Interventions to promote consumption of water and reduce consumption of sugary drinks
Building Solutions for Preventing Childhood Obesity

Module 1

Interventions to promote consumption of water and reduce consumption of sugary drinks

Prepared on behalf of the Prevention Research Centres:

NSW Centre for Overweight and Obesity
NSW Centre for Physical Activity & Health
NSW Centre for Public Health Nutrition

January 2008

This is one of a set of modules in the series Building solutions for preventing childhood obesity. Other modules are:

- Overview module
- Module 2: Interventions to increase consumption of fruit and vegetables in children
- Module 3: Interventions to reduce consumption of energy-dense, nutrient-poor foods
- Module 4: Interventions to promote eating breakfast
- Module 5: Interventions to increase physical activity in children 5 - 12 years
- Module 6: Interventions to increase physical activity in adolescents
- Module 7: Interventions to reduce sedentary behaviours

ISBN: 978-1-921186-06-6

Suggested citation:

Acknowledgements:
This series of reports has been a team effort. Thanks to Josephine Chau, Louise Farrell, Libby Hattersley, Lou Hardy, Debra Hector, Lesley King, Philayarath Phongsavan, Vanessa Shrewsbury, Siranda Torvaldsen and Adeline Yaw.

The NSW Centre for Overweight and Obesity, the NSW Centre for Physical Activity & Health and the NSW Centre for Public Health Nutrition are funded by the NSW Department of Health and supported by The University of Sydney.
Module 1 - Interventions to promote consumption of water and reduce consumption of sugary drinks

Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Background and methods</td>
<td>3</td>
</tr>
<tr>
<td>1.1 Overview</td>
<td>3</td>
</tr>
<tr>
<td>1.2 Search strategy</td>
<td>3</td>
</tr>
<tr>
<td>1.3 Exclusion and inclusion criteria</td>
<td>3</td>
</tr>
<tr>
<td>2  Problem analysis and rationale for intervention</td>
<td>4</td>
</tr>
<tr>
<td>3  Available intervention evidence</td>
<td>8</td>
</tr>
<tr>
<td>3.1 Modifying school environments</td>
<td>8</td>
</tr>
<tr>
<td>3.2 School-based education programs</td>
<td>9</td>
</tr>
<tr>
<td>3.3 Whole-of school approach</td>
<td>10</td>
</tr>
<tr>
<td>3.4 Modifying home environments</td>
<td>11</td>
</tr>
<tr>
<td>3.5 Parent and family-focussed programs</td>
<td>12</td>
</tr>
<tr>
<td>4  Evidence appraisal</td>
<td>14</td>
</tr>
<tr>
<td>4.1 Modifying school environments</td>
<td>14</td>
</tr>
<tr>
<td>4.2 School-based education programs</td>
<td>14</td>
</tr>
<tr>
<td>4.3 Whole-of-school approach</td>
<td>14</td>
</tr>
<tr>
<td>4.4 Modifying home environments</td>
<td>14</td>
</tr>
<tr>
<td>4.5 Parent and family-focussed programs</td>
<td>15</td>
</tr>
<tr>
<td>4.6 Clusters and gaps in the evidence</td>
<td>15</td>
</tr>
<tr>
<td>5  Promising and appropriate strategies</td>
<td>16</td>
</tr>
<tr>
<td>6  Implications for policy and practice</td>
<td>17</td>
</tr>
<tr>
<td>6.1 Implementation considerations</td>
<td>17</td>
</tr>
<tr>
<td>6.2 Portfolio approach</td>
<td>18</td>
</tr>
<tr>
<td>6.3 Translating evidence into cross-sector actions</td>
<td>18</td>
</tr>
<tr>
<td>7  References</td>
<td>19</td>
</tr>
<tr>
<td>8  Appendix. Tables summarising the available intervention evidence for reducing consumption of sugary drinks and increasing consumption of water.</td>
<td>22</td>
</tr>
</tbody>
</table>
1 Background and methods

1.1 Overview
This research report is one of a series presenting a synthesis of the recent evidence on the effectiveness of interventions to prevent weight gain and promote healthy weight among children and adolescents. This series of reports is designed to update the proposed approaches for children and families presented by the Centre for Public Health Nutrition report, “Best options for promoting healthy weight”.

The “Building solutions for preventing child obesity” report has been presented as a series of modules to reflect clusters in the evidence base, allow clear comparisons between similar interventions, and highlight promising approaches as well as gaps in the evidence. The methods used in preparing the report are also described in the ‘Overview Module’. The specific methods used in preparing this module on interventions to promote consumption of water and reduce consumption of sugary drinks are outlined below.

1.2 Search strategy
Studies and interventions promoting reduced sugary drink consumption and increased water consumption among children and adolescents (0-18 years), published between January 1997 and April 2007 in peer-reviewed journals were identified by searching the Medline, Pubmed and Cinahl databases and by consulting systematic reviews.

The databases were searched using the following search strategy to identify intervention evidence for this module:

(Intervention OR program) AND (child OR children OR adolescent) AND (Water OR soft drinks OR sweetened beverages OR sugary beverages OR sugary drinks OR fruit juice OR fruit drinks)

1.3 Exclusion and inclusion criteria
The following exclusion and inclusion criteria were applied to research papers identified through the search strategy:

Exclusion criteria:
- Articles on interventions or programs conducted prior to 1997
- Interventions targeting adults or young people aged 18 years or older
- Articles printed in a language other than English
- Sample size <16 participants.
- Studies focused on the treatment or management of overweight/obesity.
- Studies based in a hospital setting.
- Studies which included groups with special needs (e.g., physically disabled) or specific health conditions (e.g., diabetes).

Inclusion criteria:
- Articles printed in English
- Articles published between January 1997 - September 2007
- Studies targeting children aged 0-18 years
- Studies with population-level focus.
- Studies with individual-based approaches.
- Studies with randomised controlled trial (RCT) or quasi-experimental designs.
- Post-only designs or studies with no controls were considered on a case-by-case basis.
Module 1 - Interventions to promote consumption of water and reduce consumption of sugary drinks

2 Problem analysis and rationale for intervention

High and increasing consumption of sugary drinks are considered to be factors contributing to the prevalence of overweight and obesity amongst children and young people. Reducing consumption of these beverages may prevent inappropriate weight gain. One approach to reducing the consumption of sugary drinks is to focus on the increased consumption of water.

This review module summarises the available scientific evidence on patterns of beverage consumption, links between consumption of sugary drinks and weight status and the effectiveness of interventions to increase water consumption and/or reduce consumption of energy-dense drinks. This module does not cover the marketing of soft drinks or interventions to limit or regulate food marketing.

Assessing the intervention evidence gathered for this module was complicated by the varying definitions and terminology used for the various beverage types (see Table 1). Table 1 outlines the terms and definitions used in the literature when referring to sugary beverages.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definitions used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar-containing beverages</td>
<td>Still and carbonated soft drinks, juice-based beverages, 100% fruit juices, and flavoured milk</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>Generally used to refer to carbonated beverages, and more specifically sugar-sweetened carbonated beverages, in Australia</td>
</tr>
<tr>
<td>Sugar-sweetened beverages (SSBs)</td>
<td>Soft drinks, juice drinks containing &lt; 100% juice, punches, lemonades, iced teas, and sports drinks</td>
</tr>
<tr>
<td>Sugary drinks</td>
<td>Refers to all above in a shorthand fashion</td>
</tr>
</tbody>
</table>

The term “sugary drinks” will be used throughout this review module when referring to all sugar-containing beverages, sugar-sweetened beverages (SSBs), or soft drinks.

2.1 Do sugary drinks contribute to weight gain?

The World Health Organization (WHO) report ‘Diet, nutrition and the prevention of chronic diseases’, in 2003, classified the scientific evidence on the association between sugary drink consumption and increased risk of obesity as probable. The dose-response relationship between sugar-sweetened soft drink consumption and weight gain supports causation. More recently, other researchers have summarised studies indicating the strength of the relationship between sugary drink consumption and weight. A systematic review concluded that there is strong evidence from epidemiologic and experimental studies to indicate that greater consumption of sugary drinks is associated with weight gain and obesity. Similarly, another review considered that there is reasonable evidence that a high intake of soft drinks is associated with a greater risk of weight gain and obesity. Also, a recent systematic review and meta-analysis of eighty-eight studies found clear associations between soft drink consumption, increased calorie intake and body weight. The authors of this review concluded that recommendations to reduce population soft drink consumption are strongly supported by the available science.

There is however debate about the strength of this relationship. A recent review concluded that the evidence on this topic was equivocal and that unsatisfactory methodological rigour in many of the experimental and prospective studies made it difficult to draw firm conclusions. The limitations of these studies, many of them cross-sectional, have been highlighted.
Most of the reviews available describe the effect of sugary drink consumption on weight gain and obesity in children older than five years, particularly adolescents and adults. There is paucity of evidence in the under-five year age group.

It has been argued that sugar-sweetened carbonated beverages and electrolyte drinks make the largest overall contribution to the consumption of sugary drinks in children and adolescents. These well identified, readily available and aggressively marketed products are often singled out in the link between consumption and overweight and obesity. The authors also add that “other sugar-sweetened beverages such as cordials and sweetened fruit drinks, which are consumed more regularly by young children, would have a similar impact on energy and nutrient intake”.

Four recent studies (not included in the reviews above) have examined the effect of fruit juice on weight gain in children and adolescents. Comparability between the studies is reduced due to the varying definitions used. The two Australian studies considered ‘fruit juice’ to include sweetened fruit drinks, while the two US studies analysed 100% fruit juice intake separately.

One of the US studies examined the relationship among 2801 children aged 1-4 years, recruited from Women, Infant and Children (WIC) clinics. After controlling for gender and ethnicity, the relationship between 100% juice intake and adiposity (fat) gain was found to be dependent on initial overweight status. In already overweight children, each additional serving of fruit juice daily was associated with an excess adiposity gain of 0.009 SD per month. In contrast, no association was found between type of beverage consumed (including 100% fruit juice) and the weight status of preschoolers using data from the National Health and Nutrition Examination Survey (NHANES) 1999-2002 in the US.

A longitudinal study in NSW involved 268 children with a mean age of 7.7 years at baseline and 13 years at follow-up. This study showed that, among those children who were overweight or obese at baseline, median carbohydrate intake from soft-drink or cordial was 10 g per day higher at follow-up than among those children with an acceptable BMI at baseline and follow-up. They concluded that intakes of soft drink or cordial in mid-childhood, but not fruit juice/fruit drink and milk, were associated with excess weight gain in early adolescence. In a study in south-west Victoria, ‘soft drinks’ were classified as non-diet carbonated beverages, ‘fruit juice/fruit drink’ as 100% fruit juice/diluted fruit juices (fruit drink), and ‘cordials’ as energy-containing flavoured mineral water and sports drinks. Of the 1944 kindergarten and primary school students studied, those who drank more than 3 glasses of soft drink the previous day were more than twice as likely to be overweight/obese than those who did not consume soft drinks. Children who had more than 2 servings (more than 500 ml) of fruit juice/fruit drink the previous day were more likely to be overweight/obese than children who did not, with the odds increasing as the amount of fruit juice/drink consumed increased. It was concluded that the intake of sugary drinks was associated with overweight and obesity in Australian primary school aged children and that these drinks should be a target for intervention programs aimed at preventing unhealthy weight gain in children.

2.2 How could sugary drinks contribute to weight gain?

The hypothesised mechanisms by which sugary drinks cause weight gain is their contribution to excess energy intake. There is usually no compensation for the energy intake from such beverages (through reduced energy intake from other dietary sources) therefore consuming sugary drinks leads to an overall increase in energy intake. Some experimental evidence supports this hypothesis. Energy-rich fluids have low satiating properties compared with solids and it is proposed that this leads to a lack of compensation for the energy intake. Other possible mechanisms include the glycemic load of sugary drinks, and the displacement of milk with sugary drinks in the diet.
However, a recent review disputes the evidence for a causal link between consumption of sugary drinks and weight gain, based on physiologic and metabolic grounds.\textsuperscript{8} The reviewers contend that the effect of sugar consumption on body weight should not continue to be framed in biological terms, but also depends on behavioural intent, context, and the mode of use, availability and cost of sweetened liquids. Indeed they conclude that the obesity-promoting capacity of different beverages is linked not so much by their sugar content (which is often the same — for example, caloric cola, orange juice and 1% fat milk have equivalent energy density; about 0.4 kcal/g), but by their low price. Taste is likely to be another factor.

Much of the controversy and debate around the relationship between beverages and weight gain and obesity, and possible underlying mechanisms, may result from the inclusion of different types of sugary drinks in the various studies and discussions.

### 2.3 Patterns in the consumption of sugary drinks

Sugary drinks are energy-rich and nutrient-poor so are classified as ‘extra’ foods in The Australian Guide to Healthy Eating to distinguish them from nutrient-dense core foods.\textsuperscript{17} ‘Extra’ foods should be consumed in small amounts on an occasional basis. They are not needed to fulfill the nutrient requirements of children and adolescents in Australian.\textsuperscript{18} ‘Choose water as a drink’ is one of the Australian dietary guidelines for children and adolescents.\textsuperscript{17}

At the population level in Australian, Rangan and co-workers have shown that 35% of children aged 2-18 years consumed sugar sweetened soft drinks in the previous 24-hour period of the 1995 National Nutrition Survey in 1995.\textsuperscript{18} Consumption of sweetened soft drinks was found to increase with age; adolescents between 16-18 years of age gained 5.5% of their total energy intake from sweetened soft drinks, and this figure increases to 10.8% of total energy intake after adjusting for non-drinkers. This compares with data from the US where in 2001 soft drinks accounted for 9.2% of daily energy intake in children older than 2 years.\textsuperscript{19} Another 7.3% of energy was supplied by fruit juices and milk.\textsuperscript{18}

The diets of 429 young children, with a mean age of 18.9 months, were examined in a study in western Sydney.\textsuperscript{20} The researchers showed that the children consumed 157 g of ‘extra foods’ daily and that the greatest quantity was from non-milk sweetened beverages. This grouping included cordials, soft drinks and fruit drinks but excluded 100% fruit juice.\textsuperscript{20}

In another Australian survey at the local level it was shown that 23% of young children reported having ‘soft drinks’ yesterday, although the majority of children did not usually consume soft drinks more than once per week (68.9%).\textsuperscript{12} Also, 74% had at least one glass (250 ml) of fruit juice/fruit drink on the previous day, with 23% consuming more than 3 servings.\textsuperscript{12}

It has been reported that children consuming a lot of soft drink may also have other poor dietary or lifestyle habits, such as eating less fruit and vegetables or exercising less.\textsuperscript{18} Also, in middle-school children, both school vending machine use and fast-food restaurant use are associated with overall sugar-sweetened beverage intake.\textsuperscript{21}

### 2.4 Rationale for intervention

Overall, the evidence indicates that sugary drinks, possibly including fruit juice in younger children, represent a potential target for interventions aimed at reducing obesity prevalence in children.

In addition to reducing energy intake, reducing sugary drink consumption would lead to two other important public health gains. Decreasing children’s intake of these beverages is likely to lead to a reduction in tooth decay. Several authors have pointed to a reduction in sweetened beverage intake, particularly soda consumption, as having the potential to decrease dental caries in children.\textsuperscript{22} For example, in one study a high consumption of carbonated soft drinks, as opposed to milk, water or juice, was associated with a significantly increased risk of dental caries in the primary dentition.\textsuperscript{23}
Also, reductions in sweetened beverage consumption are likely to improve the micronutrient intake of the population. Soft drink intake is associated with lower intakes of milk and thus calcium. For example, soda consumption has been found to be associated with a statistically significant decrease in calcium intake.\textsuperscript{24} The researchers highlighted that, because milk provides an important source of calcium in the diets of children and adolescents, the decline in girls' milk consumption at a time when bone mineral deposition may predispose to eventual osteoporosis is a major concern.\textsuperscript{24}

In summary, changes to beverage intake in Australian children from sugar-sweetened drinks and fruit juice to low-fat milk and water would likely result in a reduction total energy intake, improve micronutrient intake and reduce dental caries.
3 Available intervention evidence

A total of eight primary intervention studies that targeted water and/or sugary drink consumption in children or adolescents were identified from the literature. Three of these studies were conducted in the United States (US), two in the United Kingdom (UK), one in Belgium, one in New Zealand, and one in Australia (Victoria). No reviews of the evidence were identified.

Intervention design and protocol, setting, target age-group, outcome variables, and results differed markedly between studies. In the following discussion of the evidence, the eight individual studies are:

- Modifying school environments
- School-based education programs
- Whole-of-school programs
- Modifying home environments
- Parent and family-focused programs

The individual studies are also summarised in Appendix 1.

3.1 Modifying school environments

3.1.1 Increasing availability of water fountains in school

An intervention conducted in three secondary schools (two intervention; one control) in the UK aimed to increase water consumption and decrease soft drink consumption through the provision of cool filtered water in school cafeterias. One intervention school received two water coolers and students were educated about the health benefits of drinking water and how to access it through school assemblies, one forty-five minute tailored lesson and discussion per class, posters, promotional pencils and water bottles. Sports personalities attended school assemblies to help with promotion. A second intervention school also received two water coolers but without complementary education or promotion strategies. A third school acted as a control. Soft drink sales and water provision were assessed in each school for one month prior to the intervention, throughout the one month intervention period, and for two months post-intervention. Volume of water taken from coolers in the two intervention schools was measured by flow meter. Post-intervention, the average increase in water taken among students in the school that received water provision along with education and promotion was 90ml per day, significantly higher than the average increase observed in the school that received water provision without education or promotion (20ml), and in the control school (5ml). The strength of the effect was limited (P=0.05). The intervention had no significant effect on soft-drinks sales.

Appraisal

The three schools involved in this study were selected specifically from low socio-economic areas, thereby recognising health and economic disparities regarding affordable access to clean drinking water. The three schools were well separated geographically, reducing the risk of contamination between treatment groups. However, this study involved a number of major limitations including a very short intervention period (1 month) and low intervention intensity. Only two water coolers were provided per intervention school, each of which had school rolls of approximately 1,000 students, and only one 45 minute classroom education session was conducted in the first intervention school. Further, the study assessed soft drink sales and water taken from the coolers, rather than actual beverage consumption. The intervention effect was small, and students in the intervention schools continued to purchase the same amounts of soft drinks following the intervention. Therefore, it is unlikely that this intervention would have had any effect on energy intake. Further, the study team acknowledged that water coolers were not placed in prime positions in the schools. A positive aspect of this study was the post-intervention focus groups conducted with control-school students. The focus group discussions highlighted a strong desire among students for improved, affordable access to palatable water, and resulted in the instalment of a significant number of water coolers in this school post-intervention.
3.1.2 School environment changes with parental involvement

A cluster randomised controlled trial (RCT) aiming to promote healthy eating behaviours among adolescents combined environmental changes with parental involvement and computer-tailored feedback in fifteen schools in Belgium. The intervention was conducted over one school year (nine months) and involved 2,840 eleven-to-fifteen year olds. Target behaviours were fat, fruit, water and soft drink intake. The fifteen participating schools were randomly assigned to an intervention group with a parental support component, an intervention group without parental support, and a control group. School environment changes in the two intervention groups included reduced availability of soft drinks, increased availability of water at drinking fountains, and preferential pricing of water compared to soft drinks in canteens and vending machines. Students in the intervention schools also received interactive personalised computer-feedback regarding their fat and fruit intake. The parental support component was comprised of an interactive meeting at school, and information disseminated through the school paper and newsletters. Food and drink intake was assessed pre and post-intervention by food frequency questionnaire. Mean self-reported soft drink intake was high at baseline (3 glasses/day), however no intervention effects were observed for soft drink or water intake. The only outcome measure significantly changed by this program was fat intake among girls in the intervention group which received parental support.

**Appraisal**

While this intervention had a relatively large sample size and high participation rate, the study team felt that the lack of computer-tailored feedback for soft drink and water consumption may have resulted in an intervention of insufficient intensity to observe an effect on these behaviours. The main limitation of the study was the use of self-report to assess dietary intake, which may have introduced reporting bias. As a result, the findings should be treated with some caution.

3.2 School-based education programs

3.2.1 The CHOPPS study

The CHOPPS (Christchurch Obesity Prevention Project in Schools) study was a low intensity classroom-based intervention conducted in the UK with 644 primary school students (aged seven-to-eleven years). The intervention aimed to reduce intake of all carbonated drinks (sweetened and unsweetened) as a means of preventing inappropriate weight gain. In a cluster RCT design, classes in six primary schools were randomly assigned to the intervention and control groups. One classroom-based education session was conducted within the intervention classes each term for one year. The interactive sessions were one hour in length, utilised group discussion, projects and games, and were led by the primary investigator with assistance from teachers. During the sessions, water and diluted fruit juice were promoted as alternative beverage options. Students were encouraged to access further information on a tailored website. Main outcome measures were beverage consumption (self-report using three day drink records) and body mass index (BMI), assessed at baseline and post-intervention twelve months later. No significant difference in change in caloric carbonated soft drink intake was observed between the two groups, although the intervention classes did significantly reduce their mean intake of caloric and diet carbonated soft drinks when analysed together (P=0.02). Surprisingly, mean intake of water increased by 2.2 glasses in the control group (P=0.003), compared with 1.1 glasses in the intervention group. No significant difference in change in mean BMI or Z-score pre and post-intervention was observed between the groups. The mean prevalence of overweight (>91st percentile) decreased marginally in intervention classes (0.2%), compared with an increase of 7.5% in control classes, leading to a mean difference in change in prevalence of overweight of 7.7% between groups.

**Appraisal**

The differences between change in prevalence of overweight in the intervention and control groups could not be attributed to a decline in the consumption of caloric soft drinks, as this behavioural effect was not detected. However, intervention outcomes may have been restricted by relatively low mean baseline consumption of sugary drinks among participants (~1-2 glasses/3 days), and a very low intervention intensity (four one-hour sessions in total over a period of twelve months). It is possible that more significant results could have been achieved among children with higher baseline sugary drink intake, and/or a more intensive intervention.
3.2.2 The Apple Project

The Apple Project (A Pilot Programme for Lifestyle and Exercise) was a two-year pilot nutrition and physical activity, school-based intervention program conducted in Otago, New Zealand aimed at preventing excessive weight gain among five-to-twelve year old children. The intervention focussed on a non-curricular physical activity program run by designated activity coordinators (at recess, lunchtime and after school) and a nutrition education component promoting reduced consumption of sweetened drinks, and increased consumption of fruit and vegetables. Nutrition education initiatives included science lessons highlighting the adverse health effects of sugary drinks and a healthy eating resource. Cooled water filters were also provided in intervention schools. A total of 730 children from four intervention and three control schools participated in the study, with measured height, weight, waist circumference and blood pressure, and diet and physical activity assessments taken at baseline, end of year one, and immediately post-intervention (end of year two). Dietary intake was assessed using three-day validated short food frequency questionnaire. Study subjects were predominantly Caucasian (83%), with smaller numbers of Maori (16.5%) and Pacific Islander (<1%) subjects. Immediately post-intervention, children in the intervention schools reported consuming significantly fewer carbonated beverages (P=0.04), fruit juice or drinks (P=0.03) and total sweet drinks (P=0.02) than control children, although this was primarily due to increases in consumption of sweet drinks (carbonated beverages, fruit juice and drinks and flavoured milk) in the control group rather than decreases in consumption in the intervention group. Analysed individually, flavoured milk and water consumption did not differ significantly between groups (P=0.22 and P=0.07 respectively). Mean BMI Z-scores and measured waist circumference were significantly lower in intervention than control children post-intervention, although differences in prevalence of overweight were not significant between the two groups once adjusted for baseline values. Subgroup analyses showed that BMI reductions in the intervention group were only observed in children who were not overweight at baseline.

Appraisal

While this pilot intervention study is one of only a few to have reported measured values for children’s BMI and waist circumference, it was too small and had insufficient statistical power to determine which individual component(s) of the programme led to the observed differences in outcome measures. While the measured evaluation components had a high response rate (81-92%), the nutrition component involved response rates of only 62% at year one and 66% post-intervention. As a result the nutrition-related outcomes should be interpreted with caution. While only three subjects were recorded as officially dropping-out of the study, 260 students were excluded from the final evaluation due to being present at only one measurement point. Other limitations of the study were the non-random selection and assignment of schools and the delay of the nutrition intervention components until year two of the study. Further, the intervention did not appear to significantly improve BMI Z scores in children who were already overweight. A major strength of the study was a concurrently-run process evaluation which indicated positive feedback from the school communities, and may be used to develop follow-up analyses.

3.3 Whole-of-school approach

3.3.1 Health Promoting Schools framework: Fresh Kids

The one program conducted in Australia that is aimed at addressing beverage intake and has been reported in the literature has built on the Health Promoting Schools (HPS) framework focussing on organisational change. This program, ‘Fresh Kids’, aims to influence dietary consumption of fruit, water and sweet drinks among inner-west Melbourne primary school students. The Fresh Kids program has been implemented in thirty-five primary schools to-date however a recent outcome evaluation has been presented for only four of these schools. The four schools are located in culturally diverse and socio-economically disadvantaged urban areas,
with between 30-90% of the student roll in each school from culturally and linguistically diverse backgrounds. Participating schools implemented changes in three main domains: school-home-community interaction and partnerships; school organisation, ethos and environment; and school curriculum, teaching and learning. Intervention strategies included free seasonal fruit weeks (two to four times per year), scheduling of classroom ‘fruit breaks’, nutrition curriculum activities including market tours and taste-testing, distribution of student-designed water bottles, monthly nutrition newsletters sent home to parents, bilingual parent nutrition education sessions, and development of school fruit and water policies (including banning soft drinks in classrooms). Lunchbox audits were conducted in all participating schools at baseline and periodically during program implementation. Two schools (A,B) were followed for a period of two years, and two schools (C, D) which joined the study later, were followed for nine months. There was a significant increase in the observed proportion of children bringing filled water bottles to school at the end of the two-year study period (all schools reported increases of between 15-60%), and a significant decrease in the observed proportion of children bringing sugary drinks to school or ordering them from canteen (reported decreases of between 8-38%). These significant changes were sustained over the two years of follow-up.

**Appraisal**

Positive aspects of this study included use of a whole-of-school approach and well-coordinated program management (external program coordination by a community dietician and a lead teacher nominated within each school), which are both likely to have contributed to the success of the program. In addition, the study had a high response rate (in all but one instance - School A’s baseline audit - the lunchbox audits included all available eligible students in each school) and a relatively long study period (two years). Parents were not informed of the lunchbox audit dates, reducing the possibility of social desirability bias. Methodological limitations of this study included lack of a control group for comparison, and the inconsistent collection of data (lunchbox audits were conducting periodically rather than in a planned manner). The researchers noted that data collection for sweet drinks was less consistent than for fruit and water, therefore the trend for this outcome measure was less clear. In addition lunchbox audits are a measure of what children bring to school, rather than what they actually consume, and are unlikely to account for any food or beverages purchased from the school canteen or consumed outside of school hours.

**3.4 Modifying home environments**

**3.4.1 The Beverages and Student Health (BASH) study**

An intervention study aimed at reducing the intake of sugary drinks among high-school students in the US involved home delivery of non-caloric beverages (including ‘diet’ beverages and bottled water), along with written educational information and telephone counselling. In this twenty-five week pilot study, 103 students aged thirteen-to-eighteen years who regularly consumed soft drinks (at least one 360ml serve/day), and their families were randomly assigned to intervention and control groups. The primary outcome measure in this study was change in sugary drink consumption, measured by twenty-four hour dietary recall (two at baseline and two post-intervention), and the primary end-point was change in body mass index (BMI). Post-intervention, energy intake from caloric beverages had reduced by 82% in the intervention group (P<0.0001), and did not change in the controls. No significant difference in overall BMI change adjusted for age and gender was observed between groups, however adolescents in the intervention group with a high baseline BMI, in the upper-tertile (>25.6 kg/m²), did show a significant positive change compared with controls (P=0.03).

**Appraisal**

While demonstrating the potential for behaviour change as a result of the provision of free alternatives to sugary drinks in the home environment, the sample size in this study was small (n=103), and the intervention would be highly resource intensive to implement at a population level. In addition, while the positive change in sugary drink intake observed in the intervention group is promising, the intervention was relatively short-term (twenty-five weeks), providing limited evidence for the long-term effectiveness of this strategy. While a reduction in BMI was only observed in intervention participants who were in the uppermost tertile for BMI at baseline, the short intervention duration would have limited the potential for a significant change in BMI overall to be observed. Positive aspects of this study were its high retention rate (100%) and the use of process evaluation.
3.5 Parent and family-focused programs

3.5.1 USA FIT WIC

A one-year, prospective pre-test post-test intervention study in the US examined the effect of parent nutrition education on, amongst other behaviours, the frequency of parents offering their preschool-aged children water, rather than sugar-containing beverages (including 100% fruit juice), as a drink. Parents attending Special Supplemental Nutrition Program for Women, Infants and Children (WIC) clinics were non-randomly assigned to either an intervention (n=185) or control group (n=151). Control parents participated in the standard WIC program, involving six educational group sessions and two individual contacts over the course of one year. Parents in the intervention group received an equivalent number of contacts, however the six group and two individual sessions targeted six specific behaviours to promote physical activity and improve diet. The health messages were reinforced with on-going community-based promotion through collaborating organisations. Intervention outcomes were measured by parent self-report. Immediately post-intervention, parents in the intervention group were significantly more likely to report increased frequency of offering their child water instead of sweetened drinks (P=0.005). The only other behaviour to be reported with significantly higher frequency in the intervention group compared with controls post-test was parental engagement in active play with their child (P=0.009).

Appraisal

The FIT WIC intervention was of moderate intensity and duration, focused on socio-economically disadvantaged families and was delivered within existing health service infrastructure. Another major strength of the study was the use of a process evaluation, which confirmed program feasibility and acceptability. However, participants were not randomly assigned to the intervention and control groups, therefore it is possible that differences between the two groups were present at the start of the intervention, and conclusions about causality cannot be drawn. In addition, while there was moderately good retention of participants in the intervention group over the one year period (65%), a much lower retention rate was observed in the control group (43%). Other key limitations of the FIT WIC study were that it relied on subjective self-report from parents and did not actually measure children’s beverage consumption, the measures used were not validated, and there was no long-term follow-up period. While they did not report the actual costs, the authors of the study noted that the intervention was time- and cost-intensive, requiring additional staff time to contact community partners, educate WIC staff in the use of the prepared materials, and mentor staff. Another potential issue was the intervention goal of replacing fruit juice with water. This might have seemed contradictory to parents in the WIC program, which provides juice as part of a monthly food package. Finally, Hispanic participants made up 54% of the study sample and reported the greatest increases in frequency of offering water instead of sweetened beverages, limiting the applicability of the results to the NSW context.

3.5.2 Memphis GEMS

GEMS (Girls health Enrichment Multi-site Studies) is a multi-centre research program created to assess the effectiveness of nutrition and physical activity interventions at preventing excess weight gain in pre-adolescent African-American girls. In phase one of the program, four field centres independently developed and assessed their own pilot interventions following a set of common eligibility criteria and key measurements. All centres implemented their interventions for twelve weeks using an RCT design.

One of the four phase one trials, the Memphis GEMS pilot study conducted in Memphis, Tennessee, included a beverage behaviours component. This small, culturally-tailored, family-based pilot trial targeted both dietary and physical activity behaviours and involved fifty-four girls aged eight-to-ten years and their parents/caregivers. All participants had a baseline BMI greater than or equal to the highest 25th percentile of the Centres for Disease Control (CDC) growth charts, and the majority of participants were from low-income households. The principal objective of the pilot study was to assess the feasibility of the intervention approach and to determine its level of promise for preventing excess weight gain. One of the study’s nutrition objectives was to increase water consumption and reduce sweetened beverage intake. Participants were randomised to one of three arms: a child-targeted intervention with girls-only,
a parent-targeted intervention with parents-only, and a control group which focussed on self esteem. The child-targeted intervention (‘GEMS Jamboree’) consisted of weekly ninety minute interactive sessions, encompassing nutrition (Munchin’ It), and physical activity (Movin’ It) components. Nutrition activities included group discussions on healthy eating, taste-testing and food preparation, food art, a modified farmer’s market and label reading. The parent-targeted intervention (EASY - ‘Eating and Activity Skills for Youth’) also involved weekly ninety minute sessions. The control group participated in three meetings (once per month) designed to enhance self-esteem, through art and crafts, and games. Girls’ food and drink intake was assessed by two twenty-four hour recalls conducted on non-consecutive days at baseline and post-intervention. Girls’ height, weight, waist circumference, percentage body fat, insulin sensitivity and glucose levels were also assessed at baseline and post-intervention, although the study was not designed to have sufficient statistical power to detect changes in physical measures.

Post-intervention, girls in the two treatment groups, when averaged, had decreased their intake of sweetened drinks by 34% relative to controls (P<0.05). When the treatment groups were analysed separately, the intervention effect on sweetened drink consumption was significant only in the parent-targeted group compared with the controls (P=0.0087). The parent-targeted group also showed more positive trends towards increased physical activity and lower caloric intake from fat compared with the child-targeted group. No significant effect on water intake was observed in either treatment group. Girls in the two treatment groups combined did show a trend towards decreasing BMI and waist circumference, although this was not significant. Process evaluation showed that the intervention was well received and the vast majority of participants were satisfied with their participation in the program. The study team noted that many participants indicated that they would have preferred a joint parent-and-child intervention, and this approach was recommended for incorporation into Phase 2 of the GEMS trial. It was noted that there may be possible cultural differences in preferences for, and the effectiveness of, this particular approach.

Appraisal
The short duration and small sample size of this study limits the conclusions that can be drawn regarding its potential long-term effectiveness, although the primary objective of the study was to assess the feasibility and acceptability of the program design rather than effectiveness. Strengths of this study included its theoretical grounding in Social Cognitive Theory (SCT), the conduction of an initial twelve week feasibility study to pre-test the intervention strategies, comprehensive training of the intervention team, and the provision of child-care during parent-targeted sessions. The study also had very high retention (100%) and participation rates (88% attended at least 80% of scheduled sessions), likely due to the cash incentives provided to participants for completing baseline and follow-up assessments. The study targeted African-American girls and their families and had culturally-specific components, therefore some modifications to the approach and strategies used may be necessary to be applicable to the NSW context.
4 Evidence appraisal

A very limited number of intervention studies aimed at changing consumption of sugary drinks and/or water among children and adolescents are currently available. The eight intervention studies identified in this review offer only limited evidence for the effectiveness of interventions aimed at this behaviour as methodological flaws have restricted the usefulness of the findings of all of the studies. Nevertheless the programs provide some insight into promising approaches for designing and planning interventions to reduce consumption of sugary drinks and/or increase consumption of water.

4.1 Modifying school environments
Increasing the availability of water coolers in schools was shown to positively influence student’s water consumption in the UK, particularly when delivered in combination with promotion and education strategies, however the impact was small and there was no impact on soft drink sales. Therefore, while dietary intake was not measured, it is unlikely that this study would have reduced actual energy intake. A more intensive intervention conducted in Belgium addressed both water and sugary drink consumption using complementary strategies, but had no impact on either sugary drink or water consumption.

These two studies therefore offer little evidence for the effectiveness of modifying school environments, and highlight the challenge of encouraging water as a drink as an alternative to, not in addition to, sugary drinks.

4.2 School-based education programs
While school-based nutrition education addressing the benefits of replacing sugary drinks with water is likely to be a worthy strategy, the two studies to have assessed this approach, the CHOPPS and APPLE studies, suffered from significant methodological limitations and were both of insufficient intensity to detect an effect.

The effectiveness of this approach would likely be greatly enhanced by concurrently-run strategies to reduce availability of sugary drinks and improve access to palatable water within and around schools. Water filters were installed in intervention schools in the APPLE project, however the findings from this study were inconclusive.

4.3 Whole-of-school approach
The Fresh Kids program offers some promising evidence for the effectiveness of the Health Promoting Schools framework at addressing beverage behaviours, at least during school hours. While the program had substantial methodological limitations, it was effective in decreasing the amount of sugary drinks and increasing the amount of water brought to school by children in participating primary schools over a period of at least two years. The effectiveness of this program was likely greatly enhanced by the promotion of a whole-of-school approach, rather than focusing on one or two discrete strategies. By using a combination of school organisational, environmental and policy change, school-home-community partnership strategies, and curriculum and learning strategies, the Fresh Kids program provides an example of good practice in program design.

4.4 Modifying home environments
The BASH study offers some evidence for the effectiveness of providing bottled water and sugar-free soft drinks for free in children's homes as a means of reducing energy intake from sugary drinks, however this approach is not considered to be applicable or appropriate on a population scale. The limitations of this approach at the population level include cost, environmental impact and the fact that this approach does not encourage healthy drinking habits – sugar-free soft drinks still contain high levels of teeth-damaging acids, and in the case of cola drinks, caffeine.
There is potential to translate the BASH strategy to a more feasible and sustainable approach, such as encouraging and supporting parents to replace sugary drinks with low-energy drinks and/or water in their home. There is limited evidence available to support this approach, although it was used in the FIT WIC program (see below).

4.5 Parent and family-focussed programs
The two parent and family-focussed programs identified in this review, USA FIT WIC and Memphis GEMS, produced encouraging results, indicating the potential of education of parents as a means of changing drinking behaviours of children across age groups. The FIT WIC program successfully increased the self-reported frequency of parents offering their preschool-aged children water as a drink, although actual intakes were not measured, while the parent-targeted education group in the Memphis GEMS program significantly reduced consumption of sugary drinks in adolescent African-American girls.

4.6 Clusters and gaps in the evidence
Many of the intervention programs aimed at reducing consumption of sugary drinks and/or increasing consumption of water have been implemented overseas and in the school setting. Further exploration of strategies involving home and community settings are required, as are programs specifically targeted towards teenagers. Interventions delivered using electronic media, including the internet and mobile phones, have the potential to be appropriate, cost-effective and sustainable strategies for reaching large numbers of this age group. This has been demonstrated by formative research aimed at other health behaviours (diet, smoking and physical activity) in young people.

While interventions to encourage water intake have shown some success, it is not clear whether this behaviour, i.e. consumption of more water, results in a commensurate reduction in consumption of sugary drinks. Further investigation of this issue is required. In addition, while several of the school-based intervention studies available addressed availability of sugary drinks and water within school environment, there is a high probability that children compensate by drinking sugary drinks more excessively outside of school hours. Indeed, any changes to school environments will likely be undermined by the ready availability of sugary drinks, particularly soft drinks, and the inadequate availability of affordable, palatable water, in areas surrounding schools and at recreational facilities and grounds. Therefore, interventions that address the availability of drinks in areas surrounding schools and that measure the consumption of all drinks or liquids over the entire day (not just during school hours) need to be conducted using reliable measurement methods.
5 Promising and appropriate strategies

A small range of strategies targeting children’s behaviours relating to drinks have been outlined in this report. Overall, the mix of evidence continues to suggest that interventions to replace consumption of sugary drinks with water are worthwhile pursuing, as they are undoubtedly relevant, likely to be broadly acceptable and potentially effective to some extent.

Table 2. Strategies and level of promise shown in the evidence

<table>
<thead>
<tr>
<th>5.1 Promising and appropriate strategies based on the available evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent and family-focussed education strategies to promote replacement of sugary drinks with water consumption</td>
</tr>
<tr>
<td>Whole-of-school strategies to promote replacement of sugary drinks with water consumption</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.2 Strategies worthy of consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modifying school environments to increase availability of water and reduce availability of sugary drinks</td>
</tr>
<tr>
<td>Promoting attitude changes to reduce the availability of sugary drinks in the home environment</td>
</tr>
<tr>
<td>School-based education to promote water and reduce consumption of sugary drinks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.3 Gaps in the evidence and priority areas for future research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions to promote water and reduce consumption of sugary drinks specifically targeted towards adolescents</td>
</tr>
<tr>
<td>Interventions that address availability of sugary drinks in areas surrounding schools and at recreational facilities</td>
</tr>
</tbody>
</table>
6 Implications for policy and practice

The accumulating data on patterns of consumption, contributions to energy intake and links to weight status continue to suggest the potential for addressing sugary drink consumption as part of obesity prevention efforts. The evidence from intervention research is limited at this stage, but illustrates a number of promising approaches including whole-of-school approaches and/or parent involvement. These strategies should be considered as priorities for implementation, while further research evidence is required to assess the effectiveness of other approaches, such as school-based education, and strategies to address beverage availability in the home and community environments.

There are many future opportunities to explore, including:

• the development and promotion of education strategies and messages for health professionals, school teachers and childcare staff;
• the promotion of messages to school teachers about the value of implementing classroom education to support canteen and school policies;
• developing and implementing parent-education programs;
• implementing and evaluating environmental strategies to promote the replacement of sugary drinks with water in both school and non-school settings; and
• connecting with local businesses and councils to enhance the effectiveness of school-based programs.

The major findings from this review of the evidence is the importance of continuing to develop and evaluate promising interventions within a wider range of target groups and settings and using methodologically rigorous research approaches.

6.1 Implementation considerations

From the evidence reviewed in this module, a number of key best practice principles appear to enhance potential for program effectiveness and long-term success. These include:

• interventions employing a mix of strategies that complement and reinforce each other (i.e. a combination of organisational change, environmental modifications, and education and promotion);
• interventions that target children with their parents/families;
• interventions that address energy-balance (i.e. promote replacement of sugary drinks with water, rather than promote water only);
• high quality interventions of sufficient size, duration and intensity to detect an effect and determine the extent to which these effects are, or are not, maintained over time; and
• interventions which address availability of beverages both within and outside of schools (i.e. areas surrounding schools, recreational facilities, home).

As the majority of the interventions discussed in this module were conducted overseas and many were tailored to specific communities and population groups, modifications will be required when translating these approaches to the NSW context. It will be important to conduct thorough expert and stakeholder consultations and pilot-testing to ensure that modified approaches are feasible and appropriate for implementation in NSW.
6.2 Portfolio approach
It is well recognised that no single intervention alone will be effective in improving children’s diets to a degree that impacts on population level obesity rates. Multiple and complementary approaches are required, and decisions about which particular strategies to include in any portfolio of interventions will depend on the needs of the target population as well as the capacity of the communities and/or organisations implementing them. Generally, the implementation and effectiveness of programs will be enhanced by supplementary initiatives, such as communication and public education through local media and other channels, promotion and reinforcement through health professionals’ capacity to opportunistically provide accurate information and consistent advice.

6.3 Translating evidence into cross-sector actions
In table 3 approaches identified as promising or worthy of consideration have been interpreted into practical actions/programs that may be relevant to areas within NSW and Australia. The relevant sectors that could contribute to implementation have also been identified.

Table 3. Sectors that could contribute to the implementation of promising approaches

<table>
<thead>
<tr>
<th>Promoting water and reducing sugary drink consumption in children</th>
<th>DO</th>
<th>CONSIDER</th>
<th>GAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent and family-focussed education strategies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole-of-school strategies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modifying school environments to reduce consumption of sugary drinks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-based education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interventions with older children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interventions that address availability of drinks in areas surrounding schools and at recreational facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sectors: C - Community services, E - Education sector, H - Health, L - Local government, P - Planning
7 References


5. Gill TP, Rangan AM, Webb KL. The weight of evidence suggests that soft drinks are a major issue in childhood and adolescent obesity. There is much to be gained by reducing children's intake of soft drinks and little – except excess weight – to be lost. *Medical Journal of Australia* 2006; 184(6): 263-264.


Appendix. Tables summarising the available intervention evidence for reducing consumption of sugary drinks and increasing consumption of water.

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Control</td>
</tr>
<tr>
<td>IV</td>
<td>Intervention</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised Controlled Trial</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>F/U</td>
<td>Follow Up</td>
</tr>
<tr>
<td>N</td>
<td>Number of participants</td>
</tr>
<tr>
<td>n.s</td>
<td>Not significant</td>
</tr>
</tbody>
</table>
Table A1. Interventions that involved modifying the school environment

<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention description</th>
<th>Outcome variables</th>
<th>Key findings/ Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loughridge and Barratt 2005</td>
<td>Controlled pilot study</td>
<td>11 to 18 yrs n=2965</td>
<td>IV school 1: Received filtered water coolers for the cafeteria (W) and IV school 2: Same as school 1, plus promotion to students (W + P)</td>
<td>Change in average water taken (mls) from school provisions /student/day pre-intervention to post-intervention</td>
<td>Water taken from school provisions: ↑ ~90mls in IV school 2 vs. ~ ↑ 20mls in IV school 1 and ~ ↑5mls in C school (P=0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>School 3: Control, no water provided</td>
<td>Change in volume of soft drinks purchased/student/day – pre-intervention to post-intervention</td>
<td>Soft drink purchases: 87ml/student/day in C school vs. 57mls in IV school 1 and 43mls in IV school 2, not statistically significant</td>
</tr>
<tr>
<td>Haerens et al 2007</td>
<td>Cluster RCT</td>
<td>11-15 years n =2840</td>
<td>Aimed to promote healthy food choices (increase fruit consumption to at least 2 pieces per day; reduce soft drinks consumption and increase water consumption; reduce fat intake) and PA engagement</td>
<td>% children exceeding the fat intake of a max of 30% of energy from fat (fat intake – self-administered questionnaire)</td>
<td>No effect on self-reported consumption of fruit, water or soft drinks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 schools</td>
<td>Healthy Food Intervention:</td>
<td>Fruit intake (FFQ)</td>
<td>No process evaluation details provided</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Fruit sold once/week at low cost or provided free</td>
<td>Soft drinks (FFQ)</td>
<td>Soft drink consumption very high at baseline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced availability of soft drinks at school</td>
<td>Water (FFQ)</td>
<td>Authors felt that lack of personalised tailored feedback for soft drink and water consumption could have resulted in an insufficiently intensive intervention for these behaviours.</td>
</tr>
</tbody>
</table>
### Table A2. Interventions that involved school-based education programs

<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention description</th>
<th>Outcome variables</th>
<th>Key findings/ Outcomes</th>
</tr>
</thead>
</table>
| James et al, 2004  
Preventing childhood obesity by reducing consumption of carbonated drinks  
The Christchurch obesity prevention project in schools (CHOPPS) | Cluster RCT (class level not school level)  
One school year (Aug 2001- Oct 2002)  
Classroom-based  
UK | 7 to 11 yrs  
n=644 | IV: One hour interactive educational session per school term. Intake of carbonated drinks (sweetened and unsweetened) was discouraged and children were encouraged to switch to water or fruit juice diluted 1:3 with water. Children were encouraged to access further information on the project website.  
C: Not specified | Mean change in self-reported intake of carbonated drinks and water over three days  
Mean change in BMI z-score and prevalence of overweight or obesity over 12 months | Total carbonated drink intake over three days: ↓0.6 glasses in intervention classes (P=0.02) and ↑0.2 glasses in controls (P=0.4) (mean difference 0.7, 95% CI 0.1 to 1.3). No difference between groups in intake of carbonated drinks with sugar. Mean water intake increased by 1.1 glasses (95% CI 0.2 to 2) in the intervention classes (P=0.02) and 2.2 glasses (0.9 to 3.5) in controls (P=0.003) but the difference between groups was not significant  
BMI z-score: no difference between groups  
Mean prevalence of overweight or obesity (%): ↓0.2 in intervention classes vs ↑7.5 (mean difference 7.7, 95% CI 2.2 to 13.1) |
| Taylor et al., 2007  
APPLE Project: 2-y findings of a community-based obesity prevention program in primary school-age children | Non-randomized controlled pilot study  
Two years  
Primary schools (4 intervention, 3 control)  
New Zealand | 5-12 years  
n=730 (260 were excluded from final evaluation)  
Caucasian (83%), Maori (16.5%) Pacific Islander (<1%) | PA component: Non-curricular physical activity program run by designated activity coordinators (at recess, lunchtime and after school)  
Nutrition component: Nutrition education promoting reduced consumption of sweetened drinks, and increased consumption of fruit and vegetables. Strategies included science lessons highlighting adverse health effects of sugary drinks, a healthy eating resource, and provision of cooled water filters.  
PA (accelerometer)  
Time spent watching TV | Measured height and weight (BMI), waist circumference, blood pressure  
Self-reported food intake  
Post-intervention: Significantly lower intake of carbonated beverages (P=0.04), fruit juice and drinks (P=0.03) and total sweet drinks (P=0.02) in intervention than control children, although this was primarily due to increases in consumption of sweet drinks (carbonated beverages, fruit juice and drinks and flavoured milk) in the control group than decreases in consumption in the intervention group. Analysed individually, flavoured milk and water consumption did not differ significantly between groups (P=0.22 and P=0.07 respectively).  
Mean BMI Z scores and measured waist circumference: significantly lower in intervention than control children  
Difference in prevalence of overweight not significant once adjusted for baseline values.  
BMI reductions in the intervention group were only observed in children who were not overweight at baseline. |
## Table A3. Interventions that involved whole-of-school approaches

<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention description</th>
<th>Outcome variables</th>
<th>Key findings/ Outcomes</th>
</tr>
</thead>
</table>
| Laurence et al 2007     | Interrupted time series    | Primary school children                           | Aimed to evaluate the effectiveness of the HPS framework to increase fruit and water consumption among primary school-aged children. Programme interventions included:  
  • Appointment of community dietitian to coordinate program and nomination of lead teacher within each school  
  • Seasonal ‘fresh fruit weeks’ 2-4 times/year (free fruit provided for 4 days)  
  • Monthly nutrition newsletters to parents  
  • Bilingual parent nutrition education sessions  
  • Scheduled ‘fruit breaks’ within classes  
  • Development of school ‘fruit and water’ policies and annual plans  
  • Linkages with the Municipal Public Health Plan  
  • Nutrition education curriculum  
  • Distribution of water bottles printed with student-designed fruit and water logos | Frequency of children with fresh fruit, water and sweet drinks in their lunch box (Lunchbox audit) – baseline and periodically over 2 years post programme implementation | Overall f/u response rate for lunchbox surveys = 81% of total student population of participating schools  
Significant increase in observed proportion of children bringing fresh fruit to school at end of 2 year study period (mean = 41%; range = 25-50%)  
Significant increase in observed proportion of children bringing filled water bottles to school at end of 2 year study period (15-60%)  
Significant decrease in observed proportion of children bringing sweet drinks to school or ordering them from canteen at end of 2 year study period = 8-38%  
However, data collection for sweet drinks was less consistent than other outcome measures and trend was less clear. |
## Table A4. Interventions that involved modifying the home environment

<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention description</th>
<th>Outcome variables</th>
<th>Key findings/ Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebbeling et al, 2006</td>
<td>RCT pilot</td>
<td>13 to 18 yrs, n=103</td>
<td>IV: Received weekly home deliveries of non-caloric beverages (includes water), written instructions regarding beverage consumption, and monthly telephone administered behavioural counselling to displace SSBs</td>
<td>Change in intake of SSBs (kJ) and non-caloric beverages (mls)</td>
<td>SSB intake (mean kJ ± SD): ↓ by 82% (-1201 ± 836) in intervention group vs. ↓ 12% (-185 ± 945) in controls, P&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>25 weeks; 2003-04 school year</td>
<td></td>
<td>Eligible participants reported consuming at least 1 serving SSB (360ml)/ day</td>
<td>BMI change from baseline to follow up (adjusted for age and gender)</td>
<td>Non-caloric beverages (mean mls ± SD): ↑156% (+396 + 493) in intervention group vs. ↑ 46% (+78 + 523) in controls, P=0.002</td>
</tr>
<tr>
<td></td>
<td>Home-based</td>
<td></td>
<td></td>
<td></td>
<td>BMI change (mean kg/m2 ± SE): ↑ 0.07 ± 0.14 in intervention group vs. 0.21 ± 0.15 in controls, non-significant overall. Although participants in the upper baseline-BMI tertile had a BMI ↓ 0.63 ± 0.23 in intervention group vs ↑ +0.12 ± 0.26 in controls, P=0.03</td>
</tr>
<tr>
<td>Beverages and Student Health (BASH) Study</td>
<td>USA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Module 1 - Interventions to promote consumption of water and reduce consumption of sugary drinks
<table>
<thead>
<tr>
<th>Ref</th>
<th>Design</th>
<th>Participants</th>
<th>Intervention description</th>
<th>Outcome variables</th>
<th>Key findings/ Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGarvey et al</td>
<td>Pre-test, post-test, non-randomised</td>
<td>2-4 years</td>
<td>Fit WIC/Bright futures in Practice</td>
<td>Frequency of engaging in active play with child (5-point scale)</td>
<td>69% Hispanic in intervention group&lt;br&gt;Spanish-speaking participants had significantly lower scores at baseline for frequency of watching TV whilst eating/frequency of offering child water during the day&lt;br&gt;Multivariate tests for pre-test post-test differences by site (time x site) statistically significant for: frequency of engaging in active play with child and frequency of offering the child water&lt;br&gt;Also, Spanish-speaking participants reported a greater increase in frequency of offering water instead of sweetened beverages than did English-speaking&lt;br&gt;Limitations: self-report outcome measures; non-validated measures; non-random sampling; differential rates of follow-up at two sites; high costs</td>
</tr>
<tr>
<td>2004</td>
<td>1 year</td>
<td>IV: n=185</td>
<td>Educational groups once / 2 months Individual session with nutritionist once / 6 months</td>
<td>Frequency of watching TV whilst eating (5-point scale)</td>
<td>34.1% decrease in sweetened beverage consumption (P&lt;0.05) – greatest difference between parent-targeted IV group and C (P=0.0087), other two pair-wise comparisons n.s. 1.5% increase in servings of water (n.s.)</td>
</tr>
<tr>
<td></td>
<td>WIC program (Special Supplemental Nutrition for Women, Infants and Children Clinics – Education)</td>
<td>C: n=151</td>
<td>Simple educational messages (hard backed notebook with diagrams); staff reinforcement; community reinforcement</td>
<td>Family activity level (5-point scale)</td>
<td>High retention rate (100%) and attendance rate (88% attended at least 80% of sessions)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One clinic intervention site; one clinic comparison site – received normal WIC nutritional education messages without specific content and the supportive staff and community activities</td>
<td>Frequency of offering child water (6-point scale)</td>
<td>Fruit and vegetables consumption (5 point scale)</td>
<td>IV groups combined:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>One clinic intervention site; one clinic comparison site – received normal WIC nutritional education messages without specific content and the supportive staff and community activities</td>
<td>Mealtime behaviour (index of togetherness around meals)</td>
<td>Post-intervention interviews</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beech et al</td>
<td>RCT</td>
<td>8-10 yr old African-American girls with BMI ≥ 25th percentile of CDC growth charts and their parents or care-givers.</td>
<td>Recruitment was conducted through public service announcements on local African-American radio stations, segments on live radio talk shows and via flyers distributed at local elementary schools.</td>
<td>Height, weight, waist circumference, % body fat (DEXA scan), sexual maturation, insulin sensitivity, blood glucose levels</td>
<td>High retention rate (100%) and attendance rate (88% attended at least 80% of sessions)</td>
</tr>
<tr>
<td>2003</td>
<td>3 arms: Child-targeted and parent-targeted IV groups, 1 C group.</td>
<td>N=60; n(IV)=21 girls, 21 parents; n(C)=18.</td>
<td>Formative research and feasibility study were conducted prior to pilot.</td>
<td>Diet: Two dietary recalls on non-consecutive days (first face-to-face, second by telephone)</td>
<td>IV groups combined:</td>
</tr>
<tr>
<td></td>
<td>12 weeks</td>
<td>Household income: 35%&lt;$20,000; 68%&gt;$40,000.</td>
<td>Highly interactive 90 minute weekly group sessions: IV group sessions focused on knowledge and behaviour change skills to promote healthy eating and physical activity;</td>
<td>PA: Accelerometer, self-report recall</td>
<td>34.1% decrease in sweetened beverage consumption (P&lt;0.05) – greatest difference between parent-targeted IV group and C (P=0.0087), other two pair-wise comparisons n.s. 1.5% increase in servings of water (n.s.)</td>
</tr>
<tr>
<td></td>
<td>Family-based</td>
<td></td>
<td>C group sessions = lower contact (sessions three monthly), focussed on self esteem</td>
<td>Post-intervention interviews</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td></td>
<td>Data collected at baseline and post IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>