2013)	15	African-American girls 5-12 years old	School, community, home, or multi-setting (3 weeks-2 years)	Education and activities to modify diet and/or increase physical activity	4/6 interventions reported lower adiposity (some NS). All reported positive effect on dietary and physical activity behaviours (some NS).	Inconclusive evidence of the most effective way to involve family members in interventions
(Wilks, et al., 2011)	13	Children 3-12 years old	School or community (4-24 months)	Education and activities to increase physical activity	1/4 interventions reported significantly lower adiposity. Some reported positive effect on physical activity levels (some NS).	Insufficient evidence to support the effectiveness of using physical activity interventions alone
(De Bourdeaudhuij, et al., 2011)	6	Children 6-12 years old in Europe	School (6 weeks-6 years)	Education, activities and environmental changes to modify diet and/or increase physical activity	2/6 interventions reported significantly lower adiposity. Some reported positive effect on dietary and physical activity behaviours (some NS).	Inconclusive evidence to support the effectiveness of using school-based interventions alone
(Bond, et al., 2011)	4	Children <5 years old	Home, preschool, or both (14-24 weeks)	Education and activities to modify diet and/or increase physical activity	1/4 interventions reported significantly lower adiposity. No significant difference in objective activity levels.	Insufficient evidence to support the effectiveness of interventions for young children
(Showell, et al., 2013)	4	Children ≤12 years old	Home (1-24 months)	Education and activities to modify diet and/or increase physical activity and/or decrease sedentary behaviours	No consistent effect on adiposity, physical activity or dietary behaviours.	Insufficient evidence to support the effectiveness of using home-based interventions alone
(Nguyen, et al., 2011)	3	Children 8-11 years old	Home, school, camp or multi-setting (8-12 weeks)	Education and computer-based activities to modify diet and/or increase physical activity	1/3 interventions reported significantly lower adiposity. Some reported positive effect on dietary and physical activity behaviours (some NS).	Insufficient evidence to support the effectiveness of using electronic interventions alone

^a Number of intervention studies that aimed to prevent obesity in children up to 12 years of age included in the systematic review

^b Results of intervention compared to control group

^c Evidence was described as either inconclusive (studies too heterogenous or findings too inconsistent), or insufficient (too few studies) to support the effectiveness of the interventions
NS, statistically non-significant