Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations

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Summary

Childhood obesity is a global epidemic and rising trends in overweight and obesity are apparent in both developed and developing countries. Available estimates for the period between the 1980s and 1990s show the prevalence of overweight and obesity in children increased by a magnitude of two to five times in developed countries (e.g. from 11% to over 30% in boys in Canada), and up to almost four times in developing countries (e.g. from 4% to 14% in Brazil). The goal of this synthesis research study was to develop best practice recommendations based on a systematic approach to finding, selecting and critically appraising programmes addressing prevention and treatment of childhood obesity and related risk of chronic diseases.

An international panel of experts in areas of relevance to obesity provided guidance for the study. This synthesis research encompassed a comprehensive search of medical/academic and grey literature and the Internet covering the years 1982–2003. The appraisal approach developed to identify best practice was unique, in that it considered not only methodological rigour, but also population health, immigrant health and programme development/evaluation perspectives in the assessment. Scores were generated based on pre-determined criteria with programmes scoring in the top tertile of the scoring range in any one of the four appraisal categories included for further examination. The synthesis process included identification of gaps and an analysis and summary of programme development and programme effectiveness to enable conclusions to be drawn and recommendations to be made.

The results from the library database searches (13 158 hits), the Internet search and key informant surveys were reduced to a review of 982 reports of which 500 were selected for critical appraisal. In total 158 articles, representing 147 programmes, were included for further analysis. The majority of reports were included based on high appraisal scores in programme development and evaluation with limited numbers eligible based on scores in other categories of appraisal. While no single programme emerged as a model of best practice, synthesis of included programmes provided rich information on elements that represent innovative rather than best practice under particular circumstances that are dynamic (changing according to population subgroups, age, ethnicity, setting, leadership, etc.). Thus the findings of this synthesis review identifies areas for action, opportunities for programme development and research priorities to inform the development of best practice recommendations that will reduce obesity and chronic disease risk in children and youth.

A lack of programming to address the particular needs of subgroups of children and youth emerged in this review. Although immigrants new to developed countries may be more vulnerable to the obesogenic environment, no programmes were identified that specifically targeted their potentially specialized needs (e.g. different food supply in a new country). Children 0–6 years of age and males

represented other population subgroups where obesity prevention programmes and evidence of effectiveness were limited. These gaps are of concern because (i) the pre-school years may be a critical period for obesity prevention as indicated by the association of the adiposity rebound and obesity in later years; and (ii) although the growing prevalence of obesity affects males and females equally; males may be more vulnerable to associated health risks such as cardiovascular disease. Other gaps in knowledge identified during synthesis include a limited number of interventions in home and community settings and a lack of upstream population-based interventions. The shortage of programmes in community and home settings limits our understanding of the effectiveness of interventions in these environments, while the lack of upstream investment indicates an opportunity to develop more upstream and population-focused interventions to balance and extend the current emphasis on individual-based programmes.

The evidence reviewed indicates that current programmes lead to short-term improvements in outcomes relating to obesity and chronic disease prevention with no adverse effects noted. This supports the continuation and further development of programmes currently directed at children and youth, as further evidence for best practice accumulates. In this synthesis, schools were found to be a critical setting for programming where health status indicators, such as body composition, chronic disease risk factors and fitness, can all be positively impacted. Engagement in physical activity emerged as a critical intervention in obesity prevention and reduction programmes.

While many programmes in the review had the potential to integrate chronic disease prevention, few did; therefore efforts could be directed towards better integration of chronic disease prevention programmes to minimize duplication and optimize resources. Programmes require sustained long-term resources to facilitate comprehensive evaluation that will ascertain if long-term impact such as sustained normal weight is maintained. Furthermore, involving stakeholders in programme design, implementation and evaluation could be crucial to the success of interventions, helping to ensure that needs are met.

A number of methodological issues related to the assessment of obesity intervention and prevention programmes were identified and offer insight into how research protocols can be enhanced to strengthen evidence for obesity interventions. Further research is required to understand the merits of the various forms in which interventions (singly and in combination) are delivered and in which circumstances they are effective. There is a critical need for the development of consistent indicators to ensure that comparisons of programme outcomes can be made to better inform best practice.

Keywords: Child, obesity, synthesis research.

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1. Background

1.1 The extent and impact of childhood obesity

The increases in overweight and obesity among children internationally over the past three decades indicate that childhood obesity is a global 'epidemic' (1–3). Rising fatness trends are apparent in both developed and developing countries (1–9). Current estimates of childhood overweight and obesity range from 12% to over 30% in developed countries and from 2% to 12% in developing countries (3). However, the true extent of the problem is difficult to accurately estimate because of variations in definition of childhood obesity between clinical and epidemiological

studies. Defining obesity during childhood and adolescence is complicated because of variability in growth rates and the natural, gender-specific variations in body composition that occur at different maturational stages. Weight-for-height indices are the most widely used for assessing prevalence of childhood obesity in population studies for reasons of feasibility and practicality. However, until the recent development of body mass index (BMI) for age and sex as an international standard for assessment of childhood overweight and obesity (10), use of different growth standards and cut-off criteria for definition of overweight complicated comparisons of epidemiological studies and determination of secular trends. To account for these difficulties, Ebbeling *et al*. (2) reported on changes within populations from studies that used similar definitions of overweight. The increases reported varied from an almost twofold increase in Britain over the past 20 years (e.g. from 5.4% to 9.0% in boys) (11) to a more than threefold increase in developing countries (e.g. from 2% to 9% in Egypt) (2). A recent review describes how the global prevalence of childhood overweight is unevenly distributed with the highest rates evident in industrialized countries such as North America and Europe and lowest rates evident in developing countries such as Africa and Asia (3). This review also describes how the pattern differs within developed and developing nations. In industrially developed countries, lower income families are more vulnerable; while in developing countries, childhood obesity is most prevalent among advantaged groups (3). Furthermore, in industrialized countries ethnicity may be a factor, as seen in the United States (USA). For example, where the rising prevalence of child obesity is much more evident among Hispanic and African Americans at around 25% compared with Caucasian groups at 10–12% (3).

Obesity has been described as a multi-factorial trait determined by genetic and non-genetic factors (12). It is widely acknowledged that fatness is to some extent 'heritable'. In the majority of cases obesity seems to be polygenic with a non-Mendalian pattern of transmission (12) and single gene defects are rare (13). A complex interaction involving at least as many as 250 obesity-associated genes (14) and non-genetic, environmental factors cause predisposition to obesity (2,15). This raises the concept of 'susceptibility genes' whereby a particular genotype does not necessarily determine the development of obesity but increases risk of the disease given a particular environment. Such gene–environment interactions are very complex and, as yet, are poorly understood. Progress in this area is likely to be critically important for effective obesity prevention (12). While the variation in body fatness that can be explained by genetic factors remains controversial (15) there is consensus around the critical role of the environment as a predisposing factor (2,16–18). The rapid rise in obesity prevalence observed over the past two decades in genetically stable populations strongly confirms the need to tackle environmental factors leading to obesity (12).

The comorbidities of childhood obesity are evident in many areas of paediatric medicine; however, the true extent of adverse health outcomes tends to be underestimated (19). Many overweight children grow up to become obese adults. In particular, those who are severely overweight, are affected by obesity during adolescence (20), or have at least one parent who is obese (21,22) – the latter situation made increasingly likely by dramatic increases in adult obesity rates over recent years. This is expected to add significantly to the prevalence of chronic diseases associated with adult obesity (1). Furthermore, risk factors for cardiovascular disease (hyperinsulinanaemia, impaired glucose tolerance, dyslipidaemia and hypertension) tend to cluster in childhood and are strongly associated with obesity and its duration (23). These risk factors have been identified in overweight children as young as 5 years of age (24). A significant aspect of the epidemic of childhood obesity is the increased prevalence of Type 2 diabetes in paediatric populations and the prospect of the associated macro- and micro-vascular complications (25). Moreover, the mental health implications of lifelong obesity likely confer additional morbidity. In summary, the cumulative anticipated impact on chronic disease prevalence carries implications for sustainability of healthcare systems.

1.2 The challenges of treatment and prevention

Facilitating preventive action to address childhood obesity is complex. First, there is strong prejudice against overweight people (26,27), which many children are clearly aware of (28) including those as young as 4 years of age (29). Care must be taken so that obesity prevention programmes do not induce unhealthy slimming practices, which may lead to the development of clinical eating disorders (30) or risky behaviour such as smoking to control weight (31). Second, adequate nutrition is essential for the preservation of normal growth and development. Energy restriction in obese children who were on well-controlled and supervised weight reduction diets have led to reductions in height velocity (32). Nonetheless, Epstein *et al*. have shown that individualized treatment with frequent monitoring can be effective without compromising growth (33). Such close follow-up of children and adolescents would, however, overwhelm resources for prevention initiatives. The current situation requires a population health approach in addition to the one-on-one weight reduction treatment required for severely overweight children or those with complications. This has led to recommendations from experts that focus prevention initiatives on the goal of promoting healthy eating, active living and positive self-esteem rather than the achievement of ideal body weight (34–38). In fact, prolonged weight maintenance rather than

weight loss is recommended for mildly overweight children without complications (34–36). Such weight stabilization as children grow in height allows a gradual decline in BMI, which is deemed sufficient for the majority of children (34–36).

Traditionally, public health strategies have focused on the individual, promoting healthy food choices and regular physical activity. Therefore, the classical interpretation of populations becoming obese, failing to lose weight or recidivism after initial weight loss, is failure on the part of the individual, the intervention, or both. However, the problem of rising obesity prevalence does not appear to be owing to a lack of interest by the individuals in the population. On the contrary in the USA, where the evidence of increasing obesity rates is very reliable, there is evidence that the majority of the population are actively trying to control their weight (39). Recent reviews suggest that a paradigm shift, which considers the environment in which these individuals make choices on food consumption and engagement in physical activity, is necessary to understand and tackle the problem. There is a growing consensus that effective intervention to address the obesity epidemic requires a multi-strategic approach involving all levels of society – both for the population as a whole and for the individual (2,16–18). This relates to ensuring a balance in intervention strategies along the continuum that stretches from individualized health care (downstream investments) to the introduction of policy and legislation that affects whole populations on a macro level (upstream investments). Currently, considerable resources are invested in downstream activities compared with upstream interventions (40). There is a growing consensus that more upstream investment is required to tackle the obesogenic environment (2,16,18). In addition the new concept of integration in the prevention of chronic diseases has been introduced into public health practice (41,42). This concept promotes integration of activities so that several chronic diseases with common risk factors can be addressed simultaneously. For example, a programme which integrates the three main healthy living strategies (diet, physical activity and mental health) has the ability to address cardiovascular disease, Type 2 diabetes and cancer simultaneously. Compelling arguments for integration concern the optimization of scarce resources, congruent messages to the public and potential to enhance access for marginalized populations (41,42).

1.3 Special issues for immigrant and minority populations

Adverse health consequences of obesity vary according to ethnic origin and because of cultural factors. For example, increased risks associated with obesity have been shown at lower BMI levels in Asians compared with Caucasians and these populations are also predisposed to visceral or abdominal obesity (43). Furthermore, even controlling for differences in adiposity, Black and Hispanic youths in the USA are at greater risk for Type 2 diabetes and cardiovascular disease than their white counterparts (44,45). In contrast, however, Caucasian girls are often more vulnerable to the psychosocial effects of obesity compared with girls from other ethnic groups (46). Cross-sectional comparisons of the African Diaspora populations have been undertaken to investigate the increase in risk of obesity and associated chronic disease as people migrate from non-industrialized to industrialized countries. Luke, Durazo-Arvizu *et al.* compared obesity prevalence (BMI > 30 kg m^{-2}) in people of African origin living in West Africa (non-industrialized), Caribbean (mid-way between non-industrialized Africa and industrialized America) and America (industrialized) (47). In this cross-sectional comparison, these researchers found a marked east-to-west increasing gradient in the prevalence of obesity, which was lowest for Nigerian men (5%) and highest for African-American women (49%). The health consequences in terms of morbidity and mortality patterns in obesity-related chronic diseases, most notably Type 2 diabetes and cardiovascular disease, were also very evident across the African Diaspora (48). These data indirectly illustrate the need for public health strategies that protect immigrants new to industrialized countries from developing obesity and associated chronic disease as well as to prevent such disease from becoming prevalent in developing countries.

Immigrants new to industrialized countries undergo social integration, which includes transition from traditional diet and physical activity habits to those that prevail in the host country. Children and adolescents among immigrants new to industrialized countries are likely to be particularly susceptible to the obesogenic environment of their new host country because they tend to participate in the local culture and become socially integrated more quickly than their parents (49). A recent report from Statistics Canada indicates that immigrants compared with non-immigrants in Canada have superior health in terms of chronic conditions even when accounting for age education and income (50). Furthermore, immigrants' odds for reporting any chronic conditions increase with time living in Canada (50). The USA National Longitudinal Study of Adolescent Health provides data which suggest that overweight is substantially and significantly less common among Hispanic and Asian-American adolescents who were first generation immigrants (i.e. born outside the USA) than among the second (born in the USA with at least one foreign-born parent) and third (born in the USA of native-born parents) generation immigrants (51). Using the 85th percentile cut-off for BMI-for-age kg m^{-2} to define overweight, Native American Indian adolescents with a prevalence of 42%, had the highest rate for overweight

compared with adolescents in other ethnic groups such as Black (31%) and Hispanic (30%) and compared with overall overweight rate of 27% in this study (51). Although Asian-American adolescents had the lowest rates of overweight (20.6%); a further breakdown of this rate by generation reveals a rising prevalence of overweight from first generation (12%), through second generation (27%), to third generation (28%) in this ethnic group and highlights the urgency of effective prevention for immigrant subgroups (51). In addition, these data point to an important role of acculturation or assimilation into lifestyles that prevail in industrialized countries as a risk factor for obesity. Successful public health measures to address this are likely to involve the upstream interventions of a population health approach – such as food quality, policy, advertising and politics. In relation to this, Sobal links the differing prevalence of obesity in America, China and Russia with globalization of food and activity patterns (49). Furthermore this hypothesis is extended to explain differences in obesity prevalence in rural and urban communities in China and Russia leading to the conclusion that global as well as community and national public health measures may be needed to adequately deal with the globalization of obesity (49).

1.4 Identifying best practice: examining the evidence

While, population-based interventions to address the rising prevalence of obesity in children and youth are based in a theoretical and rational viewpoint, the evidence base for such strategies is limited (17,18). Similar to clinical situations systematic reviews are used to generate evidence-based recommendations for best practice using population-based approaches suitable for public health. However, unlike the clinical model, the methodology for synthesis reviews of public health practice is still under development. This is mainly the result of the multifaceted nature of population health approaches, which complicates evaluation of effectiveness (52–54). Furthermore, the use of randomization to control for confounding factors in population-based interventions compared with clinical trials is more limited on practical, economic and feasibility grounds (52–54). In some circumstances observational study designs may be appropriate to generate evidence for public health where there is a need to assess the impact of population health interventions and where randomized controlled trials or interventions that include control groups are difficult to introduce (55). Another difficulty in determining the methodological rigour of population health interventions arises from the equivocal nature of the outcomes used. For example, effective strategies need to be assessed beyond endpoints alone (i.e. whether a particular intervention has a successful outcome), but also at each stage of programme development and implementation (41). While quantitative studies may provide data on effectiveness of a programme, qualitative studies are better suited to describe and therefore understand the key phenomenon that cannot be easily captured by quantitative studies (56). Incorporation of information from qualitative and observational studies therefore provides a promising approach.

Notwithstanding the need for a more comprehensive appraisal of methodological rigour, the formulation of best practice recommendations for obesity prevention requires assessment of the evidence base from other perspectives. For example, an assessment of programme potential for acceptance and integration with the community (57); utilization of multidimensional, upstream population health strategies; and in some cases the applicability of programmes for population subgroups. However, there is limited inclusion of varying research approaches to date in the systematic reviews of obesity prevention and treatment interventions targeting children and youth (58–60).

Over the past 20 years, when obesity rates were rapidly increasing, numerous interventions with potential to reduce rates of obesity or associated risk of chronic diseases in children and youth have been implemented in a diverse range of settings. Some of these interventions were implemented under well-controlled conditions and provided information that had undisputed validity, while some successfully addressed large population groups but provided less valid data on effectiveness. Others were successful in engaging the target population, while others had specific attributes that met the needs of minority groups. The potential of all of these types of interventions to provide valuable insight on best practice for reducing obesity and associated chronic disease in children and youth was explored in this synthesis research paper. Therefore, in addition to the usual step of appraising methodological rigour, the appraisal process was extended to cover three further important aspects – programme development/evaluation, applicability of population health and immigrant health principles. A global perspective was taken in this research; however, issues were examined in a Canadian context reflecting the country where the research was carried out. Thus an established Canadian conceptual model (see Fig. 1) (41,61–63), incorporating the fundamental principles of population health, was used to guide the process. Finally to ensure a comprehensive approach, the search strategy for reports which addressed the research questions that guided the synthesis, included the Internet, grey literature and articles in foreign languages.

2. Research questions

Globally, what programmes/models represent best practice in promoting healthy weights in children and youth for the prevention of chronic disease associated with obesity?

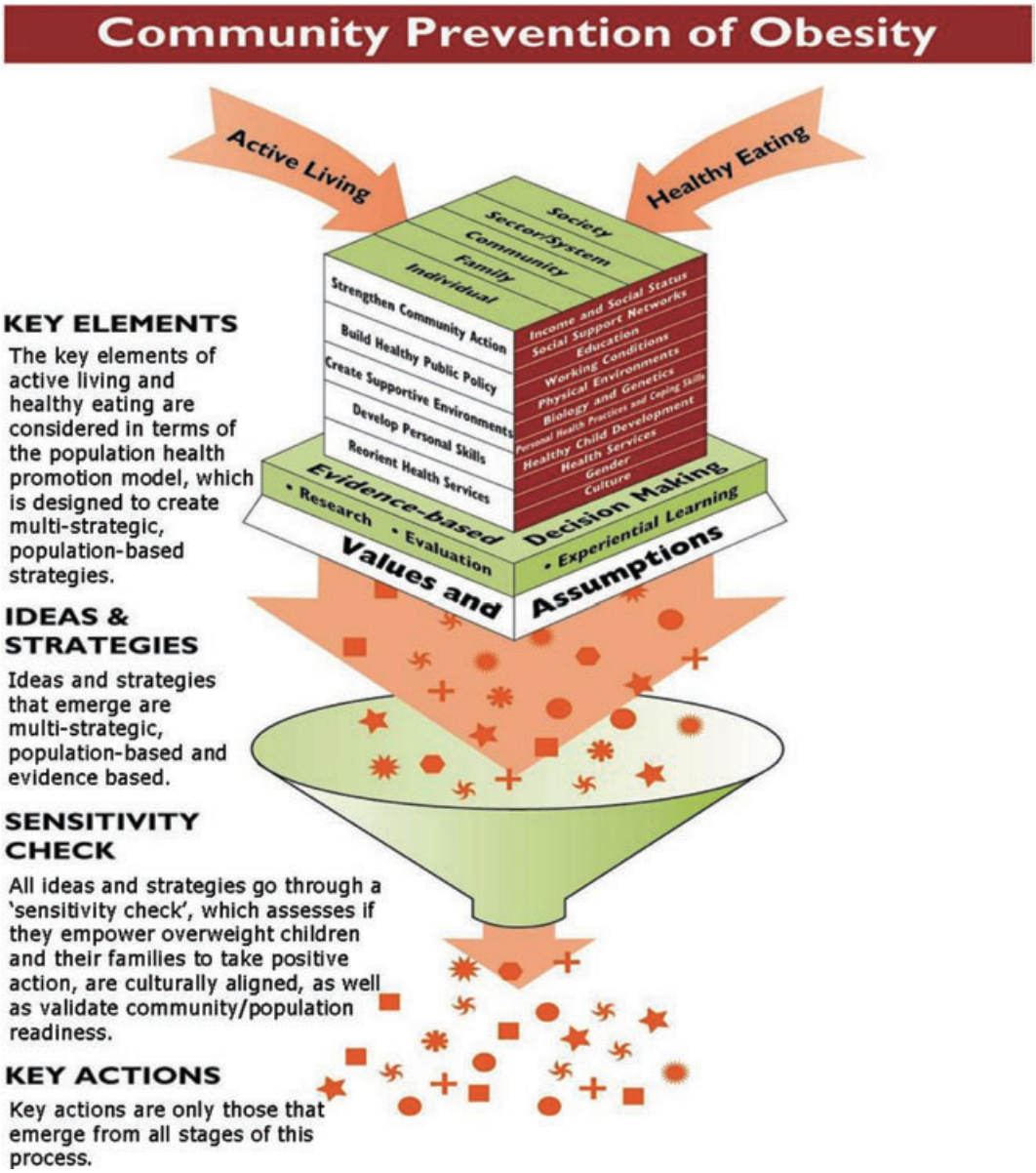

Figure 1 Community prevention of obesity [(63), adapted from Hamilton and Bhatti (61)].

Specifically:

1. What gaps are evident in populations served, settings used and programme features?
2. What are the features of those programmes/interventions representing best practice in programme development?
3. What are the features of those programmes/interventions which represent best practice in programme effectiveness?
4. What programmes represent best practice in immigrant families new to industrialized countries?

3. Methods

3.1 Overview

In order to formulate best practice recommendations from a population health perspective, this review explored interventions and strategies that have been implemented to promote healthy weights in children and prevent chronic diseases associated with obesity. The emphasis therefore was on inclusion so that recommendations would be as comprehensive as possible. An algorithm of the overall process is presented in Fig. 2. Research studies and pro-

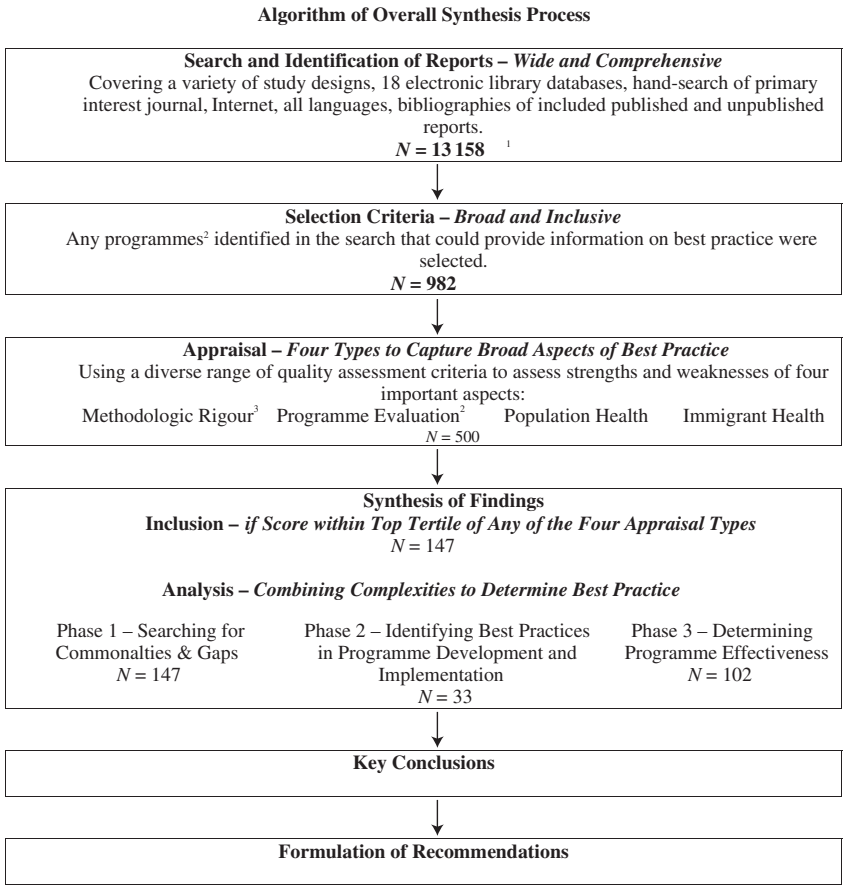

Figure 2 Algorithm of overall synthesis process.
[1]13 158 indicates only library databases hits, other reports are not counted in this number.
[2]'Programme' in the context of this review refers to a wide range of strategies from policy implementation affecting whole populations to individualized treatment.
[3]Methodological rigour or programme evaluation – some programmes were only amenable to either one of these appraisal types and not both.

gramme reports were identified from a search strategy that included the Internet in addition to 18 library databases. The appraisal process involved the development of a scoring system that enabled investigators to identify programmes that were most promising from programme evaluation, methodological rigour, and population health and immigrant health perspectives. The synthesis process involved three stages. Information was extracted from the most promising programmes, in the first phase, to provide a descriptive overview of key components of the programmes. This was used to identify commonalties, outcomes and gaps. The second phase of the synthesis focused on identifying best practices in programme development and evaluation while the third phase of the synthesis involved analysis of programme outcomes based on methodological rigour to formulate 'best practice' recommendations on the most promising strategies. Details related to the methodological approaches used in this synthesis can be found in a document prepared as a web-based supplementary material to this supplement (64). Content includes a record of search strategy terms, specifics of the appraisal scoring approaches (including the spreadsheets used in data management), and tables describing characteristics of the programmes included for this synthesis. Throughout the process an expert panel provided guidance to the investigative team.

3.1.1 Investigative team, expert panel and collaborators

The investigative team co-ordinated the project, including the recruitment, training and supervision of short-term project research staff. An expert advisory panel, comprised of six individuals with expertise in the areas of medical paediatrics and obesity, population health strategies and immigrant populations, exercise physiology, nutrition, behavioural sciences and health policy, provided guidance to the investigative team. Specifically, the panel provided consultation on the search, appraisal and synthesis of findings phases, the key informant surveys and the preparation of the final report and key recommendations. The panel met formally on four occasions – two videoconferences, one teleconference and one 3-day meeting in Calgary. Collaborators, with expertise in areas that include population health and community development, diabetes prevention in culturally diverse communities, paediatric dietetics and access to leisure amenities for diverse urban communities, provided support to the investigative team in the critical appraisal phase of the project. The expert panel, collaborators and key informants are listed in Appendix 1.

3.2 Search strategies

The search, covering publications in the years from 1982 to 2003, commenced in late July 2003 and extended to October 2003. The following sources were included in the search process.

3.2.1 Electronic library databases

MeSH terms for Medline and the Thesaurus for other databases, expanded to include all narrower terms (64), were the primary strategies used as recommended by Lowe and Barnett (65) to increase the comprehensiveness and reduce the ambiguity of the search. Key words were used only when mapped subject headings and the Thesaurus were not available for a particular search database. Obesity was used as the main search term and combined with additional terms deemed relevant to the key questions. These additional terms were identified by the expert panel, local experts in public health, nutrition, active living, psychology and immigration and from terms used in relevant reviews (15,58,60). Databases searched included the following: MEDLINE, PreMEDLINE, CINAHL (Cumulative Index for Nursing and Allied Health Literature), CDSR (Cochrane Database of Systematic Reviews), ACP Journal Club (American College of Physicians Evidence Based Medicine), DARE (Database of Abstracts of Reviews of Effectiveness), CCTR (Cochrane Central Registry of Controlled Trials) Health Star, PAIS (Public Affairs Information Service), Proceedings First, Population Index, Proquest Digital Dissertations, PsycINFO, Sociological Abstracts, Sports Discus, ERIC (Education Resources Information Centre), AGRICOLA and EMBASE (foreign language only).

3.2.2 Hand searches

A hand search of the International Journal of Obesity for the years 1987 to July 2003 was conducted. In addition, reference lists from reports were hand searched for other eligible reports.

3.2.3 Internet

There were three approaches to the Internet search. First, the investigators developed a list of 22 relevant organizations and society web sites. The second involved using the search engine, Google, with the terms 'obesity' and 'children' and either 'programme', 'treatment' or 'prevention'. The Google search initially produced 137 000 hits. To eliminate irrelevant sites, the 550 hits ranked first by the Google Page/Rank analysis programme, were searched using predefined criteria based on several guides for finding reliable information from trustworthy sources on the Internet (66–68). Sites were eliminated if (i) they were clearly just commercial; (ii) they did not seem to be trustworthy or reliable sources (i.e. personal homepages); and/or (iii) had little to no relevant information. One hundred and sixty-two relevant web sites (64) were further investigated from the Google search. These web sites included 10 from the investigators' original list that were not identified in the Google search.

The third Internet search approach focused on the official web sites of 48 non-industrialized countries, representing the original homelands of the top six sources of most numerous immigrants to Canada. A total of 288 sites were identified but the search was limited to 51 English language sites. Therefore, 213 web sites in total were included in the search strategy.

3.3 Key informants

Key informants (see Appendix 1) were consulted via email in three surveys. Three of 16 members of The Childhood Obesity Task Force, European Association for the Study of Obesity, who were contacted in the first key informant survey to identify potentially missing foreign language reports, provided additional literature. Five of 15 experts in immigrant health issues, who were identified in a literature search and were contacted in the second key informant survey, responded with feedback to assist in development of an appraisal approach for programme applicability for immigrants new to industrialized countries. The third key informant survey invited nine experts, identified by the Expert Panel, to check the comprehensiveness of the final list of manuscripts and reports included for review, to identify missing reports, and to choose the 10 most important for practice. Four of these nine informants responded to the survey.

3.3.1 Additional literature

Additional literature was consulted to provide context to the reports included for appraisal and synthesis of findings. Although not identified by a systematic process multiple sources of material, including reference lists of included reports, reviews identified in the search, and the knowledge of the Research Team and Expert Panel were employed to ensure all sources were explored.

3.4 Selection strategies

3.4.1 Criteria for considering programme reports for this review

In the context of this review the term 'programme' includes a wide range of strategies from policy implementation or legislation affecting whole populations to individualized therapy or counselling of individuals in an experimental setting. To enable evaluation in terms of best practice, programmes had to include at least one of the outcomes or process indicators listed in Table 1. Exclusion criteria are listed in Table 2.

Table 1 Outcome and process indicators used as criteria to select programmes for review

Outcome indicators
Indices of overweight and obesity (anthropometry, body mass index, body fat distribution, growth rates, other*)
Risk factors for obesity (exercise/activity levels, fitness, dietary habits/food choice, psychosocial factors, e.g. body image/self-esteem, anxiety, depression, other*)
Chronic disease risk factors/markers associated with obesity (blood pressure, blood glucose and insulin levels, blood lipids levels, leptin levels, other*)
Chronic disease associated with obesity (Type 2 diabetes, cardiovascular disease, cancer, other*)
Adverse effects (eating disorders, smoking, other*)
Process indicators
Numbers invited versus numbers completing programme
Descriptions of individuals or community groups participating
Other information evaluating how programme was proceeding (acceptability/popularity, access, other*)

*Other, any other marker/risk factor of overweight or chronic disease, or information on process not listed specifically in Table 1.

Table 2 Criteria used to exclude programmes for review

- Age: the majority of participants were older than 17 years of age
- Physical health: programmes involving children and adolescents who had compromised physical health because of a chronic condition (e.g. diabetes, respiratory dysfunction etc.)
- Mental health: programmes involving children and adolescents with mental illness including eating disorders.
- Programmes with a primary focus on: children of diabetic mothers, low-birthweight/pre-term infants and pregnant adolescents
- Case studies, surgical intervention
- Programme reports published before 1982
- Programme reports associated with marketing materials/products
- Foreign language reports that did not include English abstract in the library databases searched and were not identified as relevant by the Key informants
- Programmes with no indicators of either outcome or process (feasibility, acceptability of programme, numbers of dropouts etc.) were available. Programmes must include at least one to meet the inclusion criteria to enable some evaluation of programmes in terms of best practice

3.4.2 Process of report selection for appraisal

With the exceptions of EMBASE, Agricola and the Internet, selection of articles from the library databases and the International Journal of Obesity were carried out in duplicate by two independent researchers blinded to each other's selections. The continuously changing nature of the Internet impeded a duplicate selection. Because of time constraints, selection was not carried out in duplicate for Agricola and Embase, which were added after the first search had been conducted. The investigative team settled discrepancies in selection decisions made in the duplicate search. Exclusion of many reports initially selected for inclusion occurred during the critical appraisal phase of the project, where close scrutiny of programmes was undertaken by the investigative team. Trained translators verified foreign language reports for inclusion/exclusion criteria for selection.

3.5 Data management and extraction

Spread sheets and databases were developed to detail search and selection results, to record relevant information extracted from all programme reports selected for appraisal and to score each report as part of the critical appraisal process (64). Details included programme characteristics, consideration of potential adverse effects, participants' demographics (participation rates, age, sex, race), setting, evaluation and analysis strategies and main findings. A data extraction form adapted from the work of Zara *et al.* (54) was also developed for translators reading the foreign language reports (with the exception of French and Spanish) (64).

3.6 Critical appraisal overview

3.6.1 First appraisal

All selected programmes were appraised from four types of perspectives – programme evaluation, methodological rigour, population health and immigrant health, using scoring systems specifically designed for this review. Scores were based on standards relevant to each of the four kinds of appraisal. Programmes were categorized as 'High', 'Mid' and 'Low' within each perspectives depending on total scores attained relative to pre-set criteria, where 'High', 'Mid' and 'Low' reflected programmes scoring within the upper, middle or lower one-third of total scores respectively.

3.6.2 Second appraisal

All reports categorized as 'High' (scoring in the upper tertile) underwent a second appraisal by two investigators who were not blind to the first appraisal scoring. In addition to validating the ranking of all 'High' scoring reports, this second appraisal focused on outcomes and relevance for synthesis. Any discrepancies arising in categorization of reports were resolved by consensus.

3.6.3 Inter-rater reliability

To reduce the likelihood that variability, in appraisal scoring between researchers, did not exclude valid material for synthesis, 42% (43/103) of all reports categorized as 'Mid' were re-appraised for inter-rater reliability. A purposive approach was used to capture potential sources of variability. Therefore, selection of excluded reports for re-appraisal ensured that different types of interventions (i.e. population-based, experimental, school-based, etc.) were covered and care was taken to have these reliability appraisals carried out by researchers with different backgrounds (e.g. epidemiology vs. health promotion). The investigative team settled any discrepancies in categorization of reports arising from this reliability appraisal.

3.6.4 Foreign language reports

Foreign language reports were appraised by research staff based on the data extracted by translators (64). The only exception was Spanish language reports, which were appraised in the same manner as English and French reports by a research staff member who was proficient in Spanish. For all other foreign languages appraisal was, in general, less thorough reflecting the information that was available for scoring, and thus ranking was based on fewer criteria. The advantage of having less comprehensive appraisal criteria is that there was a greater opportunity for inclusion of foreign language reports, which has not been the case in previous reviews.

3.7 Appraisal for methodological rigour

Methodological rigour was examined from both qualitative and quantitative research perspectives. Quantitative studies were scored in three main categories: selection bias, information bias and confounding. The Oxford Centre for Evidence Based Medicine (69) and the work of Zara *et al*. (54) were used as the basis for developing a scoring system for quantitative studies (64). Programmes were scored on a total of 18 standards categorized under: (i) 'Selection bias' (eight standards to identify potential distortions resulting from procedures to select subjects and factors influencing participation); (ii) 'Information bias' (seven standards to identify potential errors in measurement); and (iii) 'Confounding' (three standards to identify potential distortions in results because of extraneous factors confusing or mixing effects).

The approach used for developing the appraisal scoring system for qualitative studies was based on several sources (70–73). Programmes were scored on a total of 13 standards categorized under three areas: (i) 'Reflexivity' (two standards on the researchers' influence on the motives, plan and results of the study); (ii) 'Credibility' (10 standards on the theoretical framework guiding evaluation and the approaches to data collection and analysis); and (iii) 'Transferability' (one standard on characteristics of population and context of study) (64).

3.8 Appraisal for programme development and evaluation

The programme development and evaluation appraisal type was designed to assess programme development, overall programme design, how well it was evaluated as well as potential for acceptance and integration within the community. The Framework for Programme Evaluation in Public Health devised by the Centers for Disease Control and Prevention was used as the basis for scoring criteria for this appraisal type (57).

Programmes were scored on 27 standards categorized under four areas (64): (i) 'Utility' (six standards indicating how useful the programme results would be to potential programme users [stakeholders] such as programme providers, funding agencies, or health researchers); (ii) 'Feasibility' (three standards based on programme practicality); (iii) 'Propriety' (seven standards assessed to determine if it was ethical and legal and if evaluations were undertaken fairly); and (iv) 'Accuracy' (11 standards ensuring the evaluation provided adequate information on features that determine the worth of the programme).

3.9 Appraisal for principles of population health

As previously described, the Population Health Model developed by Hamilton and Bhatti in 1996 (61) is the key component of the conceptual model guiding this synthesis review (see Fig. 1) and was used to develop the population health scoring approach. Three scores were used to assess the population health perspective: (i) how well a programme under review utilized multidimensional approaches; (ii) level of upstream investment involved in the intervention strategies; and (iii) integration of healthy living strategies (healthy eating, active living and mental health) to address common risk factors implicated in chronic diseases associated with obesity.

Programmes were scored on multidimensional approaches using 21 criteria 'reflecting population health principles' in three areas: (i) 'Who' (five standards relating to the intervention level of a programme ranging from the

individual to society overall); (ii) 'What' (11 standards on determinants of health); and (iii) 'How' [five standards based on the areas identified for action in the Ottawa Charter (62) ranging from strengthening community action to developing personal skills] (64).

The level of upstream investment score reflected a weighting of the 10 criteria for the 'Who' and 'How' components of the multidimensional area to describe the relative placement of a programme along the continuum from downstream to upstream.

The degree of integration in addressing chronic disease prevention scoring had two parts: (i) integration of healthy living strategies and (ii) integration in targeting chronic disease (64). Integration of healthy living strategies was assessed on three key elements (healthy eating, active living and mental health) common to the chronic conditions – diabetes, cardiovascular disease and cancer that are associated with obesity. Ranking for integration in targeting chronic disease was derived from a count of the number of the three chronic diseases (cardiovascular disease, diabetes and cancer) specifically targeted by the programme under review.

3.10 Appraisal for immigrant health perspective

Literature on ethnicity-specific health interventions shows that programmes must be targeted to specific populations. Thus, in developing programmes that are appropriate for a specific immigrant sub-population, research is necessary to identify whether a given cultural element is supportive, neutral, or opposes the desired outcome (e.g. healthy eating, increased physical activity) (74). Cultural preferences may reflect different concepts of recreation and the tendency to engage in different activities. Therefore, to be effective, recommendations for recreation should be realistic and consideration given to cultural acceptability and preference (75). Linguistic and cultural competence is another important consideration, particularly when targeting more recent immigrant populations or subgroups (i.e. women) within the population. This could include translating and adapting resource materials, using interpreters, or hiring bilingual/bicultural staff (both professional and lay health workers). Lastly, the significant influence of social factors on health has been well established. Social support has particular meaning for immigrant populations as their previous social, and in many cases, family support networks have been disrupted (76). Ethnicity-specific health interventions have often involved family and have partnered with community organizations in their effort to foster a sense of cohesion and trust. In honouring the cultural values of interdependence and community, partnerships also often provide direct access to the target population (77–80).

In the absence of an existing framework or model, the development of a scoring system was based on feedback from the key informant survey and a logic model approach, which was established from literature on service models for immigrant population groups. Programmes were scored on 16 newly established standards categorized in five areas: (i) 'Recruitment' (six standards on accommodations made to address barriers for immigrants during the recruitment process); (ii) 'Gender roles' (one standard on consideration given to gender roles and values of immigrant cultures); (iii) 'Religion/Culture/Setting' (three standards – two on accommodation of immigrant religious and cultural customs, and one on consideration of setting implications); (iv) 'Food/Activity customs' (two standards on accommodations made for immigrant food and activity traditions/customs); and (v) 'Familiarity' (four standards – two on considerations given to lack of familiarity with lifestyle/health practices and two on accommodations made for cultural perceptions around obesity and special needs of refugees) (64).

3.11 Appraisal of systematic reviews of obesity prevention and treatment interventions

A number of review articles including systematic reviews and meta-analyses were obtained during the literature search. These articles were examined by one of the research team members and those that used a systematic approach to the literature search were included in the synthesis as a systematic review.

The reviews were critiqued using a narrative description based on a scoring system (81) adapted from work by Oxman *et al*. (82–84). Table 3 lists the key points considered during the review of the reviews and was developed to provide a summary of the reviews and to serve as a basis for contrasting and comparing the reviews and their results in order to place them into the context of this synthesis research.

3.12 Synthesis of findings

3.12.1 Introduction

Because of the inclusive nature of the selection process and the diverse appraisal criteria, programmes included for synthesis in this review were heterogeneous, which ruled out a quantitative approach to the synthesis of best practice. This leads to questions about the definition of 'best practice'. While best practice for treating individuals on the basis of strength of evidence is well defined and understood, definition of this for population-based interventions is still under development (52,53,85). In developing the methodology for this review one of the main considerations concerned the lack of adequate methodological rigour in many of the programmes carried out over the past 20 years.

Table 3 Key points considered in assessing quality of systematic reviews

Research question
Includes population definition, intervention and outcomes as well as study design used
Search methods
Clearly stated including databases searched, strategy used and years reviewed
Methods comprehensive, replicable and inclusive of non-published work
Selection methods
Defined inclusion and exclusion criteria
More than one independent judge for selection
Replicable
Data extraction
More than one independent extractor
Attempts made to retrieve missing data
Agreement reported
Validity assessment
Criteria reported
Addresses bias
Combining of findings
Methods used reported and appropriate given the outcomes, homogeneity etc.
Data presented

This applies particularly to multidimensional population health approaches where scale and complexity demands a broader range of designs for evaluating effectiveness than those that have been established over many years for individual level interventions (52,85). It was expected that the appraisal process developed for this review would result in the inclusion (52,53,85) of programmes that would yield information other than evidence of effectiveness, e.g. best practice in terms of programme development or the application of population or immigrant health principles. However, it was recognized that translating the evidence of effectiveness into recommendations would necessitate synthesis on a more limited number of programmes where methodological rigour was adequate to ensure the validity of intervention activities and outcome associations.

The settings in which interventions took place: preschool, primary school, secondary school, community, home and clinic, emerged as a natural way of categorizing programmes for this synthesis. A qualitative approach was employed to identify areas where programme activity was low, to explore patterns identifying main strengths and weaknesses of included programmes and finally, on a limited number where methodological rigour was adequate, direction of effect. This approach to synthesis was developed using prevailing knowledge from a number of sources (the literature, expert opinion and experiential learning) to define best practices for promotion of healthy weight in children and prevention of chronic diseases associated with obesity. However, many aspects of the definition of best practice within this review are without precedence and therefore need further testing and evaluation.

3.12.2 Approach

Gap analysis – first phase of synthesis. Summary statistics were used to describe and compare programmes in terms of commonalties and gaps. Age ranges of children and youth were used in addition to settings to fully explore population groups targeted by these interventions. Population characteristics comprised number of children enrolled, age ranges, gender, ethnicity and programme focus. Focus was described as either 'Universal' (targeting all in a healthy population), 'Selected' (targeting only those described as 'at risk' who were identified within a healthy population, e.g. overweight children identified among healthy children) or 'Targeted' (targeting those at definitive risk, e.g. recruited from a clinic) (1). Details of programme features and programme outcomes were categorized into common elements identified during appraisal (see Table 4). In addition, table of the features (population characteristics, interventions and results for each of the 147 programmes by setting) was prepared (64).

Best practices in programme development – second phase of synthesis. With two exceptions (86,87), all included programmes scored 'High' on appraisal of programme development and evaluation (see Section 6.2), indicating this appraisal type acted as a filter for programme inclusion for synthesis. This provided an opportunity to synthesize included programmes to determine best practice in terms of programme development, implementation and evaluation. To synthesize the 'best of the best' this analysis was limited to programmes that scored 'High' on all four components of the programme development and evaluation appraisal (i.e. utility, feasibility, propriety and accuracy). Furthermore, with the exception of Spanish, reports in languages other than English and French were excluded from this phase of the synthesis because of the more limited information available for appraisal (see Sections 3.6 and 3.7 for more details). Programmes within each setting were examined to explore patterns that emerged on the basis of actual scoring within the four components of programme development and evaluation. This analysis also examined the extent to which (i) population health principles were used and (ii) immigrant health perspectives were considered. The appraisal of programme development and evaluation was newly designed for this synthesis research and has not been validated as a tool for generating best practice recommendations.

Best practices in programme effectiveness – third phase of synthesis. The final phase of synthesis, undertaken to

Table 4 Interventions and outcomes by categories used to describe programmes

	Selected examples
Intervention categories	
Physical activity	Actual engagement in physical activities
Diet	Intervention focus on dietary intake
Psychosocial	Focus on self-esteem, body image, peer support and stress management
Family	Involvement of family
Behaviour modification	Motivational reinforcement
Education	Education on healthy eating, active living
Environment	Environmental modification within community, cafeteria menus
Incentives or rewards	Money, sports equipment, stickers
Outcome categories	
Body composition	BMI, fat distribution, prevalence of obesity/overweight, skin-fold thicknesses
Physical fitness	Fitness testing measures, heart rate, VO_2 max
Chronic disease risk factors	Blood pressure, lipid levels, insulin levels, glucose levels
Nutrition	Dietary habits, food choice, food consumption, energy intake and sources
Physical activity	Frequency, duration, intensity, sedentary behaviour
Psychosocial factors	Self-esteem, body image, stress level, feelings of support
Knowledge	Knowledge of chronic disease risk factors, nutrition and physical activity requirements for optimal health

determine the most promising and least effective intervention strategies, was limited to include programmes that had 'Mid' or 'High' scores on methodological rigour. Details of programmes selected for this phase of synthesis (intervention features, outcomes [improvement, no change or negative response], duration, focus ['Universal'/'Selected'/'Targeted'] and scoring rank on other appraisal types) were examined by programme setting for qualitative analysis. Statistically significant outcomes were extracted and categorized under physical activity/fitness, body composition, chronic disease risk factors, nutrition, psychosocial and others (see Table 4). Assessment methods were noted for physical fitness and nutrition outcomes. Growth was taken into account when assessing body composition changes. Direction of outcomes (improvement, negative response and no change) and the associated intervention features were examined within each setting, with consideration given to programme focus and duration. Patterns indicative of programme effectiveness were identified and used to formulate best practice recommendations on most promising strategies within each setting. Simultaneously, patterns associated with poor outcomes were explored in an attempt to identify ineffective strategies. Greater weight was given to strategies associated with outcomes that were directly measured (e.g. changes in body composition, chronic disease risk factors and physical fitness), compared with those indirectly assessed (e.g. dietary intakes, physical activity levels and self-esteem) or those that were indicative of behaviour change (e.g. improvement in knowledge). For presentation of results the former were categorized as status indicators of chronic disease risk, while the latter were categorized as intermediary indicators of chronic disease risk.

Normal growth and development throughout childhood and adolescence impacted several programme outcome categories (e.g. body composition, knowledge, psychosocial factors) and was taken into account when assessing whether the direction of outcome change indicated improvement, a negative response or no change. Body composition posed a particular challenge for this review as guidelines for the evaluation and management of childhood overweight have been introduced relatively recently (34,36). These guidelines, which include weight maintenance as a positive outcome for many overweight children, were used in addition to authors' conclusions when assessing the direction of body composition changes.

4. Results: search and selection

Details of the search, selection and inclusion results are found in Table 5. The library databases search yielded the largest number of reports with 13 158 hits. There were 418 discrepancies between searchers that required resolution by one of the investigators to determine selection for appraisal. This yielded an inter-rater agreement, for selection of articles for appraisal, of >95% (8702/9120 calculated for the library databases only).

A total of 982 reports from all sources were selected for detailed examination. This resulted in exclusion of another 482 (failure to meet selection inclusion criteria). A total of 500 reports were fully appraised at least once including 64 which were not written in English: 414 from the library database, 17 from the Internet search, six from the International Journal of Obesity hand search, 58 from the hand search of other articles, one from the foreign language key

Table 5 Summary of search, selection and inclusion results

Database/search source	Search results	Number of reports/articles		
		Selected	Appraised	Included
	Hits			
Medline	7904			
Sport discuss	863			
CINAHL	1124			
CDSR, ACP Journal club, DARE, CCTR	225			
HealthSTAR	19			
PAIS	69			
Proceedings	44 (1470 titles)			
Population index	20			
Proquest digital dissertations	163			
PsycINFO	578			
Sociological abstracts	198			
PREMEDLINE	423			
ERIC	212			
Agricola	762			
EMBASE	554			
Sub-total (search totals include duplicates)	13 158	644	414	109*
Internet	searched			
Countries (web sites)	51 (hits)	2	0	0
Google (web sites)	162 (hits)	247	17	9
Hand search				
International Journal of Obesity	1987–2003	17	6	1
Reference list search		66	58	27
Key informant surveys	Contacts			
1. Survey to find Foreign language programmes	European Childhood Obesity Group (ECOG) members contacted (3 responses)	1	1	0
2. Survey for validation of comprehensiveness of list of selected programmes	9 contacted (4 responses)	5	4	1
Sub-total		338	86	38*
Grand total	13 158 hits + Internet + hand search + key informant surveys	982	500	147*

*Publications on the same sample were combined and counted once.

informant survey, and five from the key informant inclusion list surveys.

5. Results: critical appraisal

5.1 First appraisal results

During the first appraisal process, 166 articles scored 'High' in one or more of the appraisal types. More articles scored 'High' on programme appraisal than any other type while the fewest articles scored 'High' on population health. Only 28 articles or 5% of the total scored 'High' on methodological rigour. However, an additional 143 scored 'Mid' indicating just over one-third of the articles had 'Mid' to 'High' methodological quality. Twelve articles (2%) were not appraised for methodological rigour because they were primarily descriptions of formative programme evaluations, while 15 (3%) were not appraised for programme description and evaluation, primarily because of being drug trials. Table 6 provides complete results of the first appraisal.

5.2 Second appraisal results

The non-blinded second appraisals of 'High' and 'Mid' ranking reports by the main investigative team yielded an overall 81% agreement in scoring across all appraisal types with 32 articles changing rank, 20 were lowered and 12 were raised in rank. Articles reporting on the same study populations were grouped together to represent a single programme. The final appraisal and synthesis of findings is based on 147 programmes/studies representing 158 articles and reports with an additional 48 providing background information on 27 programmes/studies. Eighteen of the programmes/studies were non-English language reports.

Table 6 First appraisal results by appraisal types

Rank	Population health % (*n*)	Programme % (*n*)	Methodological rigour Quantitative and qualitative % (*n*)	Immigrant health % (*n*)
'Low'/NA	79 (395)	14 (70)	63 (317)	95 (475)
'Mid'	21 (103)	48 (239)	29 (143)	3 (14)
'High'	<1 (2)	35 (176)	6 (28)	2 (11)
Not done	0 (0)	3 (15)	2 (12)	0 (0)

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.
Numbers represent duplicates across categories.

Table 7 Summary of methodological rigour appraisal results by setting

Rank	Total *N* = 147 % (*n*)	Pre-school *n* = 1 % (*n*)	Primary school *n* = 45 % (*n*)	Secondary school *n* = 21 % (*n*)	Home *n* = 4 % (*n*)	Community *n* = 21 % (*n*)	Clinic *n* = 55 % (*n*)
Methodological rigour							
'Low'	31 (45)	100 (1)	25 (11)	29 (6)	50 (2)	33 (7)	33 (18)
'Mid'	55 (81)	0	62 (28)	52 (11)	50 (2)	62 (13)	49 (27)
'High'	14 (21)	0	13 (6)	19 (4)	0	5 (1)	18 (10)

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.

6. Results and discussion by appraisal type for programmes included for synthesis

6.1 Methodological rigour results and discussion

Key point

- Methodological rigour was appraised as 'High' for only 14% of programmes included for synthesis, and as 'Mid' for a further 55% which needs to be considered when interpreting the findings – especially relating outcomes to programme activities.

6.1.1 Results

Methodological rigour was rated 'Low' in 31% of studies ($n = 45$) – a rating which did not vary appreciably by setting (Table 7). Only 14% ($n = 21$) of programmes were ranked 'High' while half to two-thirds, depending on setting, ranked 'Mid' on methodological rigour.

Some studies had very low recruitment rates from large populations while others had very low retention and these factors were reflected in selection bias scores. Low scores for information bias reflected lack of validity and reliability for measures chosen. While some studies went to great lengths to use previously validated reliable measures, others failed to adequately test newly developed instruments or measurement techniques. This was particularly evident in dietary recall approaches. Not all studies contained comparison groups and those with single group pre-test post-test measures in some cases failed to take into consideration important potential confounding variables such as socio-economic status, parental weight status, ethnicity and/or age. Other studies, with comparison groups, failed to collect potential confounder data or either did not establish equivalency on these measures across comparison groups or take them into consideration in analysis of outcome measures.

Tables 8 and 9 provide a summary of the 21 programmes/interventions that scored 'High' in quantitative methodological quality. Twenty programmes scored 'High' on quantitative methodological rigour and two scored 'High' on qualitative rigour, one of which scored 'High' on quantitative rigour also. Twenty programmes that met the inclusion criteria by methodological standards also scored 'High' on programme criteria. None of the programmes included in the top third for methodological quality scored 'High' across each of the other three appraisal types.

6.1.2 Discussion

One of the most striking findings from this review is the fact that only 21 programmes (out of 147) included in this synthesis achieved 'High' scores methodologically. This

Table 8 Programmes scoring 'High' in appraisal of quantitative methodological rigour ($n = 20$)

Citation	Study design	Programme description	Scoring categories			Rank for other appraisal types		
			Selection bias	Information bias	Confounding	Programme	Population health	Immigrant health
Ambler *et al.* 1998 (88) (USA)	RCT	A 5-week secondary school-based endurance training and education intervention to monitor effect on energy intake and food choice aimed at healthy adolescents.	6/8	4/7	2/3	'High'	'Low'	'Low'
Barnow *et al.* 2003 (89) (Germany)	RCT	A 12-month outpatient clinic-based, behaviour-oriented group therapy, diet education and activity intervention for overweight children 6–12 years.	3/5	2/2	0/0	'High'	'Low'	'Low'
Beech *et al.* 2003 (90) (USA)	RCT	GEMS Memphis 12-week pilot study for 8–10-year-old African American girls. Community-based weekly interactive group sessions including after school activities and health education focused on knowledge and behaviour change skills to promote healthy eating and increased physical activity.	5/8	4/7	3/3	'High'	'Mid'	'Mid'
Berkowitz *et al.* 2003 (87) (USA)	RCT	A 1-year clinic-based behaviour therapy (family-based diet and exercise), group therapy and sibutramine treatment programme for obese adolescents ages 13–17 years.	5/8	7/7	3/3	Not rated	'Low'	'Low'
Davis *et al.* 1999 (91,92) Gittlelsohn *et al.* 1998, 1999 (93), 2003 (94) Helitzer *et al.* 1999 (95) Caballero *et al.* 2003 (96) Cunningham-Sabo *et al.* 2003 (97) Snyder *et al.* 1999 (98) Teufel *et al.* 1999 (99) Going *et al.* 2003 (100) Himes *et al.* 2003 (101) Lohman *et al.* 2003 (102) Stevens *et al.* 2003 (103) Story *et al.* 2003 (104) Weber *et al.* 1999 (105) (USA)	Cluster RCT	Pathways – Obesity Prevention Programme. A 3-year primary school-based programme for grades three to five aimed at promoting healthful eating and increased physical activity among American Indian children. The programme consisted of four components: food service, classroom curriculum, family involvement and physical activity.	7/8	3/7	3/3	'High'	'Mid'	'High'

Table 8 *Continued*

Citation	Study design	Programme description	Scoring categories			Rank for other appraisal types		
			Selection bias	Information bias	Confounding	Programme	Population health	Immigrant health
Deforche *et al.* 2001 (106) (Netherlands)	RCT	A 1-year residential weight reduction clinic programme providing medical support, diet, physical activity and a psychological support programme.	5/5	2/2	0/0	'High'	'Low'	'Low'
Flodmark *et al.* 1993 (107) (Sweden)	RCT	Clinic-based, 14–18-month dietary counselling, family therapy, paediatrician visit and exercise encouragement for obese children ages 10–11 years.	7/8	3/7	3/3	'High'	'Low'	'Low'
Gortmaker *et al.* 1999 (108) (USA)	Cluster RCT	Planet Health Education Programme, pilot study. A 2-year primary school-based health and fitness education programme integrated into school curriculum.	7/8	3/7	3/3	'High'	'Low'	'Low'
Harrell *et al.* 1998 (109,116), 1996 (110), 1999 (111) (USA)	Cluster RCT	Cardiovascular Health in Children Programme. An 8-week primary school-based physical activity programme, to reduce cardiovascular disease, delivered by teachers following training.	6/8	3/7	3/3	'High'	'Low'	'Low'
Hergenroeder *et al.* 1993 (112) (USA)	Cluster RCT	An 18-week secondary school-based, aerobic exercise programme instead of regular physical education class.	6/8	3/7	2/3	'High'	'Low'	'Low'
Karolkiewicz *et al.* 1998 (113) (Poland)	Cohort	A 21-day clinic-based programme of physical activity and diet restriction for obese children aged 15–17 years to examine lipid profiles and glutathione levels.	3/5	2/2	0/0	'High'	'Low'	'Low'
Komorowski *et al.* 1982 (114) (Poland)	RCT	An 8-week programme of a calorie-reduced diet and use of mazindole intervention for children aged 9–15 years.	3/5	2/2	0/0	'High'	'Low'	'Low'
Korsten-Reck *et al.* 1990 (115) (Germany)	Clinical Trial	A 6-month outpatient clinic-based sports activity, diet and behaviour modification intervention for 9–12-year-old overweight children.	3/5	2/2	0/0	'High'	'Low'	'Low'
Liveri *et al.* 1992 (116) (Italy)	RCT	A 6-month clinic-based programme of general exercise and healthy eating advice with the addition of glucomannan (dietary fibre) for children aged 5–18 years.	4/5	2/2	0/0	'High'	'Low'	'Low'

Table 8 *Continued*

Citation	Study design	Programme description	Scoring categories			Rank for other appraisal types		
			Selection bias	Information bias	Confounding	Programme	Population health	Immigrant health
Lytle *et al.* 1996 (117) Osganian *et al.* 1996 (118), 2003 (119) Nader *et al.* 1999 (120), 1996 (121) Edmundson *et al.* 1996 (122) Webber *et al.* 1996 (123) Luepker *et al.* 1996 (124) (USA)	Cluster RCT	CATCH – A 3-year primary school-based multi-component intervention that included classroom curricula, food service modifications, physical education changes and family reinforcements.	7/8	4/7	3/3	'High'	'Mid'	'Low'
Manios *et al.* 1999 (125) (Greece)	Cluster RCT	A 3-year (planned for 6 years) primary school health, fitness and nutrition education programme, involving parents in support, meetings, educational information and nutritional self-assessment. Modified from the Know Your Body programme.	7/8	3/7	3/3	'High'	'Mid'	'Low'
O'Dea *et al.* 2000 (126) (Australia)	Cluster RCT	A secondary school-based 9-week programme to improve self-esteem, body image and eating attitudes.	4/8	5/7	3/3	'High'	'Mid'	'Low'
Robinson 1999 (127) (USA)	Cluster RCT	A 6-month primary school-based curriculum with home electronic controls to reduce television, videotape and videogame use for obese adolescents.	4/8	6/7	2/3	'High'	'Mid'	'Low'
Salvatoni *et al.* 1991 (128) (Italy)	RCT	A 30-day clinic-based programme of energy restricted general healthy eating advice with the addition of glucomannan or detastranum (dietary fibre) for children aged 8–13 years.	4/5	2/2	0/0	'High'	'Low'	'Low'
Vido *et al.* 1993 (129) (Italy)	RCT	A clinic-based 2-month treatment using glucomannan (dietary fibre) as an adjunct therapy in obesity management for children ages 8–14 years.	6/8	7/7	1/3	'High'	'Low'	'Low'

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.
RCT, randomized controlled trial.

means that had methodological rigour been the only inclusion criterion, 127 programmes that scored 'High' on other appraisal types would have been excluded. Historically it has been observed that the quality of evidence does not automatically translate into best practice (131). But rather, practice/policy recommendations are often based on the synthesis of evidence across studies together with consideration of other factors. For example, the US Task Force on

Table 9 Programmes scoring 'High' in appraisal of qualitative methodological rigour ($n = 2$)

Citation	Programme description	Scoring categories			Rank for other appraisal types		
		Reflexivity	Credibility	Transferability	Programme	Population health	Immigrant health
Beech *et al.* 2003 (90) (USA)	GEMS Memphis 12-week pilot study for 8–10-year-old African American girls. Community-based weekly interactive group sessions including after school activities and health education focused on knowledge and behaviour change skills to promote healthy eating and increased physical activity.	2/2	9/11	1/1	'High'	'Mid'	'Mid'
Neumark-Sztainer *et al.* 2003 (130) (USA)	NEW MOVES: A 16-week secondary school-based alternative physical education class, nutrition education and social support sessions for overweight girls or those at risk because of low levels of activity	1/2	9/11	1/1	'High'	'Mid'	'Low'

'High': score in the top 1/3.
'Mid': score in middle 1/3.
'Low': score in the lower 1/3.
RCT, randomized controlled trial.
Reflexivity, discussion of researchers' motives/influence on plan and results.
Credibility, description of theoretical framework, approaches to data collection and data analysis.
Transferability, description of population characteristics and study context.

Community Preventive services makes recommendations for intervention to promote health and prevent disease, injury and disability on the basis of systematic reviews of evidence of effectiveness, economic evaluation and barriers to implementation (54). The Canadian Periodic Health Examination Task Force provides recommendations on the utility of various preventive strategies on the basis of the best available evidence. For example, on the basis of evidence that was available, the 1999 Periodic Health examination update on detection and treatment of obesity neither recommended for, nor recommended against, BMI measurement as a routine procedure in the general population, while it was highly recommended for routine use in obese adults (132).

As discussed previously (see Section 3.6), using methodological quality as the only criterion to formulate best practice recommendations confines the evidence base available from the past 20 years to a relatively small number of studies which were amenable to strict design criteria. Such an approach tends to exclude multifaceted population health approaches deemed necessary to tackle obesity prevention on theoretical grounds (16–18), in addition to experiential learning on programme acceptability by stakeholders and minority groups. Therefore, appraisal from different perspectives strengthens the synthesis. The limitation of this approach is that the reported effectiveness of the programmes is of questionable validity (given their 'Low' scores in methodological rigour). In addition, with the arbitrary nature of the cut-off point for 'High'/'Mid' scores chosen for this study, it is likely some of the articles receiving 'Mid' scores might have been included if the cut-off point was set at a lower level. However, studies excluded because of lower scores in methodological quality were included through criteria under other appraisal types (programme, population health or immigrant perspective).

It is difficult to assess whether the methodological criterion used for this synthesis was more stringent than those used in systematic reviews. However, 70–100% of the studies included in each of the 13 systematic reviews examined for this study were included for this synthesis. This inclusion rate indicates that the inclusion criteria used in this study were likely consistent with criteria used in previous systematic reviews. The use of other appraisal types is novel to this study, and contributes to synthesis of evidence from all available sources without significant compromise to methodological rigour.

6.2 Principles of programme development and evaluation results and discussion

Key point

- With two exceptions, all programmes had 'High' appraisal scores for programme development and evalua-

tion, which effectively gave this appraisal type the role of filter for programme inclusion for synthesis and provided an opportunity to look at programme development and evaluation more closely.

6.2.1 Results

Programme appraisal ranking was the highest for programme development and evaluation, where 99% (145) of programmes were ranked 'High'. In fact, ranking on programme appraisal was the criterion by which the majority of reports were included in the synthesis. One programme in a community setting that scored 'High' in the immigrant appraisal had a 'Mid' ranking (86) in programme development and one clinic-based programme (87) that scored 'High' in methodological rigour was not amenable to appraisal on programme development and evaluation (see Table 10).

To further explicate the scoring components and their relative impact on the total score, each programme was assigned a ranking based on where their score fell in the scoring range for each component. Each scoring component had different score potentials therefore the meaning of 'Low', 'Mid' or 'High' was determined separately for each category. For example, a 'Low' utility score would total one or less while a 'Low' accuracy score would total three or less. Table 11 summarizes the number and percent of programmes that scored in the 'Low', 'Mid' or 'High' range on each scoring component of utility, feasibility, propriety and accuracy. The majority of utility and propriety scores fell into either the 'Mid' or 'High' categories with very few (2.1% and 10.3% respectively) in the 'Low' category. The majority of feasibility and accuracy scores were 'High' (70.5% and 90.4% respectively). None of the accuracy scores were 'Low'. As shown in Table 11, of the three

Table 10 Summary of programme development and evaluation appraisal results by setting

Setting	All *N* = 147 % (*n*)	Pre school *n* = 1 % (*n*)	Primary school *n* = 45 % (*n*)	Secondary school *n* = 21 % (*n*)	Home *n* = 4 % (*n*)	Community *n* = 21 % (*n*)	Clinic *n* = 55 % (*n*)
Rank							
'Low'	0	0	0	0	0	0	0
'Mid'	<1 (1)	0	0	0	0	5 (1)	0
'High'	99 (145)	100 (1)	100 (45)	100 (21)	100 (4)	95 (20)	98 (54)

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.

Table 11 Ranking of programme development and evaluation appraisal scores by component

Category scores Programme rank	*N* = 145 Scoring components						
	Utility						
	Stakeholder involvement						
	Programme development	Programme implementation	Programme evaluation	Utility (total 6) *Usefulness of results to end users, funders and researchers*	Feasibility (total 3) *Practicality*	Propriety (total 7) *Ethics, legality and fairness of programme and evaluation*	Accuracy (total 11) *Programme and evaluation credible in terms of objectives and outcomes*
	% (*n*)	% (*n*)	% (*n*)	% (*n*)	% (*n*)	% (*n*)	% (*n*)
'Low'				2 (3)	15.8 (23)	10 (15)	0 (0)
'Mid'				47 (68)	13.7 (20)	42 (61)	10 (14)
'High'				51 (74)	70.5 (102)	48 (69)	90 (131)
Yes (stakeholder involved)	19 (27)	54 (79)	31 (45)				

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.

areas for potential involvement, stakeholders were involved most often at the programme implementation level (54.1% of citations). Stakeholders were involved in programme development and programme evaluation in 19% and 31% of citations respectively.

6.2.2 Discussion

Most programmes received full marks for the first three aspects of programme utility. Evaluators were generally credible and provided enough background information in their reports to identify their values. As well, very few articles were sponsored by organizations that would have a vested interest in the study findings.

Stakeholder involvement was assessed at three stages of the programme: its development, implementation and evaluation. Stakeholders were defined as 'anyone who can influence the programme, demand results from the programme, or hold the programme accountable to regulations or standards' (133, p. 13). As shown in Table 11 stakeholders were most often involved in the programme's implementation and were seldom involved in the programme development or evaluation. Greater involvement at the development and evaluation levels would help ensure that programmes are targeting concerns of the stakeholders and that programme objectives are addressed or modified as necessary (57). The feasibility of a programme correlates to sustainability over time. One hundred and two of the 145 programmes received at least two of the three marks for feasibility, indicating that these programmes were generally feasible. A programme that was either costly or imposed on a group may have positive results initially but maintenance is challenging once the research team departs.

The propriety assessment targeted the ethics of a programme and the trustworthiness of the authors. For this dimension scores generally fell in the 'Mid' to upper range. Those studies that described the study participant eligibility and evaluation and its strengths and weaknesses allowed the reader to assess where improvements might be made as well as point out important cautionary notes when using the data.

Programmes generally scored 'High' on the accuracy dimension and most were included because of performing well in this area. This is an expected result as most of the programmes were reported in peer-reviewed journals that have high standards for study validity and reliability.

6.3 Principles of population health results and discussion

Key points

- Programmes scoring 'Mid' ($n = 48$) to 'High' ($n = 1$) for application of population health principles were largely limited to school and community settings.
- Only one programme scored 'High' on upstream investment while the majority (72%) scored 'Low'.
- Over one-fifth (22%) of programmes had a 'High' potential to integrate their activities to address all three chronic conditions (cardiovascular disease, diabetes and cancer) in that they intervened on the common healthy living strategies of healthy eating, active living and mental health. However, none actually focused on all three chronic conditions. Only 6% of programmes addressed more than one of the three chronic conditions associated with obesity.
- The lack of upstream investment and application of multidimensional approaches in programmes represents a barrier to changing the obesogenic environment because to re-direct societal counter forces, downstream interventions need to be matched with upstream, multidimensional activities. Funders should place greater emphasis on design and evaluation components in order to contribute to the body of evidence on the value of these population health approaches.
- Focusing on programme settings offers unique opportunities to intervene at multiple levels within the target population (e.g. school administration, staff, youth and families) and using multiple strategies (policy, supportive environments, campaigns) within the setting to ensure coordination and collective action on priority areas.

6.3.1 Results

Table 12 provides a summary of the programmes included for synthesis from a population health perspective. In addition, appraisal ranking on other appraisal types (programme description and evaluation, methodological rigour and immigrant health perspectives) is presented. Overall, 67% of programmes ($n = 98$) scored 'Low' on appraisal of multidimensional strategies and 72% ($n = 106$) scored 'Low' in terms of upstream investment criteria. As anticipated, 89% ($n = 49$) clinic-based programmes did not address multidimensional strategies and 98% had a downstream focus ('Low' score on upstream). However, approximately half of primary schools programmes scored 'Mid' on multidimensional strategies (56%) and level of upstream investment (49%), while programmes in secondary school and community settings were ranked lower. Only one primary school-based programme scored 'High' on population health principles (134,135). Thirty-seven of 49 programmes scoring 'Mid' to 'High' in population health (76%) were appraised as 'High' or 'Mid' in methodological rigour; and in 20 of 49 (41%) scoring 'Mid' to 'High' on population health, the duration of intervention or follow-up period exceeded 1 year.

Over one-fifth of programmes ($n = 32$) had 'High' potential to integrate their activities in that they addressed all three healthy living strategies (active living, healthy eating and mental health) to address all three chronic diseases associated with obesity (cardiovascular disease, diabetes

Table 12 Summary of population health appraisal results by setting

Settings	All *N* = 147 % (*n*)	Pre-school *n* = 1 % (*n*)	Primary school *n* = 45 % (*n*)	Secondary school *n* = 21 % (*n*)	Home *n* = 4 % (*n*)	Community *n* = 21 % (*n*)	Clinic *n* = 55 % (*n*)
Multidimensional approaches							
'Low'	67 (98)	100 (1)	42 (19)	62 (13)	75 (3)	62 (13)	89 (49)
'Mid'	33 (48)	0	56 (25)	38 (8)	25 (1)	38 (8)	11 (6)
'High'	1 (1)	0	2 (1)	0	0	0	0
Level of upstream investment							
'Low'	72 (106)	100 (1)	49 (22)	67 (14)	75 (3)	57 (12)	98 (54)
'Mid'	27 (40)	0	49 (22)	33 (7)	25 (1)	43 (9)	2 (1)
'High'	0.7 (1)	0	2 (1)	0	0	0	0
Integration of healthy living strategies							
'Low'	29 (43)	100 (1)	29 (13)	48 (10)	50 (2)	19 (4)	24 (13)
'Mid'	49 (72)	0	51 (23)	19 (4)	25 (1)	57 (12)	58 (32)
'High'	22 (32)	0	20 (9)	33 (7)	25 (1)	24 (5)	18 (10)
Integration in targeting chronic diseases							
None	51 (75)	100 (1)	40 (18)	38 (8)	100 (4)	67 (14)	55 (30)
'Low'	43 (63)	0	56 (25)	57 (12)	0	33 (7)	34 (19)
'Mid'	6 (9)	0	4 (2)	5 (1)	0	0	11 (6)
'High'	0	0	0	0	0	0	0

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.
Multidimensional approaches: Strategies that target a number of determinants of health, multiple groups and multiple areas for action within a single programme.
Level of upstream investment: Extent to which strategies are focused on broader groups and areas of action such as society as a whole and policy change as opposed to treatment of individuals.
Integration of healthy living strategies: The combined use of healthy eating, active living and support for mental health in a single programme.
Integration in targeting chronic disease: The number of chronic diseases (cardiovascular, diabetes and cancer) that a single programme targets for prevention.

and cancer); however, none actually did. In fact only 49% ($n = 72$) programmes addressed prevention of chronic diseases associated with obesity and the majority ($n = 63$) of programmes only addressed one of the three conditions. Most ($n = 65$) programmes focused on cardiovascular disease prevention, either alone ($n = 56$) or combined with diabetes prevention programmes ($n = 9$) (87,136–143). A further six programmes addressed diabetes prevention alone (99,134,135,144–148). Only one intervention included cancer prevention as defined by this review (i.e. cancer prevention activities described within the programme methodology) and this was within a cardiovascular disease prevention programme (149). Overall few programmes in clinical (87,139–143), primary (137,150), secondary school (149,151) and community (138) settings actually integrated their activities to focus on two of the three possible chronic diseases ('Mid' score for actual integration).

The single study, scoring 'High' on population health perspectives and described in Table 13, was conducted in a primary school setting, also scored 'High' on programme and immigrant appraisal but 'Low' on methodological rigour appraisal.

6.3.2 Discussion

This appraisal of programmes has demonstrated a significant lack of application of principles of population health from comprehensive muti-strategic approaches, to upstream investment in intervention strategies and integration of activities to address chronic conditions associated with obesity. This may be partly because of the appraisal method used, which was specially developed for this review and has not been tested before. The programme settings provided some insight into environmental conditions conducive to implementation of principles of population health examined in this review. Finally for programmes ranked 'High' or 'Mid' on population health, ranking on the other appraisal types, especially the ranking for methodological rigour, and the limited duration of programme intervention and follow-up suggests a need for caution in interpreting the findings.

Multi-strategy approaches. The only programme of those reviewed to rank 'High' in the appraisal of population health was the Kahnawake Schools Diabetes Prevention project which was set in a primary school for First Nation Canadians (134,135). One of the reasons this

Table 13 Programmes scoring 'High' in appraisal of population health principles

Citation	Programme description	Scoring categories		Rank in other appraisal types				
		Multidimensional approaches	Level of upstream investment	Integration of healthy living strategies	Integration in targeting chronic disease	Methodological rigour	Programme	Immigrant health
Macaulay *et al.* 1997 (135) Jimenez *et al.* 2003 (134) (Canada)	Kahnawake Schools Diabetes Prevention Project. First Nations primary school and community health education and behaviour modification (diet and exercise) programme. Multi-strategic – follows four of the five areas set out in the Ottawa Charter (develops personal skills, strengthens community action, creates supportive environments, develops healthy public policy); involves schoolchildren, their families and community; administered by community advisory board.	14/21	23/30	2/3	1/3	'Low'	'High'	'High'

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.
Multidimensional approaches: strategies that target a number of determinants of health, multiple groups and multiple areas for action within a single programme.
Level of upstream investment: extent to which strategies are focused on broader groups and areas of action such as society as a whole and policy change as opposed to treatment of individuals.
Integration of healthy living strategies: the combined use of healthy eating, active living and support for mental health in a single programme.
Integration in targeting chronic disease: the number of chronic diseases (cardiovascular, diabetes and cancer) that a single programme targets for prevention.

programme scored well was that it was designed around the Ottawa Charter (62), which is an integral part of the population health model that was used to develop this appraisal (61). The fact that the Kahnawake programme scored just at the cut-off for ranking as 'High' in this appraisal suggests that criteria for ranking 'High' in appraisal of population health principles in this review may be too rigorous. However, the approach to assessing health promotion programmes using theory is similar to the work of others (152,153). This strongly suggests the need for further testing and refinement of this appraisal technique to determine its appropriateness for assessing multidimensional strategies, upstream investment and integration. Notwithstanding the limitations because of over-rigorous criteria, the fact that two-thirds of programmes appraised were ranked 'Low' indicates a lack of population health approaches to the promotion of healthy weights in children and prevention of chronic diseases associated with obesity. Such multidimensional aspects are critical to an environmental approach to obesity prevention (16,17).

Upstream investment. Upstream investment in intervention strategies was even less evident than multidimensional approaches in this review (72% of programmes were ranked 'Low'). The focus on downstream clinical models (individuals or groups of individuals) of intervention rather than implementing more upstream approaches has been noted elsewhere (40,41). The fact that prevalence of childhood obesity has increased dramatically despite the numerous programmes and clinical interventions that have been undertaken over the last 20 years is a testament to a deficiency in obesity prevention and treatment approaches. The full spectrum along which programmes can intervene was examined and a lack of interventions at midstream (community and sector level) and upstream (government) levels was determined. Others have indicated that to re-direct societal counter forces, downstream interventions need to be matched with upstream activities (85,154). Changing the obesogenic environment can be expected to require considerable counter forces necessitating upstream investment in intervention strategies (2,16–18,40). This is not to suggest that only upstream investments are worthy. This

review demonstrates the value of interventions that focus on changing personal lifestyle but, as others have indicated (155), these activities need to be balanced by broader ecological approaches to obesity prevention.

Integration of activities for the prevention of chronic disease associated with obesity. Just over one-fifth of programmes were ranked 'High' in terms of potential to integrate the key healthy living strategies to address chronic conditions associated with obesity. This is not surprising as the interrelationships between the key strategies of healthy eating, active living and mental health are well established and it is not unusual to have all three included in a programme. However, all three key strategies having potential to address more than one chronic disease associated with obesity is a new concept only recently articulated (41,42). Therefore, it is not surprising that no programme identified provided evidence on the effectiveness of simultaneously addressing all three chronic conditions (heart disease, diabetes and cancer) associated with obesity. This is an area that needs to be explored from many different angles to formulate an approach that would be acceptable to stakeholders, able to overcome health disparities, and be effective.

Settings. School and the community emerged as the best settings for implementation of multidimensional strategies. One way of examining health interventions is in the context of settings – residential, occupational, educational or recreational. The rationale for a settings approach is based in part on recognition of the influence and power that organizational structures can have on behaviour. Settings have definable structures, established communication patterns, and are relatively stable over time. They provide accessible channels and mechanisms for reaching specific populations and influencing health. A setting approach redirects our thinking towards understanding how the system can influence or impact health (156). A system view looks at creating a health promoting environment through policies and initiatives such as taxation, urban design, advertising and access to healthy food choices and recreation rather than focusing on the individual lifestyle changes. Population health recognizes that people do not live in just one setting; their lives span multiple settings. Conditions cross settings and therefore interventions that span more than one setting are likely to be more effective than those that focus on just one setting (157).

The advantage of the school setting has been identified by a number of groups (158–161). Children spend considerable time in schools. Given the complementary roles of health and education in promoting the optimal well-being of the child, combining the efforts of each sector more effectively should result in a potent partnership for promoting health and learning. Health promoting schools have an opportunity through three interrelated components to support health in the school community – strengthening and enriching the curriculum, developing a health supporting environment to reinforce the promotion of health enhancing behaviours, and creating strong links and access to community resources. Others have pointed to the school setting as an excellent opportunity to intervene with children who are at risk and to support those already experiencing poor health (162,163). While there are many compelling arguments for the school as an opportune setting having environmental supports that reinforce health knowledge and skill development; others have questioned the ability of schools to make a difference to health (164) or that school settings are amenable to professional efforts (156). Nonetheless, the school can serve as a hub for the delivery of services and programmes and a connector among settings (165).

Communities also offer opportunities for intervention (157,158,162). Neighbourhoods and geographical locations can promote active living and access to nutritious choices for children that complement and reinforce the home and school setting. The community is also a setting for influencing broader environmental policy changes to urban design such as access to recreational sites. Improving access includes development and maintenance of parks and walking trails, lighting, transportation and community safety. At the same time communities can be a more challenging setting because boundaries are less clear. Communities are dynamic entities where communication channels are dispersed and cannot be defined only along geographical lines (166).

Clinic settings in this research emerged as the best setting for integration to address several chronic diseases associated with reduction in obesity among those already obese. Unlike a community setting where the messaging may be diffuse and not targeted to the individual, clinic interventions are focused on the individual and/or groups with common risk. Further, they usually employ multiple risk factor interventions (physical activity, diet modifications, psychosocial counselling) that have the potential to impact more than one disease. Individual goals or targets such as BMI range, cholesterol, glucose or blood pressure levels are usually identified and evaluations (physical or biochemical) provide for personalized feedback on progress, which in turn may be motivational. Healthcare providers, especially physicians, also have credibility with the population (166).

6.4 Immigrant health perspective results and discussion

Key point

- Programmes in the community setting have the greatest potential applicability to immigrant populations.

• Only four of all appraised programmes scored 'High' from an immigrant health perspective.

6.4.1 Results

As can be seen in Table 14, only 3% of programmes ($n = 4$) were ranked 'High' in terms of immigrant health perspectives. Settings for these 'High'-ranking programmes included primary schools (92,135,159) and the community (86). Some applicability to immigrant health issues was indicated in 5% of programmes ($n = 8$), which were ranked 'Mid' on appraisal of immigrant health perspectives. Half of these programmes were in the community setting (90,160,161,167,168) with the remainder in primary schools (146,169,170). Programmes in the community setting emerged in this analysis as having the greatest applicability to immigrant populations, where 24% ($n = 5$) were ranked at least 'Mid' in terms of considering immigrant population groups.

Table 15 shows the programmes that received 'High' scores based on immigrant health. In this table, a star indicates when a programme addresses an immigrant health perspective. In addition, the rankings of the programme in other types of appraisal: methodological rigour, programme, and population health are listed for convenience.

6.4.2 Discussion

The four programmes that scored 'High' from an immigrant health perspective included three school-based programmes developed for Native North American populations, and one community-based programme targeting African-American and Hispanic pre-school children in the USA. As expected, no programmes specifically addressed the needs of new immigrants. However, extensive efforts were apparent in all four 'High'-scoring programmes to engage community participation. Furthermore, both the feasibility and cultural acceptability of the interventions were considered. These strategies would also be important for addressing issues relevant to new immigrants.

The recruitment category addresses the effort made by programmes to address the unique cultural barriers to recruitment and participation. Examples of this include curriculum translation and selection of class times based on parent polls (86); curriculum design to accommodate various levels of fitness and motor skill (92); and the construction of a walking and bicycling path in the community (135). All four programmes addressed, to varying degrees, potential barriers to recruitment and participation.

Cultural, religious, food and activity customs were considered and/or accommodations made in all 'High'-scoring programmes. It is important to identify cultural variables that may serve as protective factors or strengths that enhance intervention outcome (173). Greater research is needed to examine the impact of including traditional practices on the acceptability, adherence and sustainability of health interventions targeting immigrant populations.

Consideration of gender roles and values was present in only one of the four programmes. Pre-test data collected by Davis *et al*. (159,174) in Pueblo and Navajo schools were analysed for both tribal and gender differences in perceptions about weight. It is possible, as all 'High'-scoring programmes targeted primary school-aged children or younger, that gender roles in this age group do not yet differ to a great extent. A recent study in Australian migrant communities found no gender-based restrictions on physical activity during childhood or adolescence (175). However, it would be important to consider the acceptability of programmes in light of socio-cultural influences in immigrant populations or sub-populations where gender roles are highly defined.

Programmes addressing the issue of unfamiliarity recognize that immigrants are in the process of adapting to a new lifestyle and may not be aware of the health practices and perceptions in their new community and country. For example, a diet high in fat and fast food is often associated with prestige and prosperity in certain immigrant populations (176,177). In the literature reviewed, examples of addressing unfamiliarity include partnering with the community, involving various channels of social support, and

Table 14 Summary of immigrant health appraisal results by setting

	All $N = 147$ % (n)	Pre-school $n = 1$ % (n)	Primary school $n = 45$ % (n)	Secondary school $n = 21$ % (n)	Home $n = 4$ % (n)	Community $n = 21$ % (n)	Clinic $n = 55$ % (n)
Rank							
'Low'	92 (135)	100 (1)	84 (38)	100 (21)	100 (4)	76 (16)	100 (55)
'Mid'	5 (8)	0	8 (4)	0	0	19 (4)	0
'High'	3 (4)	0	7 (3)	0	0	5 (1)	0

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.

Table 15 Programmes scoring 'High' in appraisal of immigrant health perspective ($n = 4$)

Citation	Programme description	Scoring categories					Rank in other appraisal types		
		Recruitment	Gender roles	Religion/culture/setting	Food/activity/custom	Familiarity	Methodological rigour	Programme development and evaluation	Population health
Davis *et al.* 1993 (171) Davis *et al.* 1995 (159)	Southwestern Cardiovascular Curriculum is a primary school and community-based intervention programme for grade five students using intergenerational and culturally appropriate activities designed to promote exercise and healthy eating in two Native American Indian tribes.	*	*	*	*	*	'Mid'	'High'	'Mid'
Davis *et al.* 1999 (92) Gittelsohn *et al.* 1998, 1999 (93,172), Helitzer *et al.* 1999 (95) Teufel *et al.* 1999 (99) Snyder P. *et al.* 1999 (98)	Pathways – Obesity Prevention Programme. A 3-year primary school-based programme for grades three to at promoting healthful eating and five aimed increased physical activity among American Indian children. The programme consisted of four components: food service, classroom curriculum, family involvement and physical activity.	*		*	*	*	'High'	'High'	'Mid'
Fitzgibbon *et al.* 2002 (86)	Hip Hop to Health Jr. is a 14-week pre-school community intervention at a Head Start Centre. A culturally and linguistically appropriate exercise and nutrition programme for minority children and their parents is presented	*		*	*	*	'Mid'	'Mid'	'Mid'
Macaulay *et al.* 1997 (135) Jimenez *et al.* 2003 (134)	Kahnawake Schools Diabetes Prevention Project. First Nation Canadian primary school and community health education and behaviour modification (diet and exercise) programme. 3-year programme.	*		*	*		'Low'	'High'	'High'

'High', score in the top 1/3.
'Mid', score in middle 1/3.
'Low', score in the lower 1/3.
*Indicates sensitivity to or consideration of potential barriers or issues from a cultural/ethnic perspective that was reflected in the programme description.

promoting traditional practices and diets as activity and healthy food choices. All four programmes addressed the lack of familiarity facing people of different ethnic and cultural backgrounds. In Native American communities, traditional foods which are high in fibre and low in fat (e.g. corn, beans and squash) (174), and the use of storytelling to validate a cultural heritage of healthy eating and physical activity (92), were incorporated. Notably, the family component was strong in all 'High'-scoring programmes. Many activities encouraged parents, other family members and community elders to become role models, influencing change in the household and community environments.

6.5 Systematic reviews of obesity prevention and treatment interventions results

Key points

- Strategies to reduce the prevalence of obesity in children should consider the development and implementation of school-based programmes of sufficient duration, frequency and intensity to increase physical fitness.
- Strategies that encourage behaviour modification to reduce sedentary behaviours also show promise in reducing obesity prevalence.

6.5.1 Results

A table with the key components of each review included for analysis can be found in the web supplementary material (64). Thirteen of 17 systematic reviews, four of which contained a quantitative meta-analysis (58,178–180), were apprised. Three of the reviews included both children and adults (58,59,180). Four reviews focused on physical activity or exercise (179–182) as an intervention to treat obesity or promote physical activity. Four reviews examined interventions to prevent obesity (59,60,183,184) or weight gain (59). Two reviews examined both prevention and treatment of obesity (58,185) with three restricted to treatment of obesity (178,186,187). The Cochrane Review on obesity that was included was the most recent version (60). The review by Epstein was also an updated version (181) of an earlier review (188). Two articles were initially identified as reviews but were in fact reviews of a systematic review.

There was overlap of included studies across reviews. The number of studies included in each review ranged from a low of three to a high of 51. All reviews had different inclusion and exclusion criteria. Just over half of the reviews included only randomized control trials (58,183,185–187) or some type of control group for comparison (60,181). Three reviews restricted duration or follow-up to at least 6 months (58,185–187). Many included rigorous quality assessments based on threats to internal validity (58–60,180,183,185–187) while the others had limited or no quality assessment. With the exception of the physical activity studies, most studies included in the reviews used multiple interventions while all but one study (180) had some form of body composition as an outcome measurement either as inclusion criteria or as a reported outcome. Most reviews' conclusions were based on study design and quality assessment although four did not take methodological rigour into consideration in making recommendations based on study outcomes (179,181,182,184). Generally, there were more mixed results reported and fewer definitive conclusions from reviews that included a greater number of studies and more stringent quality assessments.

6.5.2 Discussion

A synthesis of the reviews examined for this synthesis indicates that actual physical activity is an important intervention strategy in both the prevention and treatment of obesity. Campbell *et al.* concluded that a concentration of strategies that encourages reduction of sedentary behaviours and increase in physical activity may be fruitful in the prevention of obesity in children (60). While Glenny *et al.* also indicated that the reduction of sedentary behaviours appears to be the most effective intervention for achieving and maintaining weight loss (58). School-based physical education was considered effective in increasing levels of physical activity (180) and fitness. In Canada, the National Longitudinal Survey of Children and Youth indicates that 18 min of school-based physical education daily was associated with maintaining or increasing physical activity (189). It may be important to add behaviour modification strategies to physical activities to enhance outcomes as two of the reviews identified that comprehensive behavioural treatment approaches using behaviour modification for addressing eating and physical activity behaviour (185,186) are promising.

Based on the results of the systematic reviews, strategies to reduce the prevalence of obesity in children should consider the development and implementation of school-based programmes of sufficient duration, frequency and intensity to increase physical fitness. Strategies that encourage behaviour modification to reduce sedentary behaviours and promote healthy eating also show promise in reducing obesity prevalence.

7. Synthesis of findings – results and discussion

7.1 Gap analysis – first phase of synthesis results and discussion

Key points

- The majority of programmes targeted children aged 6–11 years, while only 6% of programmes addressed the 0–5 year age range thereby indicating a lack of intervention at this early life stage where upward crossing of weight centiles is recognized as a risk for obesity.
- Rapid weight gain during the first 6 months of life is a risk factor for overweight during childhood and young adulthood. This review, which was limited to programmes in the post-natal period, only found just one programme targeting this early infancy stage.
- Fewer than 3% ($n = 5$) of programmes were implemented in the home, a pivotal setting for greater involvement of family, who may be crucial to the success of treatment and prevention programmes. This paucity of programmes limits our understanding of the usefulness of the home setting.
- In general there were few programmes that addressed gender-specific differences. Eleven per cent of programmes targeted girls only and even fewer programmes targeted boys (3%). This is particularly evident in secondary school and community settings. The success (recruitment, engagement and acceptance) of the 'girl only' programmes hold promise for programmes that specifically target boys.
- No programme specifically focused on immigrants and only one-fifth ($n = 31$) were developed for minority populations, indicating a lack of programming to protect vulnerable new immigrants who initially have a low risk of obesity and associated chronic diseases. Programmes to

address obesity among children of new immigrants are lacking.

- Most of the programmes that focused on minority groups were found in the community setting.
- Just over a quarter (28%) of programmes had follow-up or duration periods exceeding 1 year, which provide little information on programme sustainability and long-term impact on obesity and associated chronic diseases.
- Health education on diet, physical activity or both (69%) and engagement in physical activity (64%) were the most common interventions.
- Environmental modifications were infrequently observed, indicating a lack of focus on creating supportive environments to tackle obesogenic elements.

7.1.1 Results

The majority of the 147 studies were implemented in either clinical settings (37%, $n = 55$) followed by primary (kindergarten through grade six) schools (31%, $n = 45$). Fewer than 3% ($n = 5$) of programmes were implemented in pre-school settings or homes. Tables 16 and 17 provide an overview of the populations targeted by these programmes in terms of age categories, gender, minority focus, population focus ('Universal', 'Selected' or 'Targeted') and duration of follow-up.

Population characteristics of studies reviewed. Exploration of age categories targeted by the programmes showed that the majority targeted children aged 6–12 years. Only 6% of programmes ($n = 9$) addressed the 0–5-year age range. The majority of programmes (86%) included both boys and girls; however, where gender specific programmes were developed, the focus was primarily on girls (11% vs. 3% for girls compared with boys respectively). This was particularly evident in the secondary school setting where there were no programmes that specifically targeted boys while 29% ($n = 6$) were specifically developed for girls. The bias towards girls in gender-specific programmes was also apparent in community and clinical settings, but not in primary school settings.

Focus of the programmes. No programme specifically focused on immigrants, while only approximately one-fifth ($n = 31$) of the programmes targeted minority populations. Of these, 35% ($n = 11/31$) occurred in primary schools and 29% ($n = 9/31$) occurred in the community. Clinic-based programmes were least likely (13%, $n = 4$) to target minority populations. Of those programmes included for synthesis, 41% had a 'Universal' focus (i.e. everyone in a healthy population), 38% were 'Targeted' (i.e. 'at risk' participants recruited from clinical settings), while 17% were 'Selected' (i.e. 'at risk' participants selected from a healthy population). The remaining 4% of programmes had a combined 'Universal' and 'Selected' approach. Programmes implemented in schools were most likely to be 'Universal' (78% in primary and 81% in secondary schools), while those in clinics were most likely to be 'Targeted' (89%).

Intervention types. Only 28% ($n = 41$) of programmes had follow-up or duration periods exceeding a year. Of those, just over half ($n = 21$) occurred in school settings and over one-third ($n = 16$) of all longer-term programmes were clinic-based. The majority of the programmes included health education on diet, physical activity or both (69%) and engagement in physical activity (64%) was the next most common intervention. The use of behaviour modification (50%) and involvement of family (52%) were also common. Following a specifically prescribed diet such as the traffic light diet was implemented in 35% of programmes. The incorporation of psychosocial support (25%), incentives or rewards (26%) and changes to the environment (17%) was less frequent. The prescribing of a

Table 16 Summary of programme population characteristics by setting

Setting	All *N* = 147 % (*n*)	Pre-school *n* = 1 % (*n*)	Primary school *n* = 45 % (*n*)	Secondary school *n* = 21 % (*n*)	Home *n* = 4 % (*n*)	Community *n* = 21 % (*n*)	Clinic *n* = 55 % (*n*)
Age categories							
0–5 years	6 (9)	100 (1)	4 (2)	0	25 (1)	19 (4)	2 (1)
6–12 years	50 (73)	0	87 (39)	0	75 (3)	48 (10)	38 (21)
13–18 years	23 (34)	0	0	90 (19)	0	19 (4)	20 (11)
6–18 years	21 (31)	0	9 (4)	10 (2)	0	14 (3)	40 (22)
Gender							
Females	11 (17)	0	2 (1)	29 (6)	25 (1)	28 (6)	5 (3)
Males	3 (4)	0	5 (2)	0	0	5 (1)	2 (1)
Both females and males	86 (126)	100 (1)	93 (42)	71 (15)	75 (3)	67 (14)	93 (51)
Minority focus							
Yes	21 (31)	0	24 (11)	24 (5)	50 (2)	43 (9)	7 (4)
No	79 (116)	100 (1)	76 (34)	76 (16)	50 (2)	57 (12)	93 (51)

Table 17 Summary of programme intervention characteristics by setting

Setting	All *N* = 147 % (*n*)	Pre-school *N* = 1 % (*n*)	Primary school *N* = 45 % (*n*)	Secondary school *N* = 21 % (*n*)	Home *n* = 4 % (*n*)	Community *n* = 21 % (*n*)	Clinic *N* = 55 % (*n*)
Population focus							
Universal	41 (60)	100 (1)	78 (35)	81 (17)	0	32 (7)	0
Selected	17 (25)	0	9 (4)	14 (3)	75 (3)	48 (10)	95 (5)
Targeted	38 (56)	0	2 (1)	5 (1)	25 (1)	19 (4)	89 (49
Universal and selected	4 (6)	0	11 (5)	0	0	0	2 (1)
Duration + follow-up							
≤1 year	72 (106)	100 (1)	62 (28)	81 (17)	100 (4)	81 (17)	71 (39)
>1 year	28 (41)	0	38 (17)	19 (4)	0	19 (4)	29 (16)
Intervention present*							
Physical activity	64 (94)	0	67 (30)	57 (12)	50 (2)	76 (16)	62 (34)
Diet	35 (52)	100 (1)	16 (7)	5 (1)	0	38 (8)	64 (35)
Behaviour modification	50 (73)	0	44 (20)	48 (10)	75 (3)	67 (14)	47 (26)
Family	52 (77)	0	60 (27)	29 (6)	75 (3)	57 (12)	53 (29)
Environment	17 (25)	0	29 (13)	14 (3)	0	19 (4)	9 (5)
Reward/incentive	26 (38)	0	16 (7)	10(2)	100 (4)	43 (9)	22 (12)
Psychosocial support	25 (37)	0	22 (10)	38 (8)	25 (1)	24 (5)	29 (16)
Health education	69 (101)	0	80 (36)	62 (13)	75 (3)	81 (17)	58 (32)
Physical activity alone	3 (5)	0	4 (2)	5 (1)	25 (1)	0	2 (1)
Diet alone	21 (31)	0	18 (8)	14 (3)	0	24 (5)	27 (15)
Physical activity and diet	44 (65)	0	58 (26)	43 (9)	50 (2)	57 (12)	29 (16)

Universal: everyone in the general population recruited.
Selected: at risk participants selected from a healthy population.
Targeted: at risk participants recruited from a clinic setting.
*Multi-strategic programmes are represented in more than one category under Intervention.

diet was the most common element of the clinic setting while it was the least common element in both school settings.

7.1.2 Discussion

Infants and toddlers. Evidence is accumulating that early infancy may be a critical period for the development of obesity. Several studies have identified rapid weight gain during the first 6 months of life as a determinant of overweight during childhood (190) and young adulthood (191). A recent analysis by Cole demonstrates that children who gain weight rapidly so that their BMI kg m^{-2} measurements are crossing centiles upwards (these children often have a high BMI kg m^{-2}) are those who experience an early 'adiposity rebound' (192). Adiposity rebound refers to the second rise in BMI kg m^{-2} that occurs between the ages of 3 and 7 years, If a child experiences this rebound early there is an increased likelihood that the child will be overweight during adolescence (193) and adulthood (194–196). The public health significance of these associations is noteworthy considering that rapid growth during early infancy was identified in as many as 29% of babies in one of the cohort studies (191). Only one study, in this synthesis, focused specifically on early infancy; this was a well child clinic programme where breast feeding was encouraged (197).

However, apart from encouragement of breastfeeding, safe and effective interventions in early infancy for the prevention of obesity are not well established. Breastfeeding exclusively for (i) at least 2 months seems to be protective against the development of overweight in childhood (198), and (ii) for 6 months seems to be protective against the development of overweight during adolescence (199). After the first 2 months of life, growth rates of breastfed babies compared with formula-fed babies are somewhat slower. One of the mechanisms for the protective effects of breastfeeding probably relates to the relative control breastfed babies compared with formula-fed babies can exert over their energy intake (199). Breastfeeding confers many other long- and short-term health benefits to both mother and baby. Therefore, for prevention of obesity, encouragement of exclusive breastfeeding for the first 6 months of life, if possible, represents the only known safe intervention that can be implemented in early infancy (198,199). It is perhaps not surprising that only three programmes included for synthesis targeted the first 2 years of life. One was described earlier in this discussion (197) while neither of the other two focused on the first 6 months of life or breastfeeding *per se*. One involved a short-duration (16 weeks) home-visiting obesity prevention programme for Native American toddlers' age 16–30 months (200). The second involved a chronic disease prevention pro-

gramme which followed infants from age 7 months to 7 years (201–203). Now that knowledge is accumulating about the importance of early infancy, greater vigilance should be paid to promotion of breastfeeding and good infant feeding practice. The scope of this review was limited to post-natal programmes and therefore the potential benefit of antenatal care to reduce risks of intrauterine growth retardation and its associated risks for rapid growth in early infancy (204) and death from cardiovascular disease in adulthood (205) was not assessed.

Pre-school age children. Only one programme was implemented in a pre-school setting and this was an experimental study exploring the effects of a high-protein, compared with a high-carbohydrate, lunch on nutrient intakes (206). However, four programmes in the community did target children at the pre-school stage to promote healthy weights and prevent chronic diseases associated with unhealthy lifestyles. One involved a well-child clinic in Singapore, which followed children aged 3–6 years for 1 year (207). A second followed infants aged 7 months to 7 years mentioned above (201–203). A third was a 13-week nutrition education programme for mothers of pre-school children attending Head Start community centres (208). The fourth was a pilot phase of a culturally appropriate community-based programme for African-American and Latino pre-school children (86,209). Positive outcomes in terms of chronic disease risk factors (201–203), body composition (207) and dietary practices (208) were reported from three of these initiatives. This indicates that lack of programming in the pre-school setting may represent missed opportunities in obesity prevention, especially considering the significance of upward centile crossing during these years (192).

Home setting. The scarcity of programmes in the home setting may reflect difficulties relating to access. Many programmes (52% overall) in school, community and clinic settings did attempt to modify home environment by involving families either through direct involvement or through activities the children completed with family at home. Two of the four programmes in the home setting were small ($n < 15$), short-term (<10 weeks) experimental interventions, which demonstrated that sedentary behaviours can be significantly modified in this setting (210,211). The remaining two programmes were both pilot tests of obesity prevention programmes. One, alluded to above, involved the home-visiting programme for Native American toddlers age 16–30 months (200) and the second involved an Internet-based programme for African-American 8-year-old girls (212,213). Both of these pilot programmes were of short duration (<16 weeks) and, as such, failed to modify nutrition or physical activity behaviour or body composition. While the home-visiting programme for Native American toddlers showed promise (200), the Internet programme failed to retain interest with overall log-on rates of less than 50% (212). Notwithstanding the practical difficulties involved in implementing interventions in the home, this setting is likely to be important for the prevention of childhood obesity. 'Involving family more' is reported as one of the lessons learned by the multidimensional, school-based Pathways programme (103,214), which identified that to be successful, childhood obesity prevention programmes likely need to address environmental and socioeconomic factors that go beyond the school setting (215). For practical reasons, parents are often agents of change for infants and pre-school children. Furthermore, two clinic-based programmes targeting older children (6–12 years) have demonstrated that using parents as the agents of change is very effective (216–219). Of note, one programme demonstrated that using the parents as the agents of change was more effective in managing childhood overweight compared with a child-only approach (217,218). Furthermore this programme recently provided evidence that this approach was superior in the long term (7 years) (216), which strongly indicates the importance of family involvement in promoting healthy weight in children. Consideration should be given therefore to developing and evaluating programmes that intervene directly in the home environment – a pivotal setting for families.

Gender-specific. This review has revealed that few programmes for children and adolescents are gender-specific and that programmes specifically addressing boy's needs are rare. Only four of the 147 programmes included for synthesis were exclusively for boys. Two of these were experimental physical training programmes to determine effects (i) on insulin dynamics, and (ii) on subsequent spontaneous energy expenditure (147,220). The third programme for boys only was a 3-year, cardiovascular disease prevention initiative set in primary schools in Moscow (221). A programme report mentioning features that might be specifically attractive to boys as opposed to girls was a weight-lifting and resistance training intervention for pre-pubertal Arabic speaking boys in Israel (222). Self-concept analyses were performed but these indicated a decrease in self-concept over the 3 years of follow-up (222). One programme enrolling both boys and girls, which took into account gender differences, was a residential weight loss camp where children participated in gender-specific activities and self-esteem scores were increased following the camp compared to a non-overweight control group (223).

In contrast to boys, more programmes ($n = 17$) have been developed to meet the specific needs of girls, particularly adolescent girls (90,113,130,160,161,167,212,224–234) and these were most evident in secondary school and community settings. The success of the recruitment phase of low-income African American pre-adolescent girls to the Girls Health Enrichment Multi-site Study (GEMS) provides

strong support for the inclusion of the specific, gender-related needs of the target population during programme development (234). 'Girlfriends for Keeps' and popularity of dance activities are just some examples of how well the GEMS programme met the specific needs of young girls; but they also demonstrate how such programmes would not be applicable to pre-adolescent boys. Furthermore, the feasibility of an innovative, girls-only programme developed for high school students (NEW MOVES) was marked by strong satisfaction ratings among participants, parents, and school staff and also by programme sustainability (130). Another targeted after school programme aerobic dance programme, Weight Winners, also had high programme satisfaction and highlights the importance of group leaders' participation in providing empathetic and non-judgemental programme leaders (228). The latter is a factor that may be particularly important for female participants. In fact, a psychosocial component was present in 59% of the programmes targeting females only (90,130,160,161,167,212,227–229,233) compared with 21% of programmes targeting both genders and none of the programmes targeting males only.

There are many reasons why obesity prevention programmes are being developed for girls as they reach adolescence. Specific issues facing young girls at this life stage include heightened body image concerns and increased vulnerability for developing eating disorders (235–238), decreased enrolment in physical education classes and significantly reduced participation in physical activity in general (239). Therefore, there is exigency to continue to develop gender-specific programmes for girls. However, in addition to finding very few gender-specific programmes, this review has identified a lack of such programming to meet the specific needs of boys. This is a critical gap because the development of overweight during male adolescence is associated with a significant mortality risk that persists even for those boys who are of normal weight during adulthood (240).

New immigrants and minorities. A complete lack of programming to address and understand the specific needs of immigrants new to industrialized countries was identified in this review. This indicates that such families make the difficult transition from their traditional diet and physical activity patterns to those that prevail in the host country without opportunity and education to ensure this changeover is healthy. As discussed earlier (see Section 1.3), children and adolescents within new immigrant families tend to become socially integrated more quickly than their parents and as such are likely to be particularly vulnerable to an obesogenic environment (49). The increasing prevalence of overweight identified among first generation to third generation adolescent immigrants to the USA bears testament to this vulnerability (51). The prevalence of chronic diseases associated with obesity also increases among immigrants with time living in an industrialized host country (50), further demonstrating the potential long-term benefits to the healthcare system of host countries that might be expected from interventions that are effective at protecting new immigrants.

Programmes targeting minority populations have some applicability to new immigrant groups. Approximately one-fifth of programmes ($n = 32$) included for synthesis had a minority focus and over half of these were in school and community settings. In addition to the situation regarding new immigrants, there are numerous reasons why such programming needs to be continued and expanded. Ethnic diversity is increasing among populations of industrialized countries, e.g. by 2020 ethnic minorities are expected to make up 40.2% of the USA population (241). A higher prevalence of obesity has been identified among several of these minority populations, which indicates increased susceptibility and a need for programmes to specifically target these groups (158,242,243).

Duration of programmes. Obesity can become a chronic condition, yet just over a quarter of the programmes included for synthesis had duration and/or follow-up periods exceeding 1 year. This limits what can be inferred from this review about effectiveness and sustainability of programmes over the long term. The majority of these longer duration/follow-up programmes were in the primary school and clinic settings. Some, such as the Know Your Body Programmes, crossed into secondary school settings spanning grades four to nine (125,244–246). These studies measured outcomes at multiple time points, which may contribute to a better understanding of effectiveness of programmes beginning with school age children and crossing into adolescence, as well as the impact of very long-term programmes. For other programmes that are of short duration, longer follow-up is essential to determine the impact of these programmes on obesity (126,137,207,247).

Creation of supportive environments. This review revealed a lack of programming to create supportive environments that promote healthy weights and the prevention of chronic disease in children and youth. This concurs with the lack of upstream strategies employed by most of the programmes included for synthesis that was apparent from appraisal of population health principles (see Section 6.3). Most ($n = 13$) of the 25 programmes that did address the environment were in primary school settings and this mainly involved modification of school cafeteria menus and catering staff training to ensure healthier food and beverage options (92,117,124,135,248,249). A few programmes in the primary school setting implemented additional strategies to modify food service and create more supportive

environments. The CATCH (117,120,121) and Pathways (92,94,96,97,100,104) programmes had extra physical education classes/activity breaks to increase physical activity and both programmes hosted activities for families. Other programmes included activities to promote exercise such as walking clubs, school races (250), while the most multi-strategic programme in this synthesis involved the local community in treasure hunts, volleyball, line dancing classes and food fairs (135). One American programme, designed to increase fruit and vegetable intakes, involved local grocery stores to enhance promotion of fruit and vegetables at 'point of purchase' (251). The grocers staged extra activities to promote fruit and vegetables for primary school children and their families.

Three programmes in secondary school settings also took steps to create supportive environments for healthy eating and/or active living. Activities included modification of school meals, provision of exercise facilities and training (146,176,252) and community meetings (151). One of these programmes showed the significant potential of environmental modifications. The Zuni Diabetes Prevention programme intervened on dietary intakes primarily through targeting beverage consumption of secondary school students at the Zuni Pueblo in New Mexico (146,176). The water available for the Zuni Pueblo was high in sulphur and iron and was unpalatable for drinking. Students relied on soft drinks, which were replaced by the programme with palatable water in coolers located in several places on the school premises and 'diet' soft drinks. These activities combined with information promoting water over soft drinks resulted in a change in drink consumption from 800 soft drink cans per week to 250 soft drink cans and 150 gallons of water per week (146,176).

Two programmes in the community setting considered environmental strategies to enhance participation in sessions. One provided transportation to and from the community site (224,253); while the second ensured that the site was located in a safe, local neighbourhood area (161). Two programmes in the community setting were residential summer camps and thus controlled all environmental stimuli (223,254). Three programmes in clinic settings were also residential (106,255,256). With few exceptions, most of the programmes described above used just one or two approaches (e.g. changing food served in schools, enhancing physical education classes) to modify the environment to enhance healthy eating and active living among children and youth. Lessons learned in the Pathways programme suggest that multiple environmental interventions in several settings simultaneously may be required to impact the obesity epidemic (214). The multiple reinforcing effects of interventions that cover all the settings where people live, work and play (school, community, shops, home and clinic) in an integrated way is proposed as a way forward (214).

7.2 Best practices in programme development – second phase of synthesis results and discussion

Key points

- Best practice in programme development and evaluation involves stakeholders input at every step in programme development, implementation and evaluation.
- Programmes that target minority groups report strong stakeholder involvement in programme development and implementation.
- Clinic-based programmes did not tend to include stakeholder involvement in programme development.
- Few studies consider the impact of the programme facilitator or leader on programme participation and outcomes; yet this can be a pivotal aspect of total programme performance.
- Those programmes that applied principles of programme development and implementation were more likely to reflect population health principles regardless of setting.

7.2.1 Results

A total of 39 of the 147 programmes (26%) scored 'High' in all four components of programme appraisal (utility, feasibility, propriety and accuracy). However, six of these were foreign language reports of programmes in the clinic setting, which were excluded on the basis of having undergone a more limited programme appraisal (89,114,115,256–258). The remaining 33 programmes were in primary school ($n = 16$), secondary school ($n = 7$), community ($n = 6$) and clinic ($n = 4$) settings. A brief description of these programmes, their actual scores within the four components making up programme appraisal and their ranking on the other appraisal types are presented according to their settings in Tables 18–21.

Identification of patterns. Programmes that had stakeholder involvement in programme development tended to focus on unique populations or groups. In the primary school setting half of the programmes ($n = 8$) had stakeholder involvement in programme development (see Table 19). Three of these programmes focused on First Nations children (92,159,170), while a further three adapted the 'Know Your Body' programme, a school-based health, fitness, nutrition education programme, to their specific population (125,244–246). In the secondary school setting two of the seven programmes had involved stakeholders in programme development (130,267) and one of these focused on girls at risk because of being overweight or inactive (130). Five out of the six programmes in the community setting had stakeholder involvement in programme development (see Table 18). Four of these programmes focused on African American children (90,160,161,225). In the clinic setting only one of the four programmes had stakeholder involvement in programme

Table 18 Programme development and evaluation synthesis: programmes in community settings ($n = 6$)

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Baranowski *et al.* 1990 (168)	II	Community-based health education and aerobic exercise programme targeting black, fifth to seventh grade students. 14 weeks.		*	*	5/6	2/3	5/7	8/11	'Mid'	'Mid'	'Mid'
Beech *et al.* 2003 (90)	I	GEMS Memphis Pilot Study. Community-based intervention including after school activities, health education and reduction of media use in homes for 8–10-year-old girls at risk of obesity. 12 weeks.	*	*	*	6/6	3/3	7/7	11/11	'High'	'Mid'	'Mid'
Ray *et al.* 1994 (207) Singapore	IV	Community-based, well child clinic surveillance and treatment programme for pre-school children with counselling by dietitians and nurses	*	*	*	4/6	2/3	6/7	11/11	'Low'	'Mid'	'Low'
Resnicow *et al.* 2000 (225)	IV	Community-based, educational programme for low income, inner city African American girls and their mothers to promote healthful eating and physical activity. 12 weeks	*	*	*	6/6	3/3	7/7	9/11	'Mid'	'Low'	'Low'
Robinson *et al.* 2003 (160)	II	GEMS Stanford Pilot Study. Community school-based intervention including after school activities, health education and reduction of media use in homes for 8–10-year-old girls at risk of obesity. 12 weeks.	*	*		5/6	2/3	6/7	10/11	'Mid'	'Mid'	'Mid'
Stolley *et al.* 1997 (161)	I b	Community-based educational programme for low-income, inner city African American girls and their mothers to promote healthful eating and physical activity. 12 weeks.	*	*		5/6	3/3	6/7	9/11	'Mid'	'Mid'	'Mid'

'High', score in the top 1/3.
'Mid', score in the middle 1/3.
'Low', score in the lower 1/3.
I, experimental study (e.g. randomized controlled trial with concealed allocation).
I b, experimental study (e.g. randomized controlled trial without concealed allocation).
II, quasi-experimental (e.g. no randomization).
III a, cohort study.
III b, case–control study.
IV, observational study without control group.
Utility: stakeholder involvement.
*Indicates element present.

Table 19 Programme development and evaluation synthesis: programmes in primary school settings ($n = 16$)

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Bush *et al.* 1989 (244)	II	Know Your Body programme. Primary school classroom intervention. 4 years	*	*	*	6/6	3/3	5/7	11/11	'Mid'	'Mid'	'Low'
Davis *et al.* 1993 (171), 1995 (159)	I	Southwestern Cardiovascular Curriculum. A primary school and community-based intervention using intergenerational and culturally appropriate activities designed to promote exercise and healthy eating in two Native American Indian tribes. 5 years	*	*	*	6/6	3/3	7/7	11/11	'Mid'	'Mid'	'High'
Davis *et al.* 1999 (92) Gittelsohn *et al.* 1998 (172), 1999 (93) Helitzer *et al.* 1999 (95)	I b IV	Pathways – Obesity Prevention Programme. Primary school-based programme for grades three to five aimed at promoting healthful eating and increased physical activity among American Indian children. The programme consisted of four components: food service, classroom curriculum, family involvement and physical activity. Two phases: Phase 1: 3-year feasibility to develop and test the programme and evaluation instruments. Phase 2: 3-year implementation.	*	*	*	6/6	3/3	7/7	9/11	'High'	'Mid'	'High'
Dollahite *et al.* (259)	II	Process and outcome evaluation of school-based community intervention programme on nutrition knowledge and food choices in primary school children. One school year.		*	*	6/6	3/3	9/7	11/11	'Mid'	'Mid'	'Low'
Dwyer *et al.* 1983 (247)	I b	Primary school-based physical education programme. 14 weeks.		*	*	5/6	3/3	6/7	11/11	'Mid'	'Low'	'Low'
Gortmaker *et al.* 1999 (250)	II	Eat Well Keep Moving Programme. Primary school classroom-based intervention to promote healthy eating and physical activity. 2 years.		*	*	5/6	3/3	6/7	10/11	'Mid'	'Mid'	'Low'
Harris *et al.* 1988 (170)	IV	Checkerboard Cardiovascular Health Education Curriculum. Primary school-based, education programme on nutrition, smoking, obesity. Most participants were American Indians. 10 weeks.	*	*	*	6/6	3/3	6/7	9/11	'Low'	'Mid'	'Mid'
Hopper *et al.* 1996 (260)	I b	Primary school-based/home-based, nutrition education and fitness programme for children. 10 weeks.		*	*	5/6	3/3	5/7	11/11	'Mid'	'Low'	'Low'

Table 19 *Continued*

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Lytle *et al.* 1996 (117) Luepker *et al.* 1996 (124)	III a	CATCH Primary school-based programme. Multi-component intervention that included classroom curricula, food service modifications, physical education changes and family reinforcements. Groups Control and two intervention group. One intervention group was school plus a family component while the other intervention group had only the school component. 3 years.		*	*	5/6	3/3	7/7	11/11	'High'	'Mid'	'Low'
Manios *et al.* 1999 (125)	I b	'Know Your Body' modified for application to Crete. Primary school health, fitness and nutrition education programme, involving parents in support, meetings, educational information and nutritional self-assessment. 6 years.	*	*	*	6/6	3/3	7/7	8/11	'High'	'Mid'	'Low'
Marcoux *et al.* 1999 (261) McKenzie *et al.* 1997 (262) Sallis *et al.* 1993 (263)	I, II, I b	SPARK, process evaluation. Primary school-based physical activity promotion intervention; self-management education. 18 months.		*	*	4/6	3/3	6/7	11/11	'Mid'	'Mid'	'Low'
Robinson et al 1999 (127)	I	Primary school-based intervention targeting media use reduction in school children. 6 months.		*	*	5/6	3/3	6/7	11/11	'High'	'Mid'	'Low'
Simons-Morton *et al.* 1991 (249) Parcel *et al.* 1989 (264)	IV	Go for Health A primary school behaviourally based intervention including health education, fitness-oriented physical education and change in school lunches. 24 months Checkerboard Cardiovascular Health Education Curriculum. Primary school-based education programme on nutrition, smoking and obesity. Most participants were American Indians. 10 weeks.		*	*	5/6	3/3	6/7	10/11	'Mid'	'Mid'	'Low'
Snyder *et al.* 1992 (265)	IV	Lunch power programme. Primary school-based. Change school lunch menus to lower fat and sodium content. 5 months.	*	*	*	6/6	3/3	6/7	11/11	'Low'	'Low'	'Low'

Table 19 *Continued*

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Tamir *et al.* 1990 (266)	III a	Israeli version of Know Your Body programme. Community and primary school-based programme on health education; parent education; and risk factor screening. 2 years.		*	*	5/6	3/3	6/7	8/11	'Mid'	'Mid'	'Low'
Walter *et al.* 1989 (246), 1988 (245)	I	Know Your Body programme. Primary school-based. Curriculum on diet, activity and smoking prevention; parent education; and risk factor screening. 6 years.	*	*	*	5/6	3/3	5/7	9/11	'Mid'	'Mid'	'Low'

'High', score in the top 1/3.
'Mid', score in the middle 1/3.
'Low', score in the lower 1/3.
I, experimental study (e.g. randomized controlled trial with concealed allocation).
I b, experimental study (e.g. randomized controlled trial without concealed allocation).
II, quasi-experimental (e.g. no randomization).
III a, cohort study.
III b, case–control study.
IV, observational study without control group.
Utility: stakeholder Involvement.
*Indicates element present.

development and this focused on African American children (271). Three programmes specifically identified the importance of programme leaders and role models for promoting positive programme retention and outcomes (130,213,228).

Application of population health principles. The majority (82%, $n = 27$) of the 33 'best programmes' were ranked 'Mid' on application of population health principles. However, six programmes were ranked 'Low' on population health principles. Three of these were in the primary school setting (247,260,265), one was in the community setting (225) and two were in the clinic setting (107,270). Closer examination found that these lower ranking programmes tended to be more single strategy focused and although some did involve family, these support systems were more of an adjunct than an integral aspect of the interventions.

Application of immigrant health principles. Applicability to minority groups was found to be almost three times more evident among the 33 'best' programmes in programme development and evaluation. While only 8% (12/147) of the total programmes included for overall synthesis were ranked 'Mid' or 'High' on appraisal of immigrant health perspectives, as many as 21% ($n = 7$) of the 33 'best' programmes had this ranking. Most of these minority-focused programmes were in the community setting, where four (90,160,161,168) of the six 'best programmes' were ranked 'Mid' on immigrant health perspectives (see Table 18). The three remaining programmes addressing the needs of minority groups (159,170,171) were in the primary school setting (see Table 19).

7.2.2 Discussion

It is encouraging that many of the programmes involved public participation. Traditionally health planners and pro-

Table 20 Programme development and evaluation synthesis: programmes in secondary school settings ($n = 7$)

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Coates *et al.* 1985 (267)	II	Great Sensations Programme. High school-based health education, parent support and school wide media promotion to encourage healthful eating. 4 weeks.	*	*	*	5/6	3/3	5/7	10/11	'Mid'	'Mid'	'Low'
Hoerr 1985 (228), 1988 (268)	IV	Weight Winners. Multidisciplinary high school-based, after school behaviour modification, aerobic exercise and appropriate behaviour modelling programme for overweight children. 3 months.		*		5/6	3/3	5/7	11/11	'Mid'	'Mid'	'Low'
Lionis *et al.* 1991 (151)	III a	High school-based. Modified 'Know Your Body' (KYB) health education programme delivered by teachers and community health centre staff. One school year.		*	*	5/6	3/3	7/7	10/11	'Mid'	'Mid'	'Low'
Neumark-Sztainer *et al.* 2003 (130)	I	NEW MOVES programme. High school based alternative physical education class, nutrition education and social support sessions for overweight girls or those at risk because of low levels of activity. 16 weeks.	*	*	*	6/6	3/3	7/7	11/11	'High'	'Mid'	'Low'
Puska *et al.* 1982 (252)	I b	Secondary school-based Know Your Body programme focusing on cardiovascular fitness. 2 years.		*	*	5/6	3/3	5/7	9/11	'Mid'	'Mid'	'Low'
Reinhardt et al 2002 (269)	IV	School-based physical activity and nutrition education training for school teachers aimed at increasing knowledge among adolescent students. 5 weeks.		*	*	5/6	2/3	5/7	9/11	'Low'	'Mid'	'Low'
Ritenbaugh *et al.* 2003 (146) Teufel *et al.* 1998 (176)	III a	The Zuni Diabetes Prevention programme is a community- and school-based primary prevention project designed to reduce the prevalence of diabetes risk factors among high school age youth living on an Indian reservation. 3 years.		*	*	5/6	3/3	5/7	10/11	'Low'	'Mid'	'Low'

'High', score in the top 1/3.
'Mid', score in the middle 1/3.
'Low', score in the lower 1/3.
I, experimental study (e.g. randomized controlled trial with concealed allocation).
I b, experimental study (e.g. randomized controlled trial without concealed allocation).
II, quasi-experimental (e.g. no randomization).
III a, cohort study.
III b, case–control study.
IV, observational study without control group.
Utility: stakeholder Involvement.
*Indicates element present.

Table 21 Programme development and evaluation synthesis: programmes in clinic settings ($n = 4$)

Programmes scoring 'High' in each of utility, feasibility, propriety and accuracy			Scoring categories									
			Utility							Rank in other appraisal types		
			Stakeholder involvement									
Author	Study design	Programme description	Programme development	Programme implementation	Programme evaluation	Utility	Feasibility	Propriety	Accuracy	Methodological rigour	Population health	Immigrant health
Epstein *et al.* 2000 (270)	I b	Clinic and family-based behavioural weight control programme comparing targeted decreases in sedentary behaviour vs. increases in physical activity in overweight children. 6 months.		*		4/6	3/3	6/7	9/11	'Mid'	'Low'	'Low'
Flodmark *et al.* 1993 (107)	I	Clinic-based, dietary counselling, family therapy, paediatrician visits, dietitian monitoring, exercise encouragement for overweight children. 14–18 month intervention.		*	*	5/6	3/3	6/7	11/11	'High'	'Low'	'Low'
Ford *et al.* 2002 (271)	I	Clinic-based for African American children. Individual counselling on potential problems with excessive media; TV viewing monitoring; and parent education for various weight children. 4 weeks.	*	*		5/6	2/3	5/7	9/11	'Mid'	'Mid'	'Low'
Wadden *et al.* 1990 (233)	I b	Weight Reduction and Pride programme. Group behaviour weight control programme for adolescent girls and their mothers. 16 weeks.		*		4/6	2/3	6/7	10/11	'Mid'	'Mid'	'Low'

'High', score in the top 1/3.
'Mid', score in the middle 1/3.
'Low', score in the lower 1/3.
I, experimental study (e.g. randomized controlled trial with concealed allocation).
I b, experimental study (e.g. randomized controlled trial without concealed allocation).
II, quasi-experimental (e.g. no randomization).
III a, cohort study.
III b, case–control study.
IV, observational study without control group.
Utility: stakeholder Involvement.
*Indicates element present.

viders have used a top-down approach to programme design and delivery. Because clinic programmes were part of the healthcare service system, it is not unexpected that only one of the clinic programmes involved the public. However, there is growing attention to the involvement of the public in the development of health priorities, programme, strategies and outcome indicators (41,81,272,273). A paradigm shift has occurred more recently in obesity prevention which moves the focus from the individual to that of the environment (162,165,274). Public participation is at the heart of community capacity which refers to the ability of a community to harness its skills, knowledge and resources to act on community and system identified health issues (272,273). Environmental strategies require the involvement of a myriad of community stakeholders to be successful. Some of the benefits of engaging stakeholders-building trust, incorporating public values, needs and concerns, reducing conflict, increasing public acceptance, and enhancing the quality of the decisions (41,275) – were evident in the programmes reviewed.

Of note, one programme in the community setting that addressed minority groups and did *not* have stakeholder involvement in programme development had poor participation rates (168), which may have contributed to lack of positive outcomes. Programme development that responds to community-identified issues and engages community members in strategies to resolve these issues are likely to build more ownership and commitment (275,276).

Facilitator characteristics are often not reported in intervention work; however, their characteristics may have a powerful effect on retention and outcomes (228,277). The programmes that tended to describe facilitator characteristics were those that were focused on female adolescents and/or minority populations. Similar to stakeholder involvement in ensuring a culturally acceptable programme, programme facilitators can serve as positive role models and validate participant experience ensuring a relevant and acceptable programme.

While none of these programmes focused on immigrants they were applicable to population subgroups with special needs because of cultural and social diversity. Laverack and LaBonte (276) suggest stakeholder involvement presents greater challenges in marginalized populations where the population is often unable to articulate their needs or interests. It was encouraging that many of the programmes that targeted minority populations were able to successfully engage the population. Examples of community or stakeholder involvement in this research offer strategies and techniques for engaging both mainstream and minority populations. Understanding the context of the lived experience of the population is critical to building public involvement and in turn enhancing community empowerment and community capacity.

7.3 Best practices in programme effectiveness – third phase of synthesis results and discussion

Key points

- The majority of programme outcomes indicated change towards improvement.
- Body composition was the most commonly reported outcome (84/102 programmes) and most programmes in clinical and school settings showed improvement towards leanness, whereas those in community settings tended to show no change.
- Chronic disease risk status was an outcome in 47% of programmes ($n = 48$) and the majority indicated positive changes particularly those that were primary school- or clinic-based, where close to 80% demonstrated significant improvement.
- Only 31 programmes reported on physical fitness and of these programmes in the secondary school setting reported positive changes most frequently.
- Nutrition, physical activity and psychosocial outcomes were reported by between 43%, 35% and 30% of programmes respectively, with the majority indicating improvement in these endpoints.
- Knowledge was the least frequently reported outcome ($n = 17$).
- Physical activity as an intervention was prominent in body composition, chronic disease risk factors, physical activity, nutrition and knowledge positive outcomes.
- Many programmes described activities which did not have outcome data presented, which hampers assessment of intervention components that are important to include.
- Positive nutrition outcomes in community settings may be positively influenced by combining family, behaviour modification and physical activity interventions with diet and nutrition recommendations.

7.3.1 Results

A total of 45 programmes included for synthesis (top third ranking) ranked 'Low' on methodological rigour and were excluded from this phase of the synthesis. An overview of reported outcomes for the remaining 102 programmes grouped according to their settings primary school ($n = 34$), secondary school ($n = 15$), clinic ($n = 37$), community ($n = 13$), and home ($n = 2$) and including directions of effect, are presented in Table 22.

The approach taken to qualitatively analyse the relationship between interventions and outcomes within and across programmes is illustrated in Table 23 where each of the included programmes scoring 'Mid' or 'High' in methodological rigour are identified by setting with indications of the outcomes measured and interventions used. Programme intervention components were grouped into broad categories, namely, physical activity, diet, behaviour modification, family involvement, environment, rewards/incentives, health education and psychosocial support. Within the programmes included for synthesis, there was a large variation in the specific features (individual components, duration, intensity, etc.) of intervention components within these broad categories as well as types of outcomes measured. This prohibited identification of which specific intervention features, within the broad categories of interventions, may be more effective than others. For example, for physical activity frequency, duration and intensity are likely to be important. Likewise, the merits of aerobic physical training compared with skill-based sports training or fun-based physical activity could not be adequately determined in this review. Furthermore, the contribution of interventions that were ubiquitous to all programmes could not be assessed because of the analytical approach taken. For example, health education, either in general or specific to healthy eating, active living or both, was an intervention feature common to the majority of programmes in all settings. Thus no patterns could be detected for this intervention.

Table 22 Summary of outcomes by setting for programmes ranking mid to high on methodological rigour

Setting	All	Primary school	Secondary school	Home	Community	Clinic
Total number of programmes	102	34	15	2	14	37
	% (*n*)	% (*n*)	% (*n*)	% (*n*)	% (*n*)	% (*n*)
Outcomes						
Body composition						
Total programmes with reported outcome	*N* = 84	*n* = 25	*n* = 12	*n* = 1	*n* = 10	*N* = 35
Decrease in fatness	68 (57)	76 (19)	67 (8)	(0)	20 (2)	83 (29)
No change in fatness	31 (26)	24 (6)	33 (4)	100 (1)	80 (8)	17 (6)
Increase in fatness	1 (1)	0	0	0	0	0
Chronic disease risk						
Total programmes with reported outcome	*N* = 48	*n* = 16	*n* = 8	*n* = 0	*n* = 6	*N* = 18
Decrease	79 (38)	81 (13)	75 (6)		50 (3)	88 (16)
No change	19 (9)	19 (3)	25 (2)		50 (3)	6 (1)
Increase	2 (1)	0	0		0	6 (1)
Physical fitness						
Total programmes with reported outcome	*N* = 31	*n* = 12	*n* = 6	*n* = 0	*n* = 6	*n* = 7
Increase	68 (21)	75 (9)	83 (5)		33 (2)	71 (5)
No change	32 (10)	25 (3)	17 (1)		67 (4)	29 (2)
Decrease	0	0	0		0	0
Psychosocial factors						
Total programmes with reported outcome	*N* = 31	*n* = 10	*n* = 6	*n* = 1	*n* = 6	*n* = 8
Improvement	61 (19)	20 (2)	67 (4)	0	100 (6)	88 (7)
No change	36 (11)	70 (7)	33 (2)	100 (1)	0	12 (1)
Negative response	3 (1)	10 (1)	0	0	0	0
Nutrition						
Total programmes with reported outcome	*N* = 44	*n* = 20	*n* = 9	*n* = 2	*n* = 7	*n* = 6
Improvement	73 (32)	85 (17)	56 (5)	0	86 (6)	67 (4)
No change	25 (11)	15 (3)	33 (3)	100 (2)	14 (1)	33 (2)
Negative response	2 (1)	0	11 (1)	0	0	0
Physical activity						
Total programmes with reported outcome	*N* = 36	*n* = 16	*n* = 5	*n* = 1	*n* = 6	*n* = 8
Increase	64 (23)	62 (10)	100 (5)	100 (1)	50 (3)	50 (4)
No change	33 (12)	38 (6)	0	0	33 (2)	50 (4)
Decrease	3 (1)	0	0	0	17 (1)	0
Knowledge						
Total programmes with reported outcome	*N* = 17	*n* = 11	*n* = 2	*n* = 0	*n* = 3	*n* = 1
Improvement	100 (17)	100 (11)	100 (2)		100 (3)	100 (1)
No change	0	0	0		0	0
Negative response	0	0	0		0	0

*Improvement indicates a positive outcome in at least one measure within the category.

One programme (86) had not published quantitative outcome measures at the time of this analysis and thus was excluded from the analysis of associations between outcomes and interventions presented in Table 23. Several programmes reported on more than one outcome and if at least one finding was significant in the intended direction in any outcome category, it was considered to be an improvement. For example, if skin-fold measures and BMI were used to assess body composition and the skin-fold outcome was decreased but the BMI was unchanged, the outcome under the body composition is identified in Table 23 as an improvement. It was also notable that many activities described in programme reports did not have corresponding outcome measures presented. The majority of outcomes changed towards improvement with the exception of psychosocial factors where no change may suggest no adverse effects. Many programmes reported on outcomes that were directly measured and can be considered primary outcome measures. In fact body composition was the most commonly reported outcome ($n = 84$), followed by chronic disease risk ($n = 48$), almost one-third of programmes ($n = 31$) provided outcome data on physical fitness. Intermediary outcomes, most often indirectly measured, included nutrition ($n = 44$), physical activity ($n = 36$), psychosocial factors ($n = 31$) and knowledge ($n = 17$). See Table 4 for a complete description of intervention and outcome measures.

As previously identified, most programmes were of short duration, i.e. less than 1-year duration and or follow-up and these shorter programmes generally report more posi-

Table 23 Outcomes and interventions for programmes ranked 'Mid' and 'High' on methodological rigour ($n = 101$)

Citation	Outcome indicators								Interventions							
	Chronic disease risk				Intermediary											
	Duration/follow-up >1 year	Body composition	Chronic disease risk	Fitness	Psycho-social	Nutrition	Physical activity	Knowledge	Physical activity	Diet	Behaviour modification	Family involvement	Environment	Rewards/incentive	Health education	Psychosocial support
Primary schools* n = *34																
Alexandrov *et al.* 1992 (221)	+	I	I							+		+			D	
Arbeit *et al.* 1992 (278)	+	I	I	I		I		I	+		+	+	+		PAD	+
Baranowski 2000 (251)					↔	I					+	+	+	+	D	
Brownell *et al.* 1982 (248)		I							+		+	+	+		PAD	+
Burke *et al.* 1998 (279)		↔	I	I		↔	I		+		+	+			PAD	+
Bush *et al.* 1989 (244)	+	↔	I	↔	↔	I					+	+			PAD	
Davis *et al.* 1993 (171)						I	I	I	+		+	+			PAD	+
Davis *et al.* 1999 (92)	+	↔				I	I	I	+		+	+	+		PAD	
Dollahite *et al.* 1998 (259)						I		I				+	+		D	
Dwyer *et al.* 1983 (247)	+	I	I	I					+						PA	
Eikner 1983 (280)		I							+						D	
Falk *et al.* 2002 (222)	+	N		I	N		↔		+							
Figuero-Colon *et al.* 1996 (136)		I	I						+	+	+	+				+
Gortmaker *et al.* 1999 (250)						I	↔	I	+		+	+	+		PAD	
Gortmaker *et al.* 1999 (108)	+	I			↔	I	I		+						PAD	
Harrell *et al.* 1998 (109)		I	I		↔		I		+						PAD	
Hopper *et al.* 1996 (260)				I		I		I	+			+		+	PAD	
Kater *et al.* 2002 (281)					↔			I			+					+
Lytle *et al.* 1996 (117)	+	↔	↔		↔	I	I		+		+	+	+		D	
Manios *et al.* 1999 (125)	+	I	I	I		↔		I	+			+			PAD	
Marcoux *et al.* 1999 (261)	+	↔		I			I		+		+	+				
Mo-suwan *et al.* 1998 (282)		I							+							
Muller *et al.* 2001 (137)	+	I				I	I	I	+		+		+		PAD	+
Nader *et al.* 1989 (169)	+		I	↔		I	↔	I	+	+	+	+		+	PAD	
Robinson 1999 (127)		I				↔	↔					+	+		PA	
Sahota *et al.* 2001 (283)		↔			I	I	↔		+		+	+	+		PAD	
Siegel *et al.* 1989 (284)		I		I					+							
Simons-Morton 1991 (249)	+				I	I	I		+	+	+		+		PAD	
Stephens *et al.* 1998 (285)		I	↔	I	I	I	I		+							
Sung *et al.* 2002 (286)		I	I			I			+	+						
Tamir *et al.* 1990 (266)		I	I									+			PAD	+
Vandongen 1995 (287)		I	I			I	I		+	+		+			PAD	
Walter *et al.* 1988 (245)	+	↔	I	↔		I	↔	I				+			PAD	
Wolfe 1986 (226,231)		I	↔		↔				+		+	+		+	PAD	
Secondary schools* n = *15																
Ambler *et al.* 1998 (88)		↔		I		N	I		+							
Chen *et al.* 2001 (227)	+	I	I		I	I	I				+				PAD	+
Coates *et al.* 1985 (267)						↔					+	+			D	
Cooper *et al.* 1984 (288)		I	↔							+						
Ewart *et al.* 1998 (231)			I	I					+							
Frenn *et al.* 2003 (289)					↔	I	I				+			+	PAD	+
Hergenroeder *et al.* 1993 (112)		I		I					+							
Hoerr 1985 (228)		I	I	↔	I	I			+		+	+		+	PAD	+
Killen *et al.* 1988 (290)		I	↔	I		I	I				+				PAD	
Lionis *et al.* 1991 (151)		I	I			↔						+	+		PAD	
McMurray *et al.* 2002 (291)		I	I	I					+						D	
Neumark-Sztainer *et al.* 2003 (130)		↔			↔	↔	I		+		+	+			D	+

Table 23 *Continued*

Citation	Outcome indicators								Interventions							
	Chronic disease risk				Intermediary											
	Duration/follow-up >1 year	Body composition	Chronic disease risk	Fitness	Psycho-social	Nutrition	Physical activity	Knowledge	Physical activity	Diet	Behaviour modification	Family involvement	Environment	Rewards/incentive	Health education	Psychosocial support
O'Dea *et al.* 2000 (126)	+	↔			I						+	+				+
Puska *et al.* 1982 (252)	+	↔	I		I	I		I				+	+		PAD	
Sadowsky *et al.* 1999 (292)		I							+							
Home* n = *2																
Epstein *et al.* 2002 (211)						↔	I				+	+		+	PA	
Harvey-Berino *et al.* 2003 (200)		↔			↔	↔					+	+		+	PAD	
Community* n = *13*																
Baranowski *et al.* 1990 (168)				↔			N		+	+		+		+	PAD	
Beech *et al.* 2003 (90)		↔		↔	I	I	I		+		+	+			PAD	+
Ignico 1995 (138)		↔	I	I					+							
Israel *et al.* 1990 (293)	+	↔								+	+	+		+	PAD	
Katch *et al.* 1988 (294)		I	I	↔					+	+	+				D	
Lozano 1997 (295)	+	↔							+	+	+	+			PAD	+
Nader *et al.* 1983 (296)		↔	↔	↔	I	I		I	+	+	+	+		+	PAD	
Niinikoski *et al.* 1996 (202)	+		I			I				+		+			PAD	
Owens *et al.* 1999 (297)		I	↔	I			I		+					+	PAD	
Resnicow *et al.* 2000 (225)		↔	↔		I	I	↔	I	+		+			+	D	
Robinson *et al.* (160)		↔			I	I	I				+	+				+
Stolley *et al.* 1997 (161)					I	I			+		+		+		PAD	+
Story *et al.* 2003 (167)		↔			I	↔	↔	I	+		+	+		+	D	+
Clinic* n = *37																
Barnow *et al.* 2003 (89)		↔			I				+	+		+			D	+
Berkowitz *et al.* 2003 (87)		I	I						+	+	+					
Brownell *et al.* 1983 (298)		I	I								+	+		+	PAD	+
Coates *et al.* 1982 (299)		I	I							+	+	+	+	+	PAD	+
Deforche 2001 (106)		I		I					+	+			+			+
Ebbeling *et al.* 2003 (148)		I	I							+	+				PAD	
Epstein *et al.* 2001 (219)	+					I					+	+			PAD	
Epstein *et al.* 1985 (232)		I					I		+			+		+		
Epstein *et al.* 1982 (300)		I		I		↔			+	+	+	+		+		
Epstein *et al.* 2001 (301)	+	I			I					+		+	+	+	PAD	
Epstein *et al.* 1993 (302)	+	I							+	+	+			+		
Epstein *et al.* 2000 (270)	+	I					I		+	+	+	+		+		
Epstein *et al.* 1994 (303)	+	I			I	I	↔	I	+	+	+	+		+		
Ferguson *et al.* 1999 (304)		I	I	↔					+					+		
Ferrer Lorente 1997 (305)	+	I							+	+	+	+			PAD	
Ferrer Gonzalez 1998 (306)		I	I						+	+					D	
Figueroa-Colon *et al.* 1993 (150)	+	I	I						+	+	+	+		+	PAD	
Flodmark *et al.* 1993 (107)	+	I					I					+			PAD	
Ford *et al.* 2002 (271)							I				+	+			PA	
Golan *et al.* 1998 (307)		I			I		↔			+	+	+			PAD	
Graves *et al.* 1988 (308)		I			I	I	↔		+	+	+	+		+	PAD	
Gutin *et al.* 1999 (309)		I		I					+		+			+		
Hardin *et al.* 1997 (139)		↔	I	↔		I			+	+						
Karolkiewicz 1998 (113)		↔	I						+	+						
Kay *et al.* 2001 (140)		I	I							+						
Komorowski 1982 (114)		I	↔													
Korsten-Reck 1993 (310)	+	I							+	+		+			D	

Table 23 *Continued*

Citation	Outcome indicators								Interventions							
	Chronic disease risk				Intermediary											
	Duration/follow-up >1 year	Body composition	Chronic disease risk	Fitness	Psycho-social	Nutrition	Physical activity	Knowledge	Physical activity	Diet	Behaviour modification	Family involvement	Environment	Rewards/incentive	Health education	Psychosocial support
Livieri 1992 (116)	+	I	I												PAD	
Maffeis *et al.* 1992 (311)		I	I													
Mellin *et al.* 1987 (312)	+	I			I				+		+	+			PAD	+
Rocchini *et al.* 1988 (313)		I	I	I					+		+				D	
Saelens *et al.* 2002 (314)		I			↔	↔	↔		+	+	+	+		+	PAD	
Salvatoni 1991 (128)		I	I												D	
Sothern *et al.* 2000 (315)	+	I							+	+	+			+	PAD	
Vido *et al.* 1993 (129)		↔	N							+						
Wadden *et al.* 1990 (233)		↔	I		I						+	+		+	PAD	+
Zwaiuer *et al.* 1988 (142)		↔	I									+			D	

I, improvement in outcome.
↔, no change in outcome.
N, negative outcome.
+, intervention present.
D, diet alone.
PA, physical activity alone.
PAD, physical activity and diet.
*Fitzgibbon *et al.* (2002) (92) which ranked 'Mid' in rigour is missing from this table because outcomes had not been reported at time of review.

tive outcomes. This must be kept in mind in considering the impact of interventions on outcomes.

Body composition. The majority of the programmes in school (n = 27/37) and clinic settings (29/35) that had body composition measures reported a reduction in 'fatness' following interventions while community-based programmes were least likely to demonstrate a reduction (n = 2/10). In school settings, the intervention that was most prominent in association with improved body composition was actual engagement in physical activity. This association was not as striking in the secondary school setting compared with the primary setting. Overall physical activity featured in 15 of the 18 programmes in primary school settings and four of eight in the secondary school setting reporting significant improvements in body composition. The number of long-term studies reporting positive and no change in body composition showed a similar pattern of inclusion of physical activity of around 60%. Therefore, the impact of physical activity in long-term studies is not as clear as in short-term studies. Of note, half of the short-term programmes involved children that were at higher risk – either selected from healthy children because of being at higher risk (226,279,280), or recruited because of being identified as overweight (136,248,286). Different responses may be anticipated for at risk and overweight children compared with children of healthy weight. One 3-year study of Arabic boys reported an increase in body composition parameters following an individualized weight training programme (222).

In the clinic setting, 35 studies reported body composition outcomes, of these 29 were positive. Physical activity, diet, family involvement, behaviour modification and incentives were prominent interventions in varying combinations. Of note, in those programmes that did not report change in outcome, incentives and behaviour modification were for the most part absent. In the community setting, 77% (10/13) reported body composition outcomes but only two reported a positive change while the majority (n = 8) reported no change. No relationship between particular interventions and the outcomes was identified.

Chronic disease risk. Of the 48 programmes that included chronic disease risk status (i.e. changes in risk factors for

cardiovascular disease, diabetes and cancer) as an outcome, the majority (79%, $n = 38$) reported positive outcomes. Adverse effects in terms of increase in chronic disease risk factors were reported in one programme which was within a clinical setting (129). Clinic settings were also the most likely to report positive outcomes (89% $n = 16$) on chronic disease status.

Chronic disease risk factor outcomes were reported less frequently in both school settings compared with body composition outcomes, with 16 of the 34 programmes in the primary school setting (47%) reporting these outcomes but only three not reporting positive outcomes. Eight of 15 reported chronic disease outcomes in the secondary school setting, with only two not reporting positive outcomes. Among those reporting positive outcomes, physical activity was the most prominent feature. In the community setting, six of 14 reported chronic disease outcomes, with three reporting a positive change and three reporting no change. No relationship between particular interventions and the outcomes emerged.

Fitness. Physical fitness outcomes were reported in 31 of the programmes and the majority, 68% ($n = 21$), reported improvements post intervention. Positive outcomes in fitness were most often reported in secondary school settings (83%, showing improvement in fitness levels), although the overall numbers of such programmes was small ($n = 6$). No programme reported decreased levels of fitness post intervention. Physical activity was the most key feature associated with positive outcomes while family involvement was also frequently evident. The community setting had six of 14 report fitness outcomes two reported positive outcomes and four reported no change. No patterns emerged for associations between intervention features and the outcomes. Of 37 clinic setting studies, seven reported fitness outcomes, with five positive and two no change. Physical activity and behaviour modification were prominent features.

Psychosocial. Close to one-third of programmes reported on psychosocial factors. Sixty-one per cent of these ($n = 19$) reported improvements, with community ($n = 6/6$) and clinical ($n = 7/8$) the most prominent settings. The majority of programmes (70%, $n = 7$) in primary schools resulted in no change in psychosocial outcomes. There was one report of adverse psychosocial outcomes. In one study both intervention and control boys had lower self-esteem scores at the end of the intervention, indicating a possible maturation effect (222). Those that reported on psychosocial outcomes were most frequently associated with behaviour modification, family involvement and psychosocial support interventions. However, this measure was used in this review to indicate the impact of other types of interventions on mental well-being. No change in this measure could indicate a positive response in that the intervention is not having a detrimental effect.

Nutrition. Of the 44 programmes that reported on nutritional outcomes, 73% ($n = 32$) reported positive change, with the most effective programmes occurring in community and primary school settings. Adverse nutritional changes were reported by one programme (88). Nutrition outcomes, such as fat, carbohydrate and energy intake, were most frequently reported in school settings particularly the primary school setting with 20 of 34 reporting the measure. Of note and in contrast to most other outcomes, more long-term studies ($n = 10$) reported positive outcomes in the primary school setting. Physical activity was a common feature in primary school settings reporting positive nutrition outcomes in contrast to secondary school settings where it was evident in only one programme of five reported positive nutrition outcomes. Neither of the two studies in the home setting reported positive outcomes in nutrition. Positive outcomes were identified in all six community setting studies that reported nutrition outcomes where behaviour modification, physical activity and family involvement were the most prominent features. Despite most clinic programmes prescribing specific diets, i.e. nutrition interventions, very few clinic studies reported nutrition outcomes. This could be the result of an interest in endpoints such as body composition rather than intermediary outcomes such as changes in dietary practices or the result of the complexity of measuring dietary outcomes. However, in four of the six who did measure nutrition, the outcomes were positive.

Physical activity. Of the 36 programmes that included physical activity outcomes, 64% ($n = 23$) demonstrated positive outcomes. All programmes reporting on physical activity outcomes in secondary school settings ($n = 5$) reported positive outcomes. There was one report of adverse effects in terms of a decrease in physical activity (168). Sixty-four studies used physical activity as an intervention but only 27 measured it as an outcome or as an indicator of dose–response by examination of varying activity levels and response to outcomes. There were 10 studies that measured physical activity but did not include actual activity as an intervention. These studies relied on health education, family involvement or psychosocial support as interventions. Physical activity as an intervention was reported in 15 of the 23 programmes that reported a positive physical activity outcome and was most prominent in primary school settings, to a lesser extent in the community and clinic settings and even less frequently in the secondary school setting.

Knowledge. Whenever knowledge was measured ($n = 17$), the outcome was positive and was most often measured in

the primary school setting ($n = 11$). Aside from health education, family and physical activity interventions predominated. As with nutrition outcomes, more long-term ($n = 7$) than short-term studies ($n = 4$) reported positive outcomes in the primary school setting.

7.3.2 Discussion

The finding that the majority of the programmes included for synthesis provided evidence of short-term improvement in indicators of chronic disease risk status and intermediary risk status provides strong support for continued and expanded programming to address the current obesity epidemic in children. Of note, the usual bias towards positive findings in published reports was at least partially addressed in this review by the inclusion of an Internet search and key informant surveys for unpublished reports. Finally, assessment methods used to detect changes resulting from programme interventions were highly reliable as the most frequently reported outcomes (body composition and chronic disease risk factors) were directly assessed. Although changes in outcomes that were indirectly assessed, such as nutrition, physical activity and psychosocial factors, were promising, the reliability of these is weaker because of the tendency towards reporting positive eating and activity behaviours (316). Nonetheless these intermediary indicators provide important information about the necessary elements of programmes that have a positive impact in the directly assessed chronic disease status indicators (body composition, chronic disease risk factors and physical fitness).

This synthesis also indicates that there are substantial gaps in evidence and in programming that impede our efforts at obesity reduction. These will be discussed below.

Methodological rigour. Because of the broad inclusion criteria for synthesis, the final analysis, focusing on factors associated with programme effectiveness, was limited to programmes with adequate methodological rigour. This resulted in 45 programmes being excluded from this phase because of a 'Low' ranking for methodological rigour (selection bias, information bias, confounding).

In examining these 45 programmes, some studies did not describe how participants were recruited (143,223,317–320), while others were recruited from physician's offices (207,321) or were volunteers (144). In all of these studies there was no randomization of subjects to either intervention or control groups increasing the potential for selection bias. Attrition of study subjects is another factor that may contribute to selection bias. In the excluded studies the attrition rate of study participants ranged from 21% to 77% (146,149,229,321–324). However, loss to follow-up (regardless of the magnitude) makes interpretation of findings difficult if the reason for drop-out is related to the intervention, the outcome or both (325). In these studies it was difficult to assess the potential for selection bias because investigators did not report the characteristics of study participants who completed vs. those who dropped out of the studies.

To accurately measure the intended outcomes, valid and reliable instruments are crucial. Some of the excluded studies did not report on the validity and reliability of the instruments used (322–324), while in one study (170) instruments were not yet fully developed. This limited the ability to assess the validity of the intended outcomes. Control groups help to protect against false causal inferences. For example, if there are other ongoing interventions in a community, interpretation of the effectiveness of the desired programme becomes difficult. Many of the excluded studies (135,144,145,197,220,254) did not have a control group therefore it was difficult to assess effectiveness of those programmes. To conclude, studies were excluded for phase three because of a combination of methodological problems that could lead to multiple types of biases. Care needs to be taken in evaluating future programmes to ensure that issues of bias and confounding are adequately addressed.

There were also methodological rigour limitations for the studies that were included in this third phase of the synthesis. Six of the studies included in the 101 programmes did not include a control, comparison group or cross over design (113,222,225,227,228,315). However, three of the studies compared responders (222), completers (228), or attendees (225) with participants in their study who were 'less engaged' or exhibited less participation in the intervention. Most studies in the school settings randomized by school or classroom but less than half took this factor into consideration by performing a cluster analysis approach using mixed models, calculating intraclass correlations or considering the school or class as a covariate for the analysis (92,109,117,125,130,226,244,245,247,251,261,279,281–283). This can contribute to inflation of the measures of association (326). Though, many studies in this group of 102 programmes took confounding factors into consideration in recruitment or inclusion criteria, e.g. only choosing schools in a 'Low' socioeconomic area, only choosing children in a narrow age range, etc.; other studies failed to consider some of these important factors. For example, schools rarely considered parental weight status in examining outcomes of preventive programmes. Many did not take into account socioeconomic factors.

Programme duration. Another limitation, discussed earlier in Section 7.2, concerns the short duration of most of the programmes included in this review. In this phase of the synthesis, short-term compared with longer-term programmes tended to report more positive outcomes, which may partly relate to the recidivism that plagues long-term efforts to improve dietary and physical activity habits (327).

Although positive outcomes in nutrition seemed to be preserved in long-term programmes in this review, the possibility of bias because of overall underreporting energy intakes or misrepresenting dietary intakes by underreporting intakes of foods considered 'unhealthy' cannot be completely ruled out. Knowledge was another outcome that remained positive after longer-term follow-up; however, this could be partly because of the increasing capacity of children learning abilities over time. Because of the effect of follow-up time on outcome, some systematic reviews have excluded studies of short duration (58,186). However, many short-term studies are excellent pilot tests of the feasibility and acceptability of programmes, which is pertinent information for this review.

It is also notable that outcomes in programmes of long duration tend to vary according to the time point of follow-up. For those programmes lasting greater than 2 or 3 years in length with multiple measurement points, there was a tendency for improvement factors such as body composition changes and fitness not to be sustained (221,241). For example, a 3-year programme involving primary schools in Russia found that in intervention vs. control schools, BMI was significantly improved in year one of follow-up only, while blood pressure was improved in year three only. Some studies, however, maintained some improvements in some chronic disease risk factors such as blood pressure and serum cholesterol measurements compared with control groups (244,245) beyond 3 years. A Know Your Body Programme undertaken in Greece demonstrated improvements in body composition and chronic disease risk factors up to 3 years; however, sustainability beyond 3 years remains to be assessed (125).

Adverse effects. There was little evidence of adverse effects of programmes examined in this review. Negative outcome response to interventions was evident in four programmes. An experimental trial of glucomannan (dietary fibre) as an adjunct obesity therapy reported adverse changes in blood lipids of overweight children treated (129). A previous trial of glucomannan (also included for synthesis) reported significant improvements in blood lipid profile of overweight children (128). However, these children had dyslipidaemia and were also treated with a hypocaloric diet which may explain the different outcomes of the two clinical trials. A negative nutrition response involved an increase in fat and a reduction in carbohydrate intakes among girls after a 5-week, secondary school-based endurance training programme, which explored the effects of fitness and exercise on dietary intakes of healthy adolescents (88). There was one report of adverse effects in terms of a decrease in physical activity but participation rates were low, and when examined by participation rate the decrease was reversed (168). One 3-year study of Arabic boys reported an increase in body composition parameters following an individualized weight training programme (222). However, other factors such as activity levels during the summer months and diet/nutrition throughout were not measured. When the effect of training was accounted for, responders demonstrated less of an increase in body composition measures.

Psychosocial issues. It should be noted that despite concerns about the potentially negative effects on body image that could arise from the promotion of healthy weights among children (235,327), only one negative outcome on psychosocial factors (222) was evident in this review. However, less than one-third of programmes reported on psychosocial outcomes despite the recognition of psychosocial issues in relation to obesity evaluation and treatment by expert committees (34) and evidence of unhealthy slimming practices among normal-weight as well as overweight adolescents (328,329). Most of the programmes reporting on psychosocial outcomes included interventions that could ameliorate negative effects on mental well-being such as family involvement, behaviour modification and psychosocial support. Nonetheless, one long-term (250) and one short-term programmes (109) in the primary school setting did not include such intervention components but yet reported positive outcomes in body composition, nutrition and physical activity without any changes in psychosocial parameters. 'No change' in psychosocial parameters was considered positively in this review in that the intervention did not seem to invoke a detrimental effect. However, the fact that children and adolescents themselves highlight the need for sensitivity because of the stigma associated with overweight (238,330) should be heeded and a focus on improving self-esteem and reducing opportunity for negative attitudes and behaviours needs to be included in obesity prevention and treatment programming (158). In this review, many programmes reported intervention activities without assessing related outcomes, which hampers identification of the necessary programme elements for best practice. It is therefore further recommended that any psychosocial support activities included in programmes should be assessed and reported on.

Physical activity. The positive impact on body composition in school settings is very encouraging as this emerged as the most popular setting for programme interventions in this review. The importance of actual engagement in physical activity in primary schools identified in this review as a protective factor (at least in the short term) is noteworthy considering that 23% of children aged 9–13 years in the USA do not participate in any free time physical activity (331). The lack of such associations between physical activity and body composition outcome in secondary schools may relate to the far fewer programmes in this setting

compared with primary schools in this review. Actual engagement in physical activity is likely to be important for secondary school settings considering the evidence for declining participation of high school students in physical education classes (239). The association of physical activity in secondary schools programmes that resulted in improvement in chronic disease risk status (see Table 23) endorses recommendations to increase physical activity in both secondary and primary schools (158).

Programme focus and setting. Not unexpectedly programmes in clinical settings tended to report the most positive outcomes in body composition and chronic disease risk as the vast majority of these programmes were targeted in that they involved children who were already overweight. There is a different emphasis in programmes that are directed at all children in a setting ('Universal') compared with those that are directed at high risk children ('Selected') or those directed at children who are actually overweight ('Targeted'). 'Universal' approaches are directed at many children who are not overweight and for whom a change in body composition is not warranted. Guidelines issued by experts strongly emphasize that the primary goals in such circumstances concern healthy eating and activity – not achievement and maintenance of ideal body weight (34). However, if children are either 'Selected' from healthy schoolchildren because of being at higher risk, or even more particularly if they are 'Selected' because of being identified as overweight, improving body composition is an important outcome (34). However, despite most schools being universal in focus, programmes in this setting were also found to have high rates of positive outcomes in chronic disease risk factors and, for primary schools at least, body composition (see Table 22). The performance of programmes in the community setting, where most were 'Selected' and some were 'Targeted', was not as strong in terms of producing positive changes in body composition, chronic disease risk or fitness. Schools provide the opportunity for comprehensive and integrated approaches unlike any other community and have the potential to reach the vast majority of children in a population (332,333). The ability of schools to deliver multifaceted programmes that tackle the environment in which children work and play is probably a key element to the success of school-based programmes. This review confirms previous suggestions that school settings have the unique potential to play a pivotal role in promoting healthy lifestyles and in the prevention and treatment of childhood obesity and associated chronic disease (332). This also suggests that more multifaceted and comprehensive programming is required in community settings. Such strategies were notably absent in the programmes reviewed in this synthesis (see Section 6.3).

There are many other associations apparent in this review, e.g. strong outcomes in nutrition for programmes in the community setting, or the absence of behaviour modification and rewards/incentives in programmes that did not result in a change in outcomes. However, these were not explored because of the small number of programmes involved. For the same reason, further analyses were not undertaken to try to tease out the most promising type of intervention (e.g. fun-based exercise vs. skill-based exercise training) from within the eight broad categories described. However, the broad recommendation to involve stakeholders in all stages of programme development (see Section 7.3) along with comprehensive formative research (93,334), should ensure the most acceptable and feasible approaches are taken.

8. Key conclusions

8.1 Under served populations

Few programmes were directed at some key population groups where intervention may be critical.

- There is a critical shortage of studies/programmes aimed at the pre-school years which represent the important stage of growth and development. Thus, many key opportunities for early intervention and prevention of obesity and related diseases at risk children are missing (e.g. missing opportunities to influence timing of adiposity rebound). (Section 7.2)
- There is a dearth of studies to identify gender-specific interventions, which is even more pronounced for the male population who may be at greater risk if they develop obesity. (Section 7.2)
- No programme specifically focused on immigrant children and youth. However, of those that addressed minority populations, many had potential applicability. This suggests significant gaps in addressing special needs of children who are new to industrialized countries and who may be more vulnerable to the toxic effects of the obesogenic environment. (Sections 6.4 and 7.2)

8.2 Outcomes and interventions

- Many of the programmes reviewed have one or more aspects that were effective in achieving outcomes; however, no one programme emerged as a model of best practice.
- The programmes do provide rich information on elements that represent innovative rather than best practice under particular circumstances that are dynamic (changing according to population subgroups, age, ethnicity, setting, leadership, etc.). (Section 6.2)
- The majority of programme outcomes at least in the short term indicated change towards improvement, which supports continued action. (Section 7.4)

• Body composition, chronic disease risk factors and fitness are directly measured and are reliable indicators of programme effectiveness and can be used for both clinic- and population-based studies to determine changes in population indicators. (Section 7.4)

• In this review, body composition and chronic disease risk factors were commonly reported outcomes in school and clinical settings, and improvement in these indicators was particularly evident in these settings. (Section 7.4)

• Schools emerged as pivotal settings for promotion of healthy weights and prevention of chronic disease. (Sections 6.5 and 7.4)

• Actual engagement in physical activity is a critical intervention in obesity prevention and reduction programmes. (Section 7.4)

• Programmes targeting minorities involved stakeholders in programme development and implementation – there was some indication that this approach increased programme receptivity and acceptance. (Sections 6.2 and 7.3)

• Given all of the concerns expressed around the potential negative impact of obesity interventions on body image and self-esteem, surprisingly few programmes had assessed psychosocial well-being. (Section 7.4)

• Few studies were set in the community and home environments and therefore it is difficult to draw conclusions regarding interventions and their association with positive outcomes in these settings. (Section 7.2 and 7.4)

8.3 Population health and integration for chronic disease prevention

• Application of a population health approach was evident in a limited number of programmes in this review. Those programmes that ranked 'High' in programme development and evaluation were more likely to reflect population health principles regardless of setting. (Section 6.3)

• With the exception of school settings, little attention was given to environmental modifications despite the growing evidence of the need to address obesogenic environments. (Section 7.2)

• Although programmes addressed elements or strategies that are common to many chronic diseases (physical activity, nutrition and mental health), many addressed only one disease (e.g. heart disease or diabetes) potentially leading to missed opportunities to further chronic disease prevention and integrate considerations across multiple diseases. This may give rise to duplication of programmes and public confusion over healthy lifestyle behaviours. (Section 6.3.)

8.4 Methodological issues of programmes reviewed

• Lack of programmes with long-term follow-up limits the ability to determine if the short-term changes are sustained, and if lifestyle behaviours are permanently impacted. (Section 7.2)

• Lack of adequate methodological rigour across all programmes included limits the validity of the findings. (Sections 6.1 and 7.4)

• Some studies did not adequately control for potential confounders (socioeconomic status, single-parent family, informal or formal support, and food and employment security, family history of obesity) which may have influenced outcomes. Many school programmes would have benefited from an improved understanding of potential confounders. Furthermore, many did not describe adherence to the programme or programme integrity. (Sections 6, 7.3 and 7.4)

• Few studies considered impact of the programme leader on the success of the programme. Studies that discussed this topic indicated that success of the programme might be related to qualities and characteristics of the programme leader/supervisor in addition to the programme components. (Section 7.3)

• Many school-based studies used cluster randomization as a design feature but the analysis did not adequately take into consideration the intraclass correlations among the study groups and thus positive results may be falsely inflated. (Section 7.4)

• Accurate assessment of nutrition, physical activity and psychosocial outcomes are challenging because of the validity of self-report behaviour which tends to align with socially desirable norms. (Section 7.4)

• Given the scope of the review and the inclusion criteria, the small numbers of programmes involved in each setting prevent meaningful comparisons between settings.

9. Key recommendations

Based on findings, the following recommendations require immediate attention by a broad range of sectors, organizations and professionals.

9.1 Recommendations for programme funding agencies

Agencies, particularly government departments that fund programmes, should support the following:

1. Funding should be directed to develop obesity prevention and treatment programmes for those critical population subgroups identified as being currently under served in this review – immigrants, young children (0–5 years) and males.

2. Funding should be directed to develop obesity prevention programmes with rigorous evaluation components in community and home settings where limited programme activity is evident and effectiveness is unknown.

3. Funding should be directed towards developing population-based interventions to balance, support and extend the current emphasis on individual-based programmes. This is critical to stem the escalating problem of childhood obesity.

4. Funding should be directed towards implementation of long-term initiatives that include long-term follow-up to determine the sustainability of programme impacts as relates to maintenance of normal body weight.

5. To maximize funding and health impact, funding should be directed towards evaluating the effectiveness of programmes that integrate strategies to address more than one chronic disease associated with obesity. Healthy eating, active living and mental well-being are the common elements of prevention programmes for obesity and also for several chronic diseases associated with obesity.

9.2 Recommendations for programme developers

Agencies and programme planners should undertake the following:

6. In designing obesity intervention and prevention programmes, more attention needs to be paid to stakeholder involvement in programme development and programme integrity.

7. Programme design process should be developed to allow continual incorporation of new elements associated with greater programme effectiveness such as type of project leader, nature of intervention delivery, etc.

9.3 Recommendations for research/evaluation funding agencies

Agencies that fund research and evaluation initiatives should support the following:

8. Research grants for investigating obesity prevention and treatment initiatives should require research protocols adequately address sample size, study design, validity and reliability of outcome measures, analysis strategies, potential confounding factors, strategies to maintain and monitor programme adherence and integrity.

9. Funding for programmes need to adequately resource a comprehensive evaluation plan which includes but is not limited to methodological rigour (process evaluation is also critically important).

10. Funding should be directed to further knowledge regarding the merits of the various forms in which interventions (singly and in combination) are delivered and in which circumstances they are effective. In particular attention should be paid to assessment of psychosocial impacts of intervention strategies in youth.

11. Funding should be directed towards evaluating programmes that invest in upstream strategies such as policies and environmental changes to promote active living and healthy eating.

12. The appraisal and search strategies used in this research project should be reviewed and considered for further testing and refinement.

9.4 Recommendations for agencies serving children and youth

Health, education, social, recreation and voluntary organizations and communities should take the following action:

13. Notwithstanding the current state of knowledge on best practices, intervening to prevent obesity is worthwhile and all organizations/groups involved with children are encouraged to take action.

14. Schools are encouraged to take steps to increase active engagement in physical activity and chronic disease risk factor interventions as strong evidence for positive outcomes in school populations exists.

9.5 Recommendations to governments

15. To further understand the comparison of obesity prevalence and programme effectiveness within and across countries, consideration should be given to standardizing indicators and definitions for obesity related measures.

16. Develop and maintain a database of population health-based strategies.

17. Enhance funding for more upstream investment that is sustainable where impact can be measured over time.

10. Final comments

The Guide to Community Preventive Services: Systematic Reviews and Evidence-Based Recommendations (the Guide) (52) was used as a basis for developing the methodology to define best practice for this synthesis research. With some innovations, the steps advocated by the Guide for obtaining and evaluating evidence were followed. First, a multidisciplinary team and Expert Advisory Panel steered this review, which enhanced comprehensiveness, a balance of perspectives and reduced the likelihood of bias in interpretation. Second, a conceptual model (see Fig. 1), supplemented with an algorithm (see Fig. 2) and a review of service delivery models (see Section 3.10), was used to guide the approach taken. Third, an inclusive approach was taken to the selection of programmes for appraisal. This was carried out by trained researchers and, for the most part, the selection process was undertaken in duplicate. An innovative feature was the inclusion of programmes where outcomes were limited to process indicators. Fourth, the search strategy for programmes was carried out systematically and was wide and comprehen-

sive. An innovative feature was the inclusion of grey literature and an Internet search. Fifth, each programme selected was appraised at least twice as is recommended by the Guide. However, the appraisal process to assess the quality and summarize the body of evidence from programmes selected was innovative, involving three additional appraisal types – population health principles, programme development and evaluation and immigrant health perspectives.

The innovations, to the selection and appraisal process outlined above, influenced the approach to the remaining three steps advocated by the Guide, which represented the synthesis process for developing best practice recommendations. Recommendations for best practice were formulated from the sixth step where research gaps were identified and summarized; the seventh step where information on evidence other than effectiveness (in this case programme development) was considered; and the final step where evidence of effectiveness was explored (52).

In developing the synthesis process for this review, one of the main considerations concerned the lack of adequate methodological rigour in many of the programmes included for synthesis, which was a consequence of having other appraisal types whereby programmes could be selected. However, these areas – population health, programme development and evaluation and immigrant health perspective – formalized how information on evidence other than effectiveness was considered. Thus recommendations were generated on (i) the application of population health principles to address the epidemic nature of childhood obesity; (ii) programme development and evaluation, which is essential if community engagement and coalition building is to proceed (155); and (iii) programmes to address the vulnerability of immigrants new to industrialized countries. Identification of gaps, allowed for consideration of gaps in the areas of the three additional appraisal types, i.e. population health, programme development and evaluation and immigrant health. Given the growing awareness of the importance of population health approaches to the prevention of chronic disease associated childhood obesity, additional analyses were undertaken to explore different aspects of population health principles. This included examining programmes included for synthesis to identify the level of upstream investment present (85) and the extent to which integration of programme intervention activities occurred to prevent all three chronic conditions associated with obesity. It was recognized that translating the evidence into recommendations of effectiveness would require limiting that phase of the synthesis to programmes where methodological rigour was adequate to ensure the validity of intervention activities and outcome associations. Thus to build the evidence base, this synthesis involved the integration of a range of methods, both qualitative and quantitative, which is not unusual when building an evidence base for public health practice (158). In summary, there are many aspects of the definition of best practice within this review, which are without precedence and therefore need further testing. However, the methodology was developed using prevailing knowledge to define best practices to address the global epidemic of childhood obesity and support, for many elements of the approach are being acknowledged across the globe.

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Appendix 1

Expert panel

Dr. Ann Casebeer, MPA., PhD.
Associate Director, the Centre for Health and Policy Studies, Department of Community Health Sciences, University of Calgary, Alberta.

Dr. Andrew J. Hill, PhD., CPsychol.
Senior Lecturer in behavioural sciences, Academic Unit of Psychiatry and Behavioural Sciences, School of Medicine, University of Leeds, UK

Dr. Shiriki Kumanyika, Ph.D., MPH.
Associate Dean, Health Promotion and Disease Prevention; Professor of Epidemiology, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania.

Dr. M. Barbara E. Livingstone, D Phil. RNutr.
Professor of Nutrition, Northern Ireland Centre for Diet and Health, University of Ulster, Northern Ireland

Dr. Mark Tremblay, Ph.D., FACSM.
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Dr. Martin Wabitsch, MD.
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Collaborators

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Linda Kongnetiman
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Jayne Thirsk, RD, PhD
Co-Director Professional Development and Support
Dieticians of Canada.

Kay Watson-Jarvis, RD, MNS, FDC
Manager, Ambulatory, GI/Metabolic/Endocrine/Nutrition Services, Alberta Children's Hospital.

Key informants

Survey 1: immigrant health issues relevant for programme appraisal

Dr Bruce Newbold (Associate Professor), School of Geography and Geology, McMaster University, Hamilton, Ontario, Canada

Dr Karien Stronks, Department of Social Medicine, Academic Medical Centre, University of Amsterdam, Netherlands

Natasha Davidson, Coordinator, Victorian Immigrant Health Programme, Royal Children's Hospital, Parkville, Victoria, Australia

Dr Patricia Walker, Chair, Immigrant Health Task Force for State of Minnesota, Health Partners Regions Centre for International Health, St Paul MN 55101 USA

Dr Ilene Hyman, Department of Public Health Services, University of Toronto, Ontario, Canada

Survey 2: identification of foreign language reports

Marie-Laure Frelut (Chair) and Jean-Michel Oppert of the Task Force on Childhood Obesity of the European Association for the Study of Obesity

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Dr Kurt Widhalm, Sabine Dietrich and K. Damon Dept. of Pediatrics, Div. Nutrition and Metabolism, University of Vienna, Austria

Survey 3: identification of missing reports from those included for appraisal and synthesis of findings

Carolyn Summberbell, Reader in Human Nutrition, School of Health and Social Care, University of Teesside, Middlesbrough, Teeside, UK

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