

Evidence *in* Context

Issue: Childhood Overweight and Obesity
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Health research — synthesized and contextualized for use in Newfoundland and Labrador

Effective Non-clinical Interventions to Prevent and Treat Childhood Overweight and Obesity in Newfoundland and Labrador

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NEWFOUNDLAND & LABRADOR CENTRE FOR
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Who Should Read This Report?

This report is intended to inform and assist individuals who play a role in the development and delivery of childhood obesity prevention and treatment interventions. The report recognizes that childhood obesity is a health issue that challenges decision makers from several fields, including health policy, health services, health promotion, education, nutrition, recreation, and community planning and development. As a result, the research that this report draws upon is multi-disciplinary and is presented so that a specialized knowledge in a particular field is not needed to understand the content. The report is specifically focused on the province of Newfoundland and Labrador, Canada, but decision makers from other jurisdictions may also find the content helpful.

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Effective Non-clinical Interventions to Prevent and Treat Childhood Overweight and Obesity in Newfoundland and Labrador

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Glossary of Acronyms

BMI	Body Mass Index
CCHS	Canadian Community Health Survey
CDC	Centre for Disease Control (US)
CHS	Canada Health Survey
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CVD	Cardio-Vascular Disease
EPODE	Ensemble Prévenons l'Obésité Des Enfants (France)
FL	Fleurbaix-Laventie (France)
GWG	Gestational Weight Gain
HTA	Health Technology Assessment
MUN	Memorial University of Newfoundland
NL	Newfoundland & Labrador
NLCAHR	Newfoundland & Labrador Centre for Applied Health Research
NPHS	National Population Health Survey (Canada)
PA	Physical Activity
PHRED	Public Health Research, Education and Development (Ontario)
RCT	Randomized Controlled Trials
SB	Sedentary Behaviour
SES	Socio-Economic Status
SCT	Social Cognitive Theory
SLT	Social Learning Theory
SUS	Shape Up Somerville (US)

The Research Question

The rates of obesity and overweight for Canadians have increased dramatically in the past twenty years. Obesity is now the leading metabolic disorder among adults in Canada and is considered to be a leading cause of avoidable adult mortality. Obesity is closely related to higher rates of physical disease, like osteoarthritis, as well as metabolic diseases like hypertension, diabetes, and non-alcoholic fatty liver disease. Obesity is also associated with a higher incidence of psychological problems, decreased productivity, and lower educational and professional attainment.

The shift in the body-weight profile of the Canadian population also applies to children. Rates of obesity and overweight are increasing for youth in Newfoundland & Labrador and are, along with adult rates, the highest among the Canadian provinces. As with adults, overweight and obese children have increased rates of physical and psychological co-morbidities and decreased educational attainment. Since overweight tends to persist into adulthood, these trends forecast significant challenges to the population health and health care resources of Newfoundland & Labrador.

Current research is demonstrating that the causes of overweight and obesity are many, complex and inter-related. Obesity is influenced by factors that are genetic, behavioural, nutritional, social, cultural, economic, and environmental. An extensive research literature has developed on population health strategies to prevent and treat childhood overweight.

The purpose of this Contextualized Health Research Synthesis is to address the question:

What types of effective non-clinical interventions might be helpful for prevention and treatment of childhood overweight and obesity in Newfoundland and Labrador?

For the purposes of this report, a non-clinical intervention refers to any intervention that does not include surgical procedures or pharmaceutical prescriptions.

The objectives of this report are:

1. to identify high-level research that is related to the research question
2. to synthesize the evidence into a comprehensive set of findings
3. to contextualize the results so that they are attuned to the characteristics and the capacities of Newfoundland & Labrador organizations and populations, and
4. to formulate them in terms that will maximize their uptake into the local decision-making process

Background

The Body Mass Index (BMI) estimates adiposity based on height and weight. It is the most common measurement used in research and it is a reliable measure of adiposity for adults at the population level⁽¹⁾. BMI for children, unlike the BMI for adults, is age and sex specific and may be reported as a raw score or percentile (see Figure 1). Although there are some concerns about how well BMI describes overweight and obesity in children⁽²⁾, it is considered to be a reliable indicator of child adiposity⁽³⁾.

Epidemiology

Results from the 2004 Canadian Community Health Survey (CCHS) and the 1978/9 Canada Health Survey (CHS) indicate that adult obesity in Canada has increased by 64%, from 14% to 23% of the population⁽⁴⁾. Research based on the National Population Health Survey (NPHS) estimates that one in three normal weight adults became overweight between 1993 and 2003⁽⁵⁾. Newfoundland & Labrador's rates of adult overweight and obesity are among the highest in the country: 70% of the population was overweight (BMI over 25) and a full third of the population was obese (BMI over 30).

Among Canadian youth, the CHS and CCHS indicate that, in the past thirty years, rates of overweight have increased from 12% to 18% and obesity has more than doubled to 8%⁽⁶⁾. In Newfoundland & Labrador, estimates are that one-quarter of preschool children are overweight or obese⁽⁷⁾. From 1984 to 1997, rates of overweight for school-aged children in the province increased by 28%, while rates of obesity increased by 175% (Table 1). Nearly 80% of middle school and high school children in the province do not get enough exercise to meet the recommended international minimum guidelines for healthy adolescent growth⁽⁷⁾. These same children are estimated, on average, to be 65% as physically active as recommended⁽⁸⁾, and a quarter of children and adolescents are estimated to not be physically active at all in their spare time⁽⁹⁾.

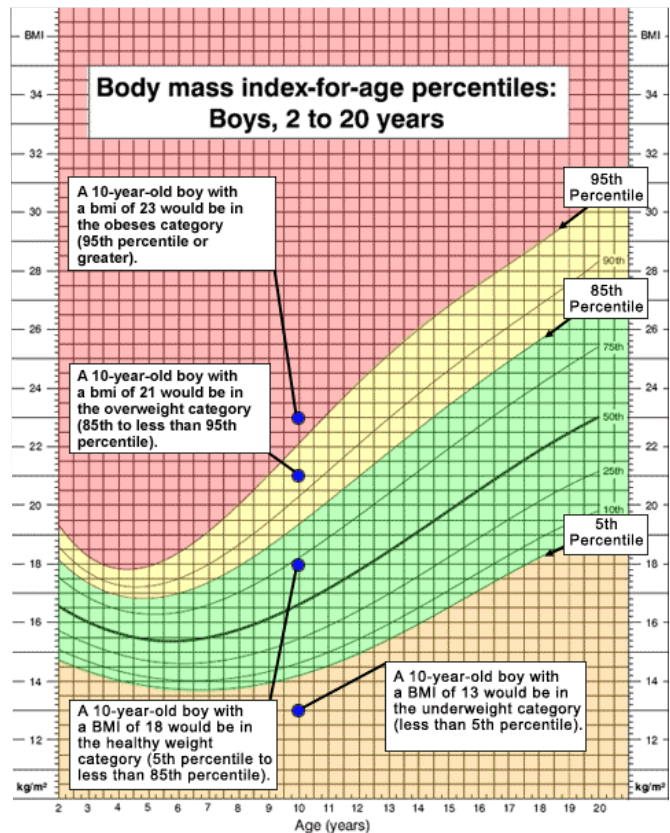
Table 1: Obesity and overweight prevalence rates for children NL

NL Cohort	1984 (781)			1997 (4171)			% Change		
	Both	Boys	Girls	Both	Boys	Girls	Both	Boys	Girls
Overweight	13.8%	13.7%	14.0%	17.7%	16.8%	18.5%	+28.26%	+22.63%	+32.14%
Obese	2.9%	2.8%	3.1%	8.0%	7.8%	8.2%	+175.86%	+178.57%	+164.52%

Source: Canning PM, Courage ML, Frizzell LM. Prevalence of overweight and obesity in a provincial population of Canadian preschool children. *Can.Med.Assoc.J.* 2004; 171 (3): 240-242.

adulthood⁽¹⁰⁻¹²⁾. The odds of remaining overweight increase with age, with as many as 85% of obese adolescents keeping their weight status through adulthood⁽¹³⁾. Childhood adiposity has been shown to predict adult fatness and weight-related health problems, especially at older childhood ages⁽¹⁴⁾. A study of NPHS data estimated that one in four overweight adults became obese between 1993 and 2003, while only one in ten overweight adults returned to normal weight⁽⁵⁾. These findings provide strong evidence that youth overweight and obesity persist and continue into adulthood⁽¹⁵⁾.

Figure 1. BMI for boys aged 2-20 years, showing age specific BMI values and percentiles.



Source: Centers for Disease Control and Prevention, National Center for Health Statistics. CDC growth charts: United States. www.cdc.gov/growthcharts/ May 30, 2000.

Consequences to health

Overweight and obesity are chronic health conditions that are likely to last through the life-span of affected individuals. Being overweight and obese in childhood consistently increases the risk of being overweight or obese in adolescence and

Among adults, overweight and obesity increase the risk of weight-related diseases (Table 2)⁽¹⁶⁾. Obese children are at greater risk for weight-related co-morbidities in childhood as well as later in life. Obese children have higher rates of both cardiovascular disease (CVD) and CVD risk factors, both types of diabetes, asthma, orthopaedic abnormalities and liver disease^(15,17-19). A high-quality systematic review found that obese children are more likely to have mental health problems (with girls more so than boys) and to suffer from low self-esteem and behavioural problems⁽¹⁷⁾.

Economic impact

In Canada, estimates of annual health care costs associated with obesity alone (excluding overweight) have risen from \$1.8 billion in 1997 to \$4.3 billion in 2004^(16,20). Research by Katzmarzyk on the 2004 estimates suggests that obesity has annual *direct costs* of \$1.6 billion (for drug purchases, care in hospitals and institutions, and health services from physicians and other health professionals) and annual *indirect costs* of \$2.7 billion (including economic output lost because of illness, injury-related work disability or premature death). In the short-term, the economic impact of childhood obesity will come mainly from direct costs. In the long term, since most obese youth (especially adolescents) *remain* overweight and/or obese, childhood obesity contributes to the overall direct and indirect costs of adult obesity.

No data exist on the costs of obesity, among children or adults, in Newfoundland & Labrador. However, a Nova Scotia study provides some context for the costs of adult obesity in Atlantic Canada⁽²¹⁾. At the time of the study, approximately 38% of Nova Scotians had a BMI over 27 (comparable to Newfoundland & Labrador). Using the same methods as Katzmarzyk, the report estimated the direct costs of overweight and obesity in 1997 to be \$120M or 7% of the total health budget. Indirect costs included only lost productivity, and were estimated at \$140M per year. These results are consistent with data from the United States, where rates of obesity are similar⁽²¹⁾.

Causes of obesity & overweight

At its core, obesity is a disease of energy imbalance where caloric intake continually runs above energy expenditure, and the surplus calories are converted and stored as adipose tissue or fat. However, the factors that influence body weight exist at multiple levels, from the individual level to the population level. Leading research indicates that the causes of childhood obesity are complex and inter-related (see Appendix 1).

There is strong evidence that genetic factors contribute to obesity, but there is no evidence that the rates of expression of these genes have suddenly increased in the population. While genes do play a role in obesity, they are not responsible for the sudden and recent increases in rates of childhood obesity⁽²²⁾. Several reviews of the causes of childhood obesity have identified risk factors within the family⁽²³⁾. The odds ratio for being overweight with two overweight parents is estimated to be eleven to one⁽¹⁹⁾. Parental lack of concern for thinness increases this risk factor⁽²⁴⁾. An emerging literature on the role of maternal obesity and the contribution of the intrauterine environment recognizes maternal pre-pregnancy weight and excessive gestational weight gain (GWG) as contributing factors to childhood obesity⁽²⁵⁻²⁷⁾.

The research literature also describes population level risk factors that contribute to an “obesogenic”, or obesity promoting, environment⁽²⁸⁾. An obesogenic environment is one where obesity promoting options are easier or more rational choices as compared to options promoting healthy weight. For example, energy-dense and low-nutrition “junk foods” that are marketed to children at low costs in large portions are fundamental components of an obesogenic environment⁽²⁹⁾. Sedentary lifestyles are also fundamental components, including increased screen time (watching television, playing most

Table 2: Health Consequences of Obesity

Disease	Summary Relative Risk ¹	95% Confidence Interval	Population Attributable Risk ² (%)
Hypertension	4.50	4.15 – 4.84	34.0
Type 2 diabetes	3.73	3.45 – 4.06	28.6
Gall bladder disease	3.33	2.86 – 3.85	25.5
Coronary artery disease	2.24	2.04 – 2.45	15.4
Osteoarthritis	1.99	1.76 – 2.24	12.7
Stroke	1.50	1.28 – 1.77	6.8
Colon cancer	1.45	1.23 – 1.71	6.2

Notes: ¹The Relative Risk is a comparison of the probability of developing the disease if a person is obese to the probability of developing the disease if not obese; an RR greater than 1 indicates an increased risk of developing the disease.

²The Population Attributable Risk is the expected change in prevalence of a disease in a population if an exposure, i.e. obesity, did not exist.

Source: C. L. Birmingham, J. L. Muller, A. Palepu, J. J. Spinelli and A. H. Anis. The cost of obesity in Canada. *Can.Med.Assoc.J.* 1999; Vol 160 (4): 483-488.

video games, using a computer), increased motorized transportation, and fewer unstructured outdoor play activities⁽³⁰⁾. These factors work in tandem: approximately 90% of Canadian children do not meet the recommended physical activity guidelines, while their average screen time is between four and six hours *daily*⁽⁸⁾. In an obesogenic environment, caloric inputs increase at the same time as caloric outputs decrease.

Obesity rates have long been associated with socio-economic status (SES). Lower income and/or parental education levels are risk factors for childhood obesity in developed countries including Canada^(22,29). In an extensive review, Drenowski and Specter⁽²⁹⁾ found that measures of SES had a major influence on childhood obesity rates and risk-factors. These effects stem in part from the inverse relationship between energy density and energy cost, as cheaper foods tend to be high-fat, high-sugar and low-nutrition. Conversely, food security for high-nutrition healthy foods like fresh fruits and vegetables tends to decrease with lower SES. Additional barriers to healthy foods are lack of availability and lack of familiarity.

Between the population level and the family/individual levels, there is also a significant social component to obesity. A rigorous study based on the Framingham Heart Study^a tracked 12,067 adults over 32 years. The results showed that a person was 57% more likely to become obese if one friend became obese, 40% more likely if a sibling became obese and 37% more likely if a spouse became obese⁽³¹⁾. The effects were not seen among neighbours, suggesting that social networks play an important role in obesity. The authors postulate that the social influence of obesity may be stronger in small towns, where socialization tends to be heavily based on overlapping social networks.

Newfoundland & Labrador has all the major risk-factor clusters for childhood obesity. Very young children and primary school children in the province have high rates of overweight and obesity that predict continued higher rates for children and adolescents. At the family level, the province has high prevalence rates of adult obesity and therefore parental obesity. At the population level, the province has several obesogenic factors: a lower SES gradient, ease of access to unhealthy processed foods, cost and access barriers to healthy foods, limited infrastructure for physical activity, high rates of vehicle ownership and widespread access to television, video games and computers. The province is characterized by a high number of small communities and overlapping social networks associated with higher likelihoods of increasing rates of obesity. The combined result of these risk factors is a high likelihood of high and increasing rates of childhood obesity.

Research Synthesis

This section synthesizes the current research literature on non-clinical interventions for the prevention and treatment of childhood obesity. The prevalence and preventability of childhood obesity and overweight are such that non-clinical interventions are heavily favoured over surgical or pharmacological treatments. The synthesis will combine the findings from the review literature and put the findings into context for Newfoundland & Labrador.

What did we look at?

We looked primarily at reviews of published studies, from 2000-2008, on non-clinical prevention and treatment interventions for childhood obesity. Non-clinical interventions were considered those that did not involve surgical or pharmaceutical interventions. Reviews were identified by searching periodical indices including PubMed, CINAHL and Google Scholar; by hand-searching on-line review catalogues including the Cochrane Library^b; health-evidence.ca; and by cross-referencing bibliographies from the research literature and government reports on obesity and child health (see [Appendix 2](#)).

A subject expert (Sara Kirk) reviewed and ranked the reviews for eligibility, methodological rigour and utility (see [Appendix 2](#) for more details). Reviews were eligible if they concentrated on research that studied prevention and treatment interventions for childhood obesity as the primary objective, that included middle-school and high-school aged children (13-18 years). Reviews of studies based on pre-existing medical conditions, such as diabetes or hypertension, and those that included infants, very young children (up to six years of age) or adults (18+ years) were excluded.

a. The Framingham Heart Study has studied three generations of Framingham, Massachusetts, residents since 1948. Study participants are evaluated every two years on a wide range of health and lifestyle variables. It is one of the biggest and longest running cohort studies in health research.

b. The Cochrane Library is a collection of high quality systematic reviews known as Cochrane reviews. The Cochrane Collaboration, who publish these reviews, develop and apply a rigorous, systematic process to review the effects of interventions tested in biomedical randomized controlled trials. Cochrane reviews are considered a top standard in the health sciences review literature. www.cochrane.org/docs/descrip.htm

c. Health-evidence.ca is a web-site intended to support evidence-informed decision making. It functions as a clearinghouse for high quality systematic reviews that are relevant to public health. <http://health-evidence.ca/html/AboutUs>

The main outcomes considered for this review were impact on adiposity, reliability, scalability or dose-response^d, lasting effects, intermediate factors related to sub-groups, and meta-effects related to settings. Systematic reviews^e that included meta-analyses^f were considered top-tier reviews, followed by systematic reviews without quantitative assessment. Second-tier reviews included narrative reviews^g, integrative reviews^h and realist reviewsⁱ. Our search initially identified 33 reviews in total, of which 26 were included in this report: seven systematic reviews with meta-analyses, nine systematic reviews and ten narrative reviews. The remaining reviews were not included because five did not focus on the appropriate age groups, one had different study outcomes and one was of low methodological rigour.

Included Reviews: Prevention

Review	Type	Age	#	Relevance
Casey & Crumley, 2004 (34)	Review of reviews	6-19	15 reviews, 62 papers	High
Connelly et al., 2007 (35)	Realistic synthesis	0-18	28 RCT's	High
Flodmark et al., 2006 (36)	Systematic review	2-18	24 controlled studies with follow-up	High
Micucci et al., 2002 (37)	Review of reviews	2-18	23 mixed reviews	High
Stice et al., 2006 (38)	Meta-analysis	2-22	64 mixed	High
Thomas et al., 2004 (39)	Systematic review	2-18	365 RCT's and cohort studies	High
Doak et al., 2006 (40)	Non-systematic review	6-19	25 mixed	Medium
Summerbell et al., 2007 (33)	Meta-analysis	2-18	22 controlled studies with follow-up	Medium

Included Reviews: Treatment

Review	Type	Age	#	Relevance
Atlantis et al., 2006 (41)	Meta-analysis	≤18	14 RCT, 13 papers	High
Casey & Crumley, 2004 (34)	Review of reviews	6-19	15 reviews, 62 papers	High
Snethen et al., 2006 (42)	Meta-analysis	6-16	7 studies	High
Summerbell et al., 2007 (32)	Systematic review	≤18	18 RCT	High
Wilfley et al., 2007 (43)	Meta-analysis	2-19	14 RCT, 19 effect sizes	High
Collins et al., 2006 (44)	Meta-analysis	≤18	17 studies	Mid
DeMattia et al., 2007 (45)	Review	<18	12/29 studies	Mid
McLean et al., 2003 (46)	Review	≤18	16 projects, 21 studies	Mid
Reilly & McDowell, 2003 (17)	Meta-analysis	≤18	3 studies	Mid
Cole et al., 2006 (47)	Review	4-14	10 studies	Low
Dobbins et al., 2001 (48)	Systematic review	6-18	11/19 projects	Low
Flynn et al., 2006 (49)	Review	≤18	147 projects, 158 studies	Low

The purpose of this synthesis is to summarize the research findings on childhood obesity prevention and treatment, with the goal of informing policy and program design. The review is not intended to recommend any specific intervention over another, or to evaluate existing programs. The findings from this synthesis are intended to provide information that can be used in making decisions about how to develop, implement and modify childhood obesity interventions.

What did we find?

It should be noted at the outset that the research literature on obesity prevention and treatment is characterized by a significant lack of rigour in research design at the individual study level, heterogeneity of treatment interventions, a lack of appropriate control groups for comparison and a lack of long-term follow-up^(32,33). These shortcomings are noted in the overwhelming majority of review papers.

d. In this context, scalability or dose-response describe the relationship between the level or exposure of a treatment and the size of the effect on the treatment recipient.

e. Systematic review: A summary of research that uses explicit methods to perform a thorough literature search and critical appraisal of individual studies to identify valid and applicable evidence.

f. Meta-analysis: A synthesis of research results using various statistical methods to retrieve, select, and combine results from previous separate but related studies.

g. Narrative review: A non-systematic review.

h. Integrative review: A synthesis of the different findings related to a particular research question, meant to improve the thinking that goes into decisions on how services should be built and delivered.

i. Realist review: A combination of theoretical understanding and empirical evidence, that focuses on explaining the relationship between the context in which an intervention is applied, the mechanisms by which it works and the outcomes which are produced.

As a result, it is problematic to compare different interventions with one another or to draw conclusions from multiple studies. The review literature has a preponderance of inconclusive findings apart from recommendations on how to improve future research. Nonetheless, while conclusive results on specific intervention components may be lacking, there is convergent evidence for the broader strategies and approaches that is both constructive and useful for informing childhood obesity interventions⁽³⁴⁾.

The findings from our survey of each of the reviews selected are listed and summarized in [Appendix 3](#). Each summary includes the key positive findings from the review. Negative findings are included only if they were reported and considered to be important by the publication's authors. The summaries are structured to report information on:

- a) the major findings of the publication including the effect sizes of interventions where reported and relevant;
- b) the reliability of and ability to generalize the findings;
- c) the scalability or dose-response of the intervention;
- d) any lasting effects on adiposity or body weight;
- e) any intermediate factors from the interventions that were identified by the publication's authors.

The research literature summaries have been divided into two sections. The first focuses on research on the *prevention* of obesity, the second on the research on the *treatment* of obesity. The research on obesity prevention is less well-developed than that on obesity treatment.

In the following section, we present a synthesis of the research findings. The synthesis combines the main research findings by theme and where possible provides an examination of how those research findings apply in the context of Newfoundland & Labrador. The contextualization of the research findings was carried out with the help of a panel of key informants from the province who are engaged in childhood obesity prevention and treatment initiatives or research related to childhood obesity.

It should be noted that contextualization of the research findings did not seek to include all relevant programs and projects related to childhood obesity prevention and intervention in the province. A full inventory of existing childhood obesity prevention programs and treatment interventions is beyond the scope of this report. Programs and projects cited are listed as examples only.

Synthesis of Findings

General findings for prevention

The reviews we have analyzed provide mixed results. Research in the field of childhood obesity *prevention* does not yet provide clear and reliable evidence that some types of programs or program components for the prevention of childhood obesity are consistently effective. While some individual studies have shown positive results, these results have not been reproduced consistently in enough other studies to draw general conclusions. This is most apparent at the highest level of research syntheses. The most reliable systematic reviews conclude that there is currently insufficient evidence to support any particular childhood obesity prevention strategy^(33,34,36,37,40).

There are several critical limitations of the existing research that contribute to this absence of strong findings. The first is the lack of a standard operational definition of obesity prevention. Key research groups in Canada^j have strongly urged that obesity prevention be defined as *the maintenance of healthy body weight in a population unselected by weight status*. Equally important for the research field is the adoption of common health outcomes to measure the effectiveness of a prevention program. The same research groups have recommended that obesity prevalence should be used as the critical measure, determined by a standardized measure of obesity (for example BMI). Differences in program delivery, resources and the content of the interventions further complicate the evaluation of those interventions. These differences introduce large uncontrolled sources of variation that make it difficult to compare programs and generalize findings. Lastly, the lack of comparable follow-up measures and appropriate control groups limits our ability to evaluate and compare the effectiveness of prevention programs.

j. Institute of Nutrition, Metabolism and Diabetes—Canadian Institutes of Health Research, Canadian Association of Paediatric Health Centres and the Paediatric Chairs of Canada, among others.

Thus, the absence of robust consensus findings on the effectiveness of childhood obesity prevention programs may not be the result of a lack of treatment effects *per se*, but rather of methodological challenges in the research design. However, the research literature is sufficiently well developed to have yielded several reviews, some general and some specific to a particular strategy for obesity prevention, that allow us to reach a number of admittedly tentative and cautious conclusions.

General findings for treatment

A broad range of non-clinical treatment interventions for childhood obesity has been developed, implemented and evaluated. They are heterogeneous in design and may include variable combinations of increased physical activity, decreased sedentary behaviour, nutritional education and diets, behaviour modification, and relaxation therapy. They are equally heterogeneous in delivery, and may target the child directly, their social group or class, their family or their community. Despite the differences in interventions, one general question may be asked about these treatments: do they work?

The review literature is conflicted in attempting to answer this question. The Cochrane review on childhood obesity interventions states unequivocally that there is insufficient evidence to draw conclusions one way or the other⁽³³⁾. This study represents the highest methodological standard and underscores the issues affecting research quality in this field: small groups of participants, lack of consistency between treatments and studies, heterogeneous outcome measures and poor follow-up data. However, another meta-analytic review by Wilfley et al.⁽⁴³⁾ was able to evaluate the effectiveness of non-clinical or “lifestyle” childhood obesity interventions. The authors identified fourteen randomized controlled trials (RCTs) with appropriate control groups and sufficient follow-up to quantify the effect size of interventions in general, regardless of design, compared to no intervention. Their results showed that interventions in general had a statistically significant impact on overweight and obese children’s BMI scores and body weight. They were also able to demonstrate a rapid increase in effectiveness over the first seven months of treatment, followed by a slower decay in effectiveness over the following two years post-intervention. The authors conclude that non-clinical interventions “are efficacious in the short term with some evidence for extended persistence”.

A high quality meta-review synthesized published review papers covering 44 individual studies on the generalized effectiveness of childhood obesity treatments⁽³⁴⁾. Nine out of ten of the reviews found evidence of a benefit of treatment in general. The results provide consistent evidence for the decrease in measures of adiposity, like BMI, in children who participated in the treatment compared to control groups. The authors conclude that there is good evidence that non-clinical treatment is effective in reducing or eliminating childhood obesity. They further “strongly recommend” (emphasis theirs) that treatment be advised since it demonstrates a significant increase in the likelihood of improvement or resolution of obesity.

Synthesis: *The research literature does not provide support for childhood obesity **prevention** in general. The research literature does, however, provide support for childhood obesity **treatment** on the whole. With the exception of the Cochrane review which is unable to reach a conclusion either way, recent high level review literature supports implementing non-clinical treatment interventions for childhood obesity.*

Contextualization: *Considering the context of Newfoundland & Labrador, the recent high level review literature provides strong evidence to support the implementation of childhood obesity treatment programs. The province has a high rate of childhood overweight and obesity, combined with a trend toward increasing rates of obesity. The relative costs of non-clinical treatment for children compared to surgical and pharmaceutical treatments for children or adults, to say nothing of the additional costs of obesity to the health care system and the provincial economy in general, strongly favour the former.*

Increasing physical activity

The most straightforward approach to obesity prevention and treatment is attempting to shift the energy balance equation by increasing caloric expenditure through physical activity. Along with diet (see below), increased physical activity is one of the traditional prevention and treatment strategies for childhood obesity and overweight. The research literature has compared a number of strategies for increasing caloric expenditure including: voluntary vs. compulsory involvement; structured physical activity vs. active lifestyles; and rewarding increased physical activity vs. rewarding decreased sedentary behaviour (see below). The variety of strategies reflects the range of delivery options available to increase physical activity in children. Structured physical activity is most often associated with school gym classes or after-school programs. Lifestyle

changes may target being more physically active during the school day or when at home.

Most research studies combine a physical activity strategy with other components such as dietary education or changes in environment. The review literature includes studies in which increasing physical activity is the sole focus and studies in which it is one of several strategies. These strategies include increased physical activity with or without nutritional education, classroom health promotion on increased physical activity, lifestyle changes to increase physical activity in day-to-day tasks, and programs to decrease sedentary behaviour. By and large, the reviews we examined attribute any lack of evidence supporting strategies to increase physical activity more to problems in the research methodologies than to a lack of treatment effects.

Prevention

The review literature did not provide consistent evidence that increasing physical activity is an effective means of preventing childhood obesity. There is one notable exception among the reviews we have examined: a 'realistic' synthesis of 28 controlled trials to prevent childhood obesity found that the provision of compulsory aerobic physical activity was more effective than similar interventions that were voluntary in nature⁽³⁵⁾. Compulsory status was defined as fulfilling two or more of the following criteria:

- physical activity integrated into the weekly curriculum;
- participation expected in sessions with or without course credits;
- participation expected in sessions with or without individual goals regarding measures of aerobic fitness; and
- specification of moderate to vigorous aerobic activity rather than another type such as muscle strengthening.

The authors stress that compulsory physical activity may be rationally understood to prevent obesity: compulsory provision would be expected to increase compliance and thus contribute to the impact of the intervention. The lack of consistent, statistically significant findings from other reviews⁽³⁸⁾, may be due to less stringent criteria for compulsory provision.

Treatment

The review literature is more convergent in finding increases in physical activity to be effective at treating, rather than preventing, childhood obesity. However, the review literature is not specific about which treatment strategies are the most effective. A systematic review of RCTs that compared control groups with groups of overweight children and adolescents treated with moderate to high intensity exercise⁽⁴¹⁾ found that the treatment group had less body fat and lower body weights, and that higher doses of exercise were statistically more effective (155-180 minutes/week vs. 120-150 minutes/week)⁽⁴¹⁾. Another review that considered a wider range of types of interventions also found that physical activity programs, in particular those with structured activities instead of voluntary or suggested activities, had significant positive effects on weight-loss⁽⁴²⁾. Among interventions directed at high-school-aged students, those that had a physical fitness component most frequently reported positive outcomes compared to other types of interventions⁽⁴⁹⁾. Positive outcomes included a reduction in adiposity and a decrease in chronic disease risk factors. Flynn et al. note that an estimated quarter of school-aged children may not otherwise engage in any moderate to intense physical activity so treatment interventions may provide their sole opportunity for aerobic exercise.

In their meta-review, Casey and Crumley⁽³⁴⁾ do not find sufficient evidence to support one strategy to increase physical activity over another⁽³⁴⁾. In the four systematic reviews included in their study, there were inconsistent findings regarding the relative efficacy of different physical fitness and lifestyle exercise strategies. However, in the same report the authors examined five systematic reviews that included ten studies on the effectiveness of exercise and diet compared to diet alone. Based on this evaluation, they conclude that there is fair evidence to support the incorporation of some exercise component into any obesity treatment intervention.

Synthesis: *Obesity prevention interventions that include structured compulsory physical activity may be expected to be more effective than those that are voluntary in nature. Structured physical activity of modest duration (~30 minutes a day) at moderate levels (i.e., aerobic activity) is an effective component of childhood obesity treatment, and should be incorporated into treatment protocols. The effectiveness of physical activity components may be expected to increase if they are delivered in a structured format that has the capacity to ensure compliance on the part of the participant.*

Contextualization: *In addition to having high rates of sedentary behaviour in general, many children in Newfoundland & Labrador lack opportunities for day-to-day physical activity: car transport to many, if not most, destinations, and a lack of public*

infrastructure conducive to physical activity. Increasing physical activity levels will depend in part on improving and/or increasing the capacity for physical activity through community development planning and support. Examples of such programs include: The Western Regional Wellness Coalition Community Grants program, which provides up to \$1,000 to support healthy living initiatives like installing playground equipment; and the Provincial Wellness Grants which fund community-based projects that have physical activity components. The lack of funding for summer recreation programs was identified as a particular challenge to increasing physical activity among children and adolescents.

The value of mandatory physical activity has been recognized in school curricula through physical education requirements for K-9 and high school grades. In order to realize the potential benefits of increased physical activity, schools will need to ensure that there are adequate human and physical resources. Maintaining gym space and outdoor recreational areas may be expected to play a key role in maintaining increased physical activity levels.

Sedentary behaviour

Sedentary behaviour is most often defined as “screen time”, e.g. being on a computer, watching television or playing video-games (that are not body movement related). There is evidence that indicates that, for overweight and healthy weight individuals alike, passive viewing of video produces a lower basal metabolic rate, and a greater increase in adipose tissue formation, than other forms of non-active behaviour such as reading⁽⁴⁵⁾. Given that the average daily screen time of children in Canada is quite high (4-6 hours), interventions that target screen time may be expected to have a positive impact on child body weight⁽⁸⁾.

In relation to the energy balance equation, sedentary behaviour is as much a contributor to the overall deficit of caloric expenditure as decreased physical activity, and potentially more so. In the childhood obesity research literature, decreasing sedentary behaviour is considered a separate component from increasing physical activity. Interventions to decrease sedentary behaviour reward subjects for not committing certain behaviours while leaving the choice of alternative behaviours up to them, whereas interventions to increase physical activity reward performing behaviours that have been pre-defined to some degree or other.

Treatment

A review of obesity treatment interventions that include sedentary behaviour change⁽⁴⁵⁾ found that both clinic and population-based interventions that targeted sedentary behaviour consistently improved health behaviour (i.e., less screen time) and improved weight parameters⁽⁴⁵⁾. Another review considered the relative efficacy of reducing sedentary behaviour as compared to increasing physical activity and found the former to be the more effective in reducing BMI scores⁽³⁴⁾. However, these findings were based on a single study and did not provide sufficient evidence to draw broader conclusions. A Cochrane review did not find any significant impact from reducing sedentary behaviour^(32,33). Another study showed that the effect size of reducing sedentary behaviour on body weight was modest, but it was also consistent in slowing the increase in the individual's BMI relative to age-matched controls⁽⁴⁵⁾. Taken together, these findings suggest that reducing sedentary behaviour is an effective obesity treatment component that may play as important a role in healthy weight maintenance as it does in reducing overweight and obesity.

Synthesis: *Decreasing sedentary behaviour is one effective component of childhood obesity treatment, and should be incorporated in treatment protocols. Decreasing sedentary behaviour may be most effective with simple limits on screen time and no prescription of alternative activities.*

Contextualization: *Newfoundland & Labrador children and youth have overall higher rates of sedentary behaviour (8), as well as numerous facilitators of sedentary behaviour. These include the combined effects of limited opportunities for physical activity and high levels of availability to multi-channel television, networked and non-networked video gaming, and broadband internet access. Although these factors are facilitators to weight gain, they also represent focused opportunities for intervention programs.*

Nutritional interventions

The other side of the energy balance equation is caloric intake. Although Canadians' average caloric intake has decreased in the past thirty years, the nutritional quality of children's diets has decreased as well⁽⁵⁰⁾. Youth derive 25-30% of their diet from snacks and more than 60% have less than the recommended five servings of fruits and vegetables. Processed foods that are high in fat, salt and sugar but nutritionally poor have been increasingly marketed to children for the past three decades.

While population-level variables for diet and nutrition are recognized as playing a key role in increasing the risk of childhood obesity, the review literature does not address diet at the population level. For example, the research literature contains few studies that test interventions targeting the contribution of food security on childhood obesity rates or the impact of socio-economic factors in healthy and unhealthy food distribution. Most of the review literature considers interventions that seek to modify personal or family diets as one part of multi-component interventions that usually include changes in the level of physical activity or lifestyle.

The research literature seems to indicate that behaviourally-focused diet interventions are more effective than education programs in changing eating behaviour. Education programs may play a critical role in changing attitudes and knowledge, but they seem to be insufficient in modifying diet. The corollary to effective diet interventions is to ensure that there are healthy food choices that are available. Changes in environment that affect food choices, in particular school cafeterias, have been cited as a crucial opportunity to promote healthy childhood body weight⁽⁵¹⁾. A trickier environmental change that, no doubt, also plays a major role in childhood body weight, is the home environment. Summerbell et al. point out that parental obesity is a major risk factor for childhood obesity, and that children with this risk factor should be targeted early for prevention and/or treatment interventions that would extend to the family⁽³²⁾.

Prevention

The review literature surveyed in this synthesis did not provide evidence that nutritional interventions alone were effective in preventing childhood obesity. The review articles found that only a minority of nutrition-based obesity prevention programs produced an observable effect. For example, one review examined fifteen studies and found three to have effective outcome measures. Micucci et al. point out that while nutrition programs alone may not be sufficient to prevent obesity, they nonetheless have been shown to be effective in increasing knowledge and attitudes about nutrition⁽³⁷⁾. The authors' interpretation of the findings is that these changes are critical to the later development of healthy eating behaviours. That nutrition education may play a moderating effect in obesity prevention is supported by findings in the treatment literature (see below) that show nutrition and physical activity interventions to be more effective than physical activity interventions alone.

Treatment

In a systematic review of randomized trials, it was observed that the most common dietary intervention strategy was the Stoplight/Traffic Light diet that consisted of categorizing food into three groups: red (very limited), yellow (limited) and green (eat freely)⁽⁴⁴⁾. A meta-analysis indicated that childhood obesity interventions that included a dietary intervention like the Traffic Light diet consistently contributed to modest weight loss outcomes over the course of the intervention. The effects of the interventions decreased during follow-up. Snethen et al. found structured diets to be more effective than suggested diets or broad nutrition education⁽⁴²⁾. In their meta-review, Casey and Crumley could find only two systematic reviews examining the effectiveness of different diet regimens and these produced inconclusive and mixed results⁽³⁴⁾. In the same report, they identified five systematic reviews comparing the effectiveness of interventions that included diet or diet and exercise. Based on the data from ten individual studies, they found that there is fair evidence to support interventions that included both diet and exercise.

Synthesis: *Nutrition education by itself is insufficient to prevent obesity but may be expected to facilitate the formation of healthy eating behaviours. Dietary **prevention** and **treatment** components need to include a behaviour modification component (see below). Modifying diet is an effective component of childhood obesity **treatment**. Given an environment that promotes messages contrary to healthy nutrition, education does not appear to provide the individual with sufficient resources to alter his/her diet. There is limited research on the effectiveness of environmental changes, but the literature does recommend promoting healthy food options and/or decreasing the availability of unhealthy foods.*

Contextualization: *The people of Newfoundland & Labrador have several dietary traditions that promote unhealthy body weights, including high calorie/low nutrition food preparation techniques, limited exposure and access to fruits and vegetables, and a long history of using non-perishable processed foods. Changing eating habits is a particularly difficult task and behaviour modification techniques may be expected to help supplant traditional food customs with healthier food choices, preparation methods and eating behaviours.*

Several programs recently adopted in Newfoundland & Labrador align well with these findings. Recently, the Province implemented the Healthy Schools Healthy Students initiative that included nutrition guidelines to direct the kinds of food sold and served in school settings and events. School district healthy eating/nutrition policies based on the provincial school food guidelines have greatly reduced the availability of obesogenic foods and beverages and increased the accessibility of healthier/nutritious options. This initiative is coupled

with nutrition education courses and plays a direct role in changing behaviour. Newfoundland & Labrador also has ongoing province-wide applied nutrition initiatives including the Kids Eat Smart Programs and the School Milk Program.

Behaviour modification

Treatment

The research literature on obesity treatment has identified behaviour modification as an overarching structural component to interventions. In contrast to education-oriented programs on physical activity, nutrition, etc., that attempt to promote changes in behaviour by changing knowledge and attitudes, behaviour modification programs apply strategies to change behaviour directly. Inconsistent results from obesity treatment interventions have been interpreted as demonstrating that it is not what is done but rather how it is done that matters: compliance and participation in the treatment is as important as the nature of the treatment itself.

There is evidence that overweight and obese children are at risk of being less motivated to comply with treatments or participate in programs. Childhood obesity is strongly associated with lower measures of self-efficacy^k and higher subjective measures of the personal exertion required to complete physical tasks^(49,52). Research findings such as these suggest that a major challenge to obesity treatment is overcoming the perceived effort needed to accomplish the intervention. This applies to the development of adaptive behaviours concerning diet and physical activity, as well as to the maintenance of those behaviours during and after the treatment intervention.

Casey and Crumley specifically addressed this issue by comparing review articles on childhood obesity treatments that included comparisons between interventions with and without behaviour modification strategies⁽³⁴⁾. Based on three systematic reviews that included at least five studies in total, they concluded there was good evidence to support the use of behaviour modification strategies. They strongly recommended that any obesity treatment incorporate some behaviour modification components. Several other reviews find similar results: research indicates that structured physical activity interventions⁽⁴¹⁾ or structured dietary interventions⁽⁴⁴⁾ are more effective than non-structured interventions. Structured interventions, by their very nature, include a behavioural component that increases compliance through group encouragement, incentives and/or external reinforcement.

Synthesis: Treatment interventions that target children directly should incorporate some form of behaviour modification strategy to facilitate the uptake and maintenance of healthy body weight behaviours.

Contextualization: Newfoundland & Labrador has risk factors that are deeply rooted in the province, from individual level (pre-existing weight status), to the familial level (parental weight status), to societal and environmental levels (food security, heavily motorized transportation). Against this backdrop of obesogenic influence, any childhood obesity treatment components may be expected to be more efficient if behaviour modification skills are also transferred to the child. These skills are expected to help increase self-efficacy and improve compliance with treatment components.

Duration

The relationship between duration and effectiveness for obesity treatment interventions is of interest both from the perspective of research design and for practical reasons. The presumption that longer durations are more effective may seem to be commonsense: the longer the duration, the greater the exposure to treatment components that will lower body weight and adiposity. Furthermore, since the benefits of obesity treatments tend to diminish post-intervention, longer treatment durations would be expected to confer a greater effect size over a set time period.

The review literature supports these assumptions. Three systematic reviews found that longer duration interventions were associated with greater obesity treatment outcomes in terms of BMI, body weight or adiposity⁽⁴¹⁻⁴³⁾. In their meta-review, Casey and Crumley were unable to find enough evidence to evaluate the relationship between treatment duration and outcome, although they do highlight that a statistically significant association was established between duration and

k. The belief that one is capable of executing certain behaviours or reaching certain goals. (Ormrod, J. E. (2006). Educational Psychology: Developing Learners (5th ed.), "glossary". N.J., Merrill: Upper Saddle River (companion website)

decrease in percent overweight in one of the two included systematic reviews⁽³⁴⁾. The dissenting finding is from Flynn et al. who found shorter durations to be more effective⁽⁴⁹⁾. However, their paper was not a systematic review but rather selected studies based on a set of a priori criteria for interventions that addressed population-level variables and best practice recommendations. Taken together, the results of the systematic reviews strongly suggest that longer durations are associated with better outcomes for childhood obesity treatment interventions.

Casey and Crumley attempted to review the literature on follow-up components that act as reinforcements for healthy weight maintenance and/or further obesity treatment⁽³⁴⁾. They identified a single review that found positive results with reinforcement, but it only included data on fifteen subjects. Although there are some promising findings in the obesity prevention research literature, there remains a large degree of inconsistency and uncertainty with regard to the design of effective prevention programs. In the absence of research that can demonstrate a consistent and effective means to maintain healthy body weight, extending obesity treatment duration may be the most reliable strategy for prolonging the effects of the treatment during the follow-up phase.

Synthesis: *Until more effective weight maintenance programs are developed or until we have more research evidence indicating otherwise, longer duration obesity **treatment** interventions may be expected to have the best long-term outcomes.*

Contextualization: *System-wide efforts aimed at healthy body weights and healthy eating have been implemented through school curricula, delivering programming over the course of the regular school year (September to June). As a result, many of the programs now in place deliver a sustained delivery schedule to the participating children and adolescents.*

Settings

There is weak evidence on the relative effectiveness of different settings for childhood obesity prevention and treatment interventions. Few studies in the field of obesity prevention and treatment research are designed with sufficient methodological rigour to be able to distinguish between the effects of the prevention program and those of the setting. The school setting provides one of the most efficient means to deliver behavioural and educational obesity prevention programs to children. Exposure and curricula offer an opportunity for mass, standardized prevention programs. This makes the school setting the most resource-efficient point of delivery for obesity prevention and treatment efforts. While these observations are not in question, what is less clear is just how effective the school setting is.

Prevention

Most of the research reviewed for this synthesis has produced equivocal results concerning the effectiveness of school-based prevention programs. One review found 8 out of 18 school-based programs were effective, while another found that 17 of 25 programs produced positive results^(35,40). Neither review could conclude that the school setting significantly improved or worsened obesity prevention program delivery. Micucci et al. cite a British Health Technology Assessment of 1999⁽¹⁾ and agree with its findings that “school health promotion could be effective in changing child and adolescent behaviour but does not do so consistently”⁽³⁷⁾.

The problem with these findings is that it is difficult to separate the effects of the prevention programs’ components from that of the setting itself. Few studies in the field of obesity prevention research are designed with sufficient methodological rigour to be able to distinguish between the effects of the prevention program and those of the setting. In a study addressing this specific problem, Veugelers & Fitzgerald performed a multi-level comparison of school programs to prevent obesity⁽⁵³⁾. Their design enabled them to consider the impact of higher-level variables such as the participants’ school, SES and neighbourhood. Their analysis quantified the relative contributions of the program components and the higher-level variables among more than five thousand Grade Five students. They found significant decreases in overweight and obesity in schools that participated in a coordinated multi-component program. The students from those schools also had healthier diets and were more physically active. Based on these findings, the authors were able to conclude that the school setting is an effective setting for obesity prevention programs.

Treatment

Since the environment most often used for childhood obesity treatment research is the school, the review literature implicitly supports schools as an effective setting for treatment delivery. Flynn et al. found that schools are the most effective

1. Lister-Sharp D, Chapman S, Stewart-Brown S, Sowden A. Health promoting schools and health promotion in schools: Two systematic reviews. *Health Technol Assess.* 1999;3(22):1-207. Available at: <http://health-evidence.ca/articles/show/16127>

setting to reach overweight and obese children at the population-health level⁽⁴⁹⁾. Summerbell et al.⁽³²⁾ implicitly accept schools as an effective setting in their findings, recommending that school-based programs consider the needs of school staff and resources in the delivery of programs. However that same study did not find sufficient research to evaluate setting independently as a factor in obesity treatment⁽³²⁾.

The meta-review by Casey and Crumley identified one review that included 21 studies⁽³⁴⁾. The results indicate that children in obesity treatment programs that are based in “specialized settings” have better health outcomes than those based in schools. (The definition of specialized settings was all settings other than schools). However, the authors also note that the resources required to provide treatments in specialized settings may limit the reach of the intervention, and that this would compromise the effectiveness of the intervention from a population-health perspective. They also allude to the possibility that a number of additional factors may contribute to this greater effectiveness; for example, families that opt for specialized settings for childhood obesity treatments may have more resources at their disposal and children who self-select into treatment programs are more likely to have better health outcomes.

Synthesis: *Schools can be an effective setting for obesity **prevention** and **treatment** delivery. Specialized, non-school settings have been demonstrated to provide increased effectiveness for obesity **treatment** interventions. School-based settings have been shown to provide a measure of effectiveness that, in conjunction with greater accessibility, provide effective treatment delivery at the population level.*

Contextualization: *In Newfoundland & Labrador, school settings provide a critical site for obesity **prevention** and **treatment** interventions targeting children and adolescents. For many communities, the school buildings provide the main or only population-level opportunities for physical activity and healthy eating efforts. Where infrastructure constraints limit accessibility, for example the lack of bussing or gym space, school-based initiatives will be critically challenged. Parental engagement in, and support for, school-based initiatives is an important factor in increasing community support and buy-in.*

The research literature included in this synthesis leaves open the possibility that childhood obesity programs that are delivered outside of the school setting may be as effective or more effective, at the individual level, than those delivered in schools. Community, experimental or clinic-based programs may offer an additional venue for treatment or an alternative setting when schools are unable to deliver any obesity treatment interventions. However, with approximately one quarter of children in Newfoundland & Labrador overweight or obese, it may prove more effective at the population level to deliver treatments in school settings to maximize recruitment and minimize costs for participation.

Family

Treatment

The family plays a critical role in childhood obesity. Research has consistently identified family-level variables, namely parental overweight or obesity, as a risk factor for childhood obesity. Family may influence eating behaviour and diet, norms for levels of physical activity and sedentary behaviour, and attitudes toward overweight and thinness. At the same time, the role of family in influencing child behaviour changes from early childhood through adolescence. Children’s behaviour is typically more influenced by their parents and siblings in early childhood than it is as they develop autonomy and personal identity in adolescence.

The research literature has examined interventions intended to include family members in overweight/obesity treatment at different stages of childhood development. In a systematic review of RCTs, McLean et al. found that treatment of both parents and younger children (<12 years) for weight loss benefited the child⁽⁴⁶⁾. Their review also found that interventions were more effective at reducing overweight/obesity with a greater number of behaviour modification techniques taught to both parents and children. Although the Cochrane review by Summerbell et al. did not find sufficient evidence to draw conclusions either way, it did identify four studies that demonstrated that younger children had enhanced weight loss when treated in conjunction with parents⁽³²⁾. It is notable that McLean et al. found that adolescent girls had better weight outcomes if they were treated separately from their parents, in particular separately from their mothers. Hardeman et al. also found that family-oriented treatments for adolescent girls are less effective when their mothers are included in the intervention⁽⁵⁴⁾, cited by Casey and Crumley⁽³⁴⁾. However, most of the research literature on family involvement is limited to pre-adolescent age groups.

The meta-review by Casey and Crumley did not find sufficient evidence to support the inclusion of parents in childhood obesity treatment interventions⁽³⁴⁾. Based on four systematic reviews that included thirteen studies, they found good evidence that parental involvement does not improve health outcomes for the child. They further recommend that resources directed at childhood obesity treatment interventions be focused directly on the child and not on the parents. This does not preclude parental involvement, but it does limit such involvement to supporting or facilitating the child's behaviour instead of modifying parental eating habits and levels of physical activity. These findings seem to be in contradiction with other research by Thomas et al. who sought to identify barriers and facilitators to healthy eating among children⁽⁵⁵⁾. In their systematic review, they identified a discrepancy between what parents tell their children they should eat and what the parents themselves actually do eat as a major barrier to children's healthy eating. This suggests that parental example is an important factor in dietary behaviour, and that parental influence on child healthy eating extends beyond facilitation and encouragement.

Synthesis: *The research evidence suggests that family involvement may enhance **treatment** interventions for childhood obesity.*

Contextualization: *Several programs have been designed and implemented with the intention of increasing parental involvement in child health and health behaviours. Some programs, for example Families and Schools Together, (in the Western region of the province), target at-risk families who are more difficult to engage and have higher need levels. Others, like the provincial Healthy Students Healthy Schools initiative, support the establishment of "Healthy Living Teams" that bring together parents and teachers (and students) to promote a culture of active and healthy living. However, the review literature suggests that if resources are limited, these resources may be better allocated directly to child-centered treatments*

Specialized training

Prevention

The research literature has paid relatively little attention to the role of specialized training in obesity prevention. Most studies focus on child-related variables while few report on teacher or program leader characteristics that may influence the effectiveness of an intervention. These may involve additional multi-disciplinary education on childhood obesity and on behaviour modification. As a consequence, the review literature on obesity prevention has reported few findings on the role of specialized training.

Thomas et al. did investigate the role of specialized training for physical education teachers in increasing aerobic activity among students with the goal of preventing overweight/obesity⁽³⁹⁾. Their results indicate that the largest increases in physical activity were in classes led by specialists. They also found that a lack of training resulted in poorer compliance with obesity prevention protocols. They conclude that teacher skill and motivation levels need to be better incorporated into the research design and that those teachers who are responsible for administering healthy body weight curricula need to have greater access to specialists in order to maximize the effects of the program. In the research literature, the more common comparison is between obesity prevention programs that are led by researchers and those that are led by non-researchers. The assumption in these studies has generally been that researcher-led programs will do better because of better resources and a higher level of motivation on the part of the leader to see a successful outcome. Two reviews^{(35); (38)} found equivocal results when comparing research-led and non-researcher-led programs.

These findings underscore how little is known about the role of leadership in prevention programs. The research literature does not provide sufficient evidence to weigh the influence of specialized training, generic teaching skills, specialist support or teacher workload on program compliance or outcomes. However, the recommendation by Thomas and colleagues that physical and health education teachers should be exposed to more specialist training and to researchers in the field of childhood obesity seems both reasonable and feasible.

Synthesis: *Partnerships among teachers/healthy body weight facilitators, specialists and researchers can help to exchange and transfer knowledge, increase compliance for childhood obesity prevention programs and facilitate collaboration in research programs.*

Contextualization: *Each education district in Newfoundland & Labrador recently instituted a School Health Promotion Liaison Consultant staff position to give specialized support to school staff and administration. These positions are funded through a partnership between the Departments of Education and Health and Community Services. The province also has placed Physical Education Specialists with advanced training backgrounds in most schools. These specialists are well-placed to take advantage of*

training in childhood obesity prevention and intervention. Memorial University and Sir Wilfred Grenfell College both have academic research faculty who specialize in fields directly related to the prevention and/or treatment of childhood obesity. These researchers are often willing to collaborate with the school system or provide consultation services. Existing infrastructure could allow remote communication between educators and researchers in the event that face-to-face meetings are not feasible.

Dose dependence

Prevention

An important question in obesity prevention research is whether or not there is a dose dependence effect. Do longer prevention programs have greater preventive effects for obesity? The literature has examples of obesity prevention effects diminishing after the intervention is over and it is well established that the vast majority of prevention programs have their greatest effects right at the end of the program. The evidence for dose dependence, or scalability, is less clear cut. In their review-of-reviews, Micucci et al. found that longer program-delivery periods were positively associated with obesity prevention⁽³⁷⁾. However, others found exactly the opposite—that shorter program durations were more strongly associated with positive outcomes⁽³⁸⁾. Doak and colleagues found mixed results to the question of whether sustainable school-based programs that continued for the duration of the academic year had better outcomes than shorter programs⁽⁴⁰⁾.

Synthesis: *There is weak evidence on the dose dependence of obesity prevention programs, and where evidence exists, it is conflicting. This makes it impossible to recommend shorter or longer obesity prevention programs.*

Although not directly addressed in the research literature, environmental changes, such as those to school cafeterias, home environments and community facilities, tend to be permanent changes, and these multi-faceted components have been shown to enhance the effectiveness of prevention programs. Structural changes may be considered separately from prevention program components that are more focused on behaviour or education.

Tailored programs

One consistent theme to emerge from the research and review literature is the need for obesity prevention and treatment programs to be tailored to the target population. Tailored programs are those that have been designed to address the particular traits, interests, attitudes and habits of the group. In particular, sex, age and ethnicity are thought to play major roles in the outcomes of obesity prevention programs; a one-size-fits-all approach is generally regarded as less effective⁽³⁴⁾. The impact of the core components of a prevention or treatment program may vary for different sub-groups, based on the way in which the components are delivered to the sub-groups. For example, while increased physical activity is an effective means to reduce body weight and adiposity, effective strategies to increase physical activity among pre-adolescent boys may differ considerably from the strategies that are effective at increasing physical activity among adolescent girls.

Prevention

Recommendations for tailoring prevention programs come primarily from findings of differences in outcomes based on gender, age and ethnicity. For example, one review found that children are more amenable to behaviour modification than adolescents⁽³⁷⁾. However, the research findings on the issue are not clear cut. Although sex-specific programming is often assumed to be more effective, one review found that single-sex and co-ed obesity prevention programs were similar in their effectiveness, with just less than half of the programs of each type reporting positive outcomes⁽³⁸⁾.

Treatment

Evidence supports tailoring physical activity treatment programs for childhood obesity. Self-selection for childhood obesity treatments and pilot-testing were both associated with increased compliance and better health outcomes for physical activity-based interventions⁽⁵⁶⁾. These findings strongly suggest that intervention design is improved when the physical activities are closely matched to the interests of the participants. This is consistent with the finding that personal fulfillment is the prime motivator for physical activity among youth⁽⁵⁷⁾. Summerbell et al. suggest that obesity treatment programs would benefit from the inclusion of stakeholders, i.e. obese children, in their development and pre-testing⁽³²⁾.

Trost et al.⁽⁵⁸⁾ and Saris et al.⁽⁵⁹⁾ both demonstrated that obese children and adolescents can have lower measures of self-

efficacy. They also showed that low self-efficacy is associated with poorer outcomes in interventions that aim to change physical or eating behaviours. Both of their interpretations are that children and adolescents who perceive themselves as unable to change are more resistant to interventions that are based on changing behaviour. Intervention programs that are able to assess self-efficacy levels and are tailored to take into account lower self-efficacy, in particular those that emphasize greater physical activity or behaviour modification of eating behaviours, are expected to produce greater effects for a given intervention strategy.

Synthesis: *Regardless of the **prevention** or **treatment** strategy, childhood obesity interventions should take into account the individual and group level characteristics of the participants in order to make the intervention activities appealing and personally fulfilling. Prevention and treatment interventions will be more effective if they are able to create environments that are consistent with the attitudes of the participants and the desired outcomes. The interventions will also benefit from setting expectations for the participants that are considered achievable by the participants themselves and that incorporate measures to enhance the perception of self-efficacy by the participants.*

Contextualization: *Obesity **prevention** and **treatment** interventions for children in Newfoundland & Labrador should consider some basic target group characteristics. Participants should be divided into basic categories based on age (children, tweens and adolescents) and sex. Pre-testing program components with the different target groups may provide feedback that will enhance the effectiveness of the intervention. Also, Newfoundland & Labrador's community-based organizations such as student councils and youth groups are well placed to help researchers and program designers tailor obesity prevention and intervention programs for children and adolescents within their local populations.*

Multi-component programs with limited objectives

Another consistent recommendation from the research literature is that childhood obesity prevention and treatment programs are more effective when they are multi-component in design but limited in their objectives. Multi-component or multi-faceted programs address healthy body weight with a range of different strategies that may include: increasing physical activity; decreasing sedentary behaviour; nutrition education; behaviour modification of eating habits; changes in environment; and changes in daily routines. Programs that have limited objectives are those that attempt to achieve a small number of explicit goals as compared to programs that have a broad mandate to improve health, and may include not smoking or drinking alcohol.

Prevention

In one high level review-of-reviews, the authors found that school-based programs are more effective when the program integrates classroom activities as well as environmental changes in the school, home and community⁽³⁷⁾. The same review strongly recommends that prevention programs focus on behaviour modification with limited objectives rather than a broader educational approach. Stice et al. also found that programs that were limited specifically to maintaining a healthy body weight had larger effect sizes than programs with multiple health objectives⁽³⁸⁾.

There seems to be an emerging consensus that obesity prevention programs should be multi-faceted, but focus more on behaviour change than on education or attitudes. The Cochrane review mentions that several projects are currently underway which are testing this hypothesis. The review literature on obesity prevention will be greatly strengthened as these research projects will incorporate the appropriate follow-up periods in order to determine the effectiveness of these kinds of programs⁽³²⁾.

Treatment

The research literature on obesity treatment is weighted heavily towards evaluating distinct components delivered within a multi-component design, rather than assessing the multiple component interventions themselves. At the present time, research designs are beginning to broaden their scope to include a greater number of variables at a greater number of levels including individual, social, and environmental levels⁽³²⁾. Despite their observation that such research is lacking, Summerbell et al. conclude that childhood obesity must be approached with a range of treatment strategies that address the individual's physical and dietary behaviour, as well as family, social and environmental factors. Casey and Crumley found fair evidence that interventions combining diet and exercise were more effective than those with diet alone⁽³⁴⁾. They also state in their conclusion that effective change will require intervention in a variety of settings (schools, homes, community) and employ a range of different strategies.

Synthesis: Single-strategy programs, for example decreasing sedentary behaviour at home or delivering nutritional education in class, will not fully exploit the potential to influence body weight. Multi-component **treatment** interventions, and to a lesser degree **prevention** programming, compared to single component interventions, are believed to be more effective, despite a relatively weak evidence base so far. Multi-component interventions that address calorie expenditure (increasing physical activity and/or decreasing sedentary behaviour), diet and nutrition, behaviour modification, environmental changes and healthy weight maintenance strategies may be expected to yield greater effects than interventions consisting of single components.

Contextualization: Childhood obesity prevention and treatment programming in Newfoundland & Labrador may be expected to benefit from a range of program components aimed at achieving and maintaining healthy body weight. Single strategy programs will reduce the effectiveness of the resources allocated to the program. Where resources are limited, collaboration and integration among healthy body weight initiatives may be an effective means to diversify the program components with minimal costs. Childhood obesity prevention and treatment programming that has a primary focus of achieving and maintaining healthy weight may be expected to be more effective than programming that integrates healthy weight into a broader healthy lifestyle goal.

Adverse effects

Prevention

Although it is rarely raised explicitly, there seems to be a latent concern that childhood obesity prevention programs could have adverse effects on participants, for example increased risk for eating disorders, negative self-image or decreased academic performance. Most of the research literature does not include any measures for adverse effects. However, the study by Flodmark et al.⁽³⁶⁾ for the Swedish Council on Technology Assessment in Health Care specifically addressed this issue. In this systematic review, 39 studies that involved over thirty-three thousand children were combined to find 15 with positive outcomes for childhood obesity, 24 with neutral outcomes and none with negative outcomes in terms of body weight or showing adverse effects. Summerbell et al. (2005) also point out that child and adolescent healthy weight programs generally have positive impacts for all participants, regardless of weight status (even if those impacts are not statistically significant in terms of reducing body weight). Studies that have looked for potential adverse effects among obesity prevention programs have found them to be exceedingly rare or non-existent.

Treatment

The survey research literature consistently finds that: a) there are extremely few, if any, adverse effects from childhood obesity treatment interventions; and b) that the benefits from any childhood obesity treatment intervention greatly outweigh any risks. Casey and Crumley⁽³⁴⁾, Summerbell et al.⁽³²⁾, and the remainder of the review literature included in this synthesis, are unequivocal in recommending treatment for obese children. Where concerns over child and adolescent self-esteem have been raised in the past, they have been largely silenced as self-esteem and other self-perception variables have been shown to improve after treatment⁽⁵²⁾.

In addition, there have been concerns over the possible adverse effects of physical activity treatment interventions on academic performance. These concerns were not addressed among the included review papers for this report. However, other research papers have demonstrated that physical activity has been shown to have a small positive or no impact on cognitive function and school performance⁽⁶⁰⁻⁶²⁾.

Synthesis: The very low risk of adverse effects, in conjunction with the high and increasing rates of childhood overweight and obesity, strongly indicate that the benefits of childhood obesity **prevention** and **treatment** outweigh any potential detriments or the consequences of not reducing childhood obesity rates.

Contextualization: Programs in this province appear to place more emphasis on the risk of adverse effects than the research evidence warrants and they may thus be imposing unnecessary limits on their own effectiveness. Most, if not all, provincial and regional programs directed at healthy body weights do not make direct reference to weight and obesity. A consensus among key players in health and education has been established that direct references will have an adverse effect on children and adolescents.

Synthesis Summary

Prevention

Although there is a consensus that prevention efforts are both needed and worth the time and resources required, the research literature does not provide sufficiently robust evidence to support any one type of childhood obesity prevention program or strategy over all others. The results of this synthesis suggest that:

- Increased physical activity and/or decreased sedentary behaviour are valid childhood obesity prevention strategies. However, they may only be effective if they can ensure compliance with regular aerobic physical activity and/or sustained reductions in sedentary behaviour.
- Efforts to change diet may be expected to be effective only if they target eating habits directly, for example with behaviour modification strategies or environmental changes that promote healthy foods. Nutrition education alone is not sufficient to change eating behaviour.
- At the population level, childhood obesity prevention programs may be efficiently delivered in the school setting. Prevention programs may be expected to be more effective if the program leaders have access to support from specialists in the field.
- Interventions that are multi-component in nature but focused on a limited set of objectives should be prioritized. Prevention programs should focus on a limited set of objectives, e.g. maintaining healthy body weight or balanced energy intake/output, instead of being rolled up in a broader child/adolescent health strategy, e.g., healthy sexuality or alcohol/drug use programs.
- Any prevention strategy will be more effective, or may only be effective at all, if it is tailored to the participant group in terms of their developmental level, interpersonal dynamic with parents, gender, and social and cultural context, including broader environmental conditions that support change at the level of the individual. Including children/adolescents in the development phase of programs, including pilot-testing, may prove to be an economical and efficient way to increase effectiveness.

Treatment

The research literature is unequivocal in recommending treatment for obese children. The lack of evidence showing adverse effects, coupled with the benefits of intervention compared to no intervention, strongly supports the treatment option. Although the research literature has not formed a consensus on the most effective treatment designs, several treatment components have demonstrated successful outcomes. The results of this synthesis suggest that:

- Multi-component interventions are more successful at reducing rates of obesity, and treatment design should incorporate a combination of those components that have demonstrated effectiveness.
- Childhood obesity treatments should include components that increase calorie expenditure, i.e. moderate to intense physical activity and/or reduced sedentary behaviour. These two distinct strategies can be integrated in the same treatment program and may be expected to maximize weight loss in children. **Finding opportunities for children and adolescents to be physically active and/or reduce sedentary behaviour is critical to balancing the energy equation that leads to adiposity.**
- The effectiveness of obesity treatments depends primarily on behavioural outcomes. Treatments will be enhanced by integrating behaviour modification strategies to first change eating behaviour and then maintain that behaviour. Nutrition education and reduced access to fat-rich/sugar-rich foods and increased access to healthy foods in the school environment may facilitate healthier eating habits among children and adolescents.

- The evidence strongly indicates that schools provide an efficient and economical setting for childhood obesity treatment programs. Increasing resources for teachers and treatment leaders, including career development modules, access to specialists and standardized curricula, may provide the most effective targeting of resources for childhood obesity treatment.
- The evidence also indicates that after-school programs, particularly where participants self-select, may also provide a highly effective opportunity to treat childhood obesity. Where these programs have established themselves independently, childhood obesity programs that incorporate evidence-backed components are expected to yield good results.
- Research suggests that treatment strategies aimed at families and located in the home are the least effective.
- There is good evidence to suggest that longer-term duration treatments will produce better results than short-term ones. Considering the high rates of overweight and obesity, the lack of adverse effects and the lack of healthy body weight maintenance strategies, obesity treatment interventions may warrant inclusion in the school curricula for the full school year.
- The key to childhood obesity treatment is to maximize compliance. The development of tailored treatment components that are motivating and relevant will increase compliance and treatment effect:
 - Treatment components need to take into account the age, sex and social and cultural contexts of the children being treated.
 - Physical activities need to appeal to the participants and place reasonable expectations on the participants' ability to engage in them.
 - There is strong evidence to suggest that participants be allowed to play a role in the development of some strategies, both in order to solicit information concerning their attitudes and preferences, but also to promote a sense of self-selection for the program.
- Soliciting feedback from participants at the end of the intervention would be one means to collect evidence to further tailor the program.

Concluding Remarks

This synthesis and contextualization of the available evidence for childhood obesity prevention and treatment is intended to inform health planners and policy makers about the way forward to address this modern epidemic. Limitations in the research to date inevitably limit the conclusions that can be drawn from the available evidence. As more research becomes available, a more clear-cut picture should emerge. However, given the dramatic increase in obesity rates that we have seen over the last few decades, in adults and children, and given the health risks associated with obesity, it is clear that we cannot afford to wait for better evidence. Instead, we should invest in prevention and management strategies, based on what we do know, as a matter of some urgency.

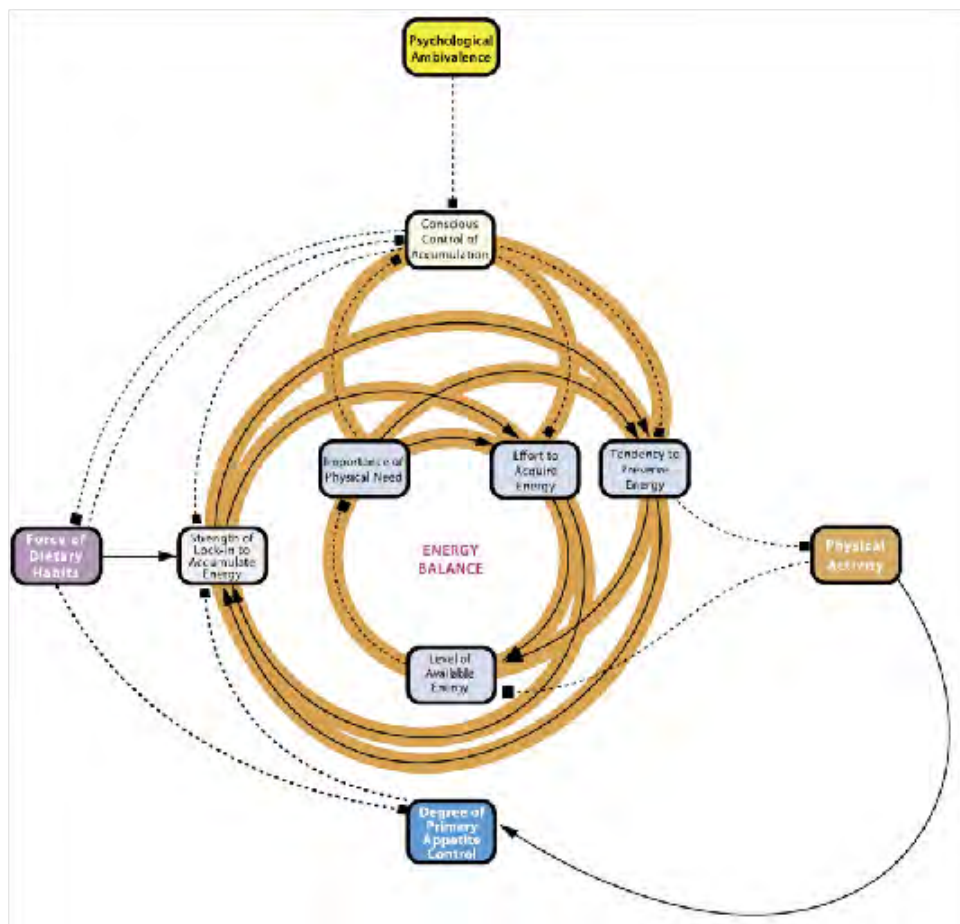
Any interventions that are implemented should include a strong evaluation component, so that some of the limitations in the research evidence can be addressed. They should also be multi-component, addressing the multiple factors that influence obesity – dietary intake, physical activity and the broader environment. The UK Foresight report (see [Appendix 2](#)), briefly outlined towards the end of this review, highlights the complexity of obesity as a public health problem. Yet as a society, we continue to focus on individual behaviour change⁽⁵¹⁾. Although research into the environmental influences on obesity is still very new, there is growing recognition that the environment in which we operate is increasingly obesogenic. Encouraging people to consume a healthy diet and be physically active alone is simply not enough to combat the effect of this obesogenic environment. Efforts to directly address energy imbalance, rather than any one side of the energy balance equation, are therefore necessary, and policy makers should consider policy options that influence energy intake and expenditure *together* at the societal level.

Appendix 1

New conceptual models for obesity and intervention designs for prevention and treatment

The UK Government Office for Science administers the Foresight Programme, an advanced multi-disciplinary futures scenario planning initiative on issues that have potential solutions in science and technology. In 2007, the Foresight project “Tackling Obesity: Future Choices” produced the most up-to-date, exhaustive and complex conceptual model for the causes of obesity.

Figure 4: Foresight Obesity System Map Central Engine. Solid lines are positive feedback and dotted lines are negative feedback



Source: Foresight, 2007

The Foresight model is built around a “central engine” that consists of three sets of interlocking feedback loops: a core balancing loop (representing the basic homeostatic functions of the human body); a reinforcement loop (also termed the “lock-in”); and a conscious-control loop (see Figure 4). The primary engine is influenced by four key variables (as well as many other secondary variables) that consist of: 1) level of primary appetite control; 2) force of dietary habits; 3) level of physical activity; and 4) level of psychological ambivalence.

Most research into the causes of childhood obesity and potential interventions have focused on these four key variables. The full Foresight model is too complex to fully describe and explain in this report, and its application to research has yet to be fully implemented. However, the complexity of the model itself is an extremely important aspect of obesity when interpreting research results for obesity prevention or intervention programs.

The Foresight model describes the multiple and inter-related factors that comprise the obesogenic environment. The complexity of inter-relations among the different factors provides an explanation for why isolating discrete causal variables for obesity, despite the obvious nature of its core causes (i.e. eating too much and doing too little), has been so problematic. This kind of model, by incorporating clusters of variables, provides a more valid representation of the breadth of factors that influence body weight. The model indicates that the current obesity epidemic may be understood as the result of many *linked* problems impacting on the energy balance equation involving: physiology, individual physical activity, the physical activity environment, individual psychology, social psychology, and food production and consumption.

The Foresight model gives a key insight into childhood obesity. Efforts to develop effective prevention and treatment programs have been limited in the scope of factors that can be addressed. **Yet linked problems like obesity cannot be solved in isolation.** This applies to not just individual factors but also to levels of factors; in other words, focusing exclusively on individual behaviour or family habits will not be successful in decreasing obesity in an obesogenic environment. In order to effect an overall change in prevalence of obesity, most, if not all, of the clusters of factors would need to be addressed through coordinated initiatives.

A small number of interventions have been designed to address multiple linked factors, taking a so-called ecological approach to obesity treatment and prevention. The results of these projects indicate that reducing childhood obesity and overweight is indeed possible, but it is also a lengthy process measured in years and one that requires full community participation. A few of these ecological interventions are summarized and linked below:

- **Fleurbaix-Laventie (FL) Program** (France). A community-wide initiative that involved interventions in the school and home setting, targeting children and family, on a broad range of nutritional and physical activity objectives. The initiative lasted thirteen years, and obesity rates in participating communities were half that of neighbouring control communities (8.8% vs. 17.8%). However, significant differences in overweight and obesity emerged only after eight years of intervention⁽⁶³⁾.
- **Ensemble Prévenons l'Obésité Des Enfants (EPODE)** (France: www.epode.fr). Based on the FL initiative, EPODE involves ten French cities in a pilot study to mobilize whole communities to achieve and maintain healthy body weight. Children, families, business owners and the public sector all participate in the initiative, including in the design of prevention strategies.
- **Be Active Eat Well** (Australia: www.goforyourlife.vic.gov.au/hav/articles.nsf/pracpages/Be_Active_Eat_Well). A community-based project involving coordinated initiatives targeting children, parents and schools over four years. At the conclusion of the project, children were, on average, watching 20% less television, drinking 70% fewer soft-drinks and had increased participation in after-school sports by 70%.
- **Shape Up Somerville (SUS)** (United States: <http://nutrition.tufts.edu/research/shapeup>). A three-year multi-faceted community-based participatory research initiative designed to alter the obesogenic environment to prevent obesity among early elementary age children. The intervention activities were designed to impact on all aspects of the children's life (before, during and after school, home and community components). Stakeholder participants included children, parents, teachers, extra-curricular program organizers, food services providers and restaurants, city departments, decision makers and health care providers. First year results reported significant BMI decreases in the test community compared to control communities⁽⁶⁴⁾.

m. The size and complexity of the model diagram make it illegible in a report of this format. Detailed views of the model diagrams may be seen online at: www.foresight.gov.uk/Obesity/Obesity_final_part2.pdf

Appendix 2

Review article searches and evaluation

Searches

Search terms (PubMed MH, CINAHL MJ tags):

- Child OR Adolescent
- Obesity OR Body Weight OR Obesity Prevention & Control OR Diet, Reducing
- Treatment OR Treatment Outcome OR Treatment Effectiveness OR Treatment Efficacy

Limits (PubMed and CINAHL):

- English language
- Publication year 2000-2008
- Human
- Review

Evaluation of review articles

Methodological rigour was ranked as low, mid or high, based on the criteria listed below. Review articles ranked as mid or high were included in this report. Review articles with high rankings were more heavily weighted in the synthesis.

1. The review article had and explained the criteria used for including and excluding studies.
2. Sample sizes of the participants in the studies.
3. The review article included studies that are randomised controlled trials (RCT), controlled clinical trials (CCT), controlled before and after studies (CBA), and interrupted time series (ITS). Cohort, qualitative and survey studies may have been considered.
4. The review article included studies with a minimum requirement of at least one data point before and one after the intervention.
5. The review article included studies with a minimum time period of three months between baseline and repeat measures for interventions.
6. The review article included studies with primary outcome measures of BMI, weight and/or waist circumference. Secondary outcomes of diet and/or physical activity, changes in knowledge, attitudes and awareness were also considered, where appropriate and in addition to objective measures of change.

Utility was a subjective rating by the Team Leader that rated the review article in terms of methodological rigour and the generalizability of the findings of the review. The intention of the utility score was to evaluate the research findings for prevention and treatment interventions, in the context of their value to decision makers. The scores were used in both the synthesis and contextualization sections of the report. The rating scores were:

- **Green Light:** the findings from the review article were clear enough and robust enough to inform decision makers to consider the intervention effective.
- **Yellow Light:** the findings from the review article were not clear enough and/or robust enough to inform decision makers to consider the intervention effective or ineffective.
- **Red Light:** the findings from the review article were not clear enough and/or robust enough to inform decision makers to consider the intervention ineffective.

Appendix 3

Research Summaries: Prevention

Casey, L., & Crumley, E. (2004). Addressing childhood obesity: The evidence for action.

This meta-review included six systematic reviews and six narrative reviews of obesity prevention programs. The reviews ranged in quality, with the narrative reviews all scoring at the lowest end of the scale. Based on the systematic reviews, less than half of the primary research studies showed a benefit to reducing obesity among the target groups. However, three of the narrative reviews did find supporting evidence that prevention programs have beneficial effects on dietary and physical activity behaviours associated with maintaining healthy body weight. The authors concluded that there is insufficient evidence to support the effectiveness of interventions aimed at preventing obesity among children and adolescents.

Connelly, J. B., Duaso, M. J., & Butler, G. (2007). A systematic review of controlled trials of interventions to prevent childhood obesity and overweight: A realistic synthesis of the evidence. *Public Health*, 121(7), 510-517.

This review found that 11 of 28 (39%) randomized controlled trials (RCTs) for obesity prevention among youth demonstrated significant decreases in adiposity compared to control group. The criterion used was effective vs. ineffective study outcomes based on a significant decrease in adiposity, and an intensity score based on a priori criteria for: 1) Intervention based on an explicit theory or on pilot studies or formative research, 2) Intervention implemented by the researchers, 3) Physical activity judged to be compulsory rather than voluntary, and 4) Multi-component intervention. Neither scalability nor lasting effects were addressed. No relationship was found between intensity score and effectiveness. Girls were found to have poorer outcomes than boys. Compulsory provision emerged as highly associated with effectiveness, and was found to have an excellent level of non-chance agreement. On the basis of realism, this association is here argued to be causal and rational: Causal because moderate to vigorous aerobic physical activity is biologically an effective means of body fat reduction; Rational as the compulsory nature of this provision is very likely to ensure adherence. The reliability of the review is considered high.

Doak, C. M., Visscher, T. L., Renders, C. M., & Seidell, J. C. (2006). The prevention of overweight and obesity in children and adolescents: A review of interventions and programmes. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, 7(1), 111-136.

This review found that 17 of 25 (56%) of the prevention interventions were found to be effective in reducing overweight, obesity or adiposity measures. The review compared key elements and methodological approaches in reduction of adiposity compared to a control group (deemed effective or ineffective). The reliability of the study is considered moderate. Neither scalability nor lasting effects were addressed. All interventions were school-based and the authors conclude that the school setting is an appropriate channel for prevention. Effective studies tended to target fewer objectives than non-effective interventions, but were still multi-component in design. Effective interventions tended to have an educational component and ineffective interventions a physical instruction component, but there was no discussion of this finding; it may have been the result of a difference in age group distribution between the effective group and the ineffective group. The study included an analysis of potential unhealthy outcomes of the prevention measures: none were found.

Flodmark, C. E., Marcus, C., & Britton, M. (2006). Interventions to prevent obesity in children and adolescents: A systematic literature review. *International Journal of Obesity* (2005), 30(4), 579-589.

This study is an update of a review by the Swedish Council on Technology Assessment in Health Care on obesity prevention that included a total of 25,896 children. It found that 15 of 39 (41%) of the studies, representing 40% of the participants, were effective. The remaining studies were neutral (no effect on body weight) and none reported negative effects, for example eating disorders, negative self-image or increased body weight. The review considered studies effective if they were able to reduce overweight measures compared to a control group. The reliability of the study is considered to be high. Scalability and lasting effects were measured but not reported. The review concluded that it is possible to prevent obesity in children and adolescents through limited, school-based programs that combine the promotion of healthy dietary habits and physical activity.

Micucci, S., Thomas, H., & Vohra, J. (2002). The effectiveness of school-based strategies for the primary prevention of obesity and for promoting physical activity and/or nutrition, the major modifiable risk factors for type 2 diabetes: A review of reviews. PHRED Program, Public Health Branch, Ministry of Long-Term Care, Toronto, ON.

This review of reviews found that while school health promotion could be effective in changing child and adolescent behaviour it has not been consistently shown to do so. These findings are consistent with a British Health Technology Assessment (1999) (Lister-Sharp D, Chapman S, Stewart-Brown S, Sowden A. Health promoting schools and health promotion in schools: Two systematic reviews. *Health Technol Assess.* 1999;3(22):1-207. Available at: <http://health-evidence.ca/articles/show/16127>). The report stressed that inconclusive results were more a consequence of research design and methodologies rather than of the absence of treatment effects. The report was equivocal in recommending a particular intervention program or component but did find that children were more amenable to changes in behaviour than adolescents. The review also found that, in addition to age, gender and ethnicity play roles in mediating the effectiveness of interventions. The report found that knowledge, such as healthy nutrition information, is not sufficient to change behaviour but is a necessary precondition for change to occur. The authors concluded that behaviour modification is an effective and crucial component of obesity and overweight interventions. In addition, the report found the following:

- School-based interventions should be multi-faceted, in particular including both classroom programs and environmental changes.
- Environmental changes are essential for population-based interventions to have significant and lasting treatment effects.
- Interventions are more effective when they are behaviourally focused.
- Dose responses have been shown, when studies had longer durations and timely use of refresher components for the intervention.
- Successful interventions tailor the intervention to the target group's characteristics, in particular age, gender and ethnicity.

Stice, E., Shaw, H., & Marti, C. N. (2006). A meta-analytic review of obesity prevention programs for children and adolescents: The skinny on interventions that work. *Psychological Bulletin*, 132(5), 667-691.

This study is a meta-analysis involving 46 studies that reported on a total of 64 interventions. The overall average effect size was positive and small but significant. Thirteen of the 64 (21%) interventions had positive, moderately-sized and clinically significant intervention effects on obesity prevention. All studies included a control group and most were school-based. The reliability of the study is considered to be high. The duration of the intervention had a negative impact on effect size, with shorter interventions having a larger effect size. Three of the interventions had weight gain prevention effects that persisted for "a significant follow-up period." The relationship between age and effect size was found to be U-shaped, with middle school children showing the smallest effect sizes and primary school and adolescents the best outcomes. There was evidence that girls had better outcomes than boys and that single-sex interventions were more effective than co-ed interventions for obesity prevention. Interventions that focused on obesity prevention instead of including other healthy behaviours, as well as those whose participants self-selected, had bigger effect sizes. Several moderators that were expected to improve intervention effect sizes did not have a significant impact: these include mandated improvements in diet and exercise, sedentary behaviour reduction, parental involvement, and delivery of interventions by trained professional interventionists (rather than teachers). Summerbell, C. D., Waters, E., Edmunds, L. D., Kelly, S., Brown, T., & Campbell, K. J. (2005). Interventions for preventing obesity in children. *Cochrane Database of Systematic Reviews* (Online), (3)(3), CD001871.

This Cochrane review is a meta-analysis that included 22 studies on childhood obesity prevention in developed and under-developed countries. Ten studies were long-term (>12 months) and twelve were short-term; most studies were school-based (86%). The studies were considered too heterogeneous to combine all of them in a statistical model. As is often the case in systematic reviews with very high levels of methodological rigour like the Cochrane Reviews, no significant effect size was found for any of the intervention groups compared to control groups. Scalability and follow-up effects were investigated but not reported. Evidence from one long-term study indicated that girls had better outcomes than boys. Two out of four interventions to increase physical activity had small, positive non-significant effects to reduce obesity.

Thomas, H., Ciliska, D., Micucci, S., Wilson-Abra, J., & Dobbins, M. (2004). Effectiveness of physical activity enhancement and obesity prevention programs in children and youth. Ottawa, Ontario, Canada: Health Canada.

This project report reviewed a total of 365 primary research studies on a range of interventions grouped into five systematic reviews. The different groups reflect the primary objectives of the reviews, which were to evaluate interventions aimed at: improving nutrition, decreasing physical inactivity, increasing physical activity, multifaceted interventions (241) and environmental interventions (5). Since the main objective of these reviews was not obesity prevention per se, only the findings that are directly relevant to obesity have been included in this report. Overall, the methodology of this report was rigorous and had a high reliability for all but the environmental review. While all eligible studies were included in the analysis, only the methodologically strongest ones were included in the discussion. Throughout the report, the authors stress that making students set their own goals and employing trained teachers (either in the classroom or for physical education class) are consistently associated with better behavioural outcomes.

The review of studies on interventions to improve nutrition (n=76) found small but significant changes in eating behaviour. No significant obesity prevention effect was mentioned, but the review concluded that educational messages targeting specific behaviour or behavioural change are more effective than general nutritional information. Multifaceted approaches consistently show greater results than one-dimensional interventions.

The review of studies to decrease physical inactivity (n=17) found that specialized teacher training to promote reduced screen time (television, computers, video games) produced clinically significant reductions in inactivity. All reviewed studies were based on six intervention programs, four of which were associated with significant decreases in adiposity measures and all had Social Learning Theoryⁿ underpinning the research design.

The review of studies to increase physical activity (n=26) found mixed results—additional physical activity classes, instead of skill development classes, had better outcome measures (3/26 studies). No clinical or significant change in BMI values was associated with any of the studies.

The largest review of studies concerned those that were ‘multifaceted’, i.e., aimed at increasing both physical activity and nutritional intake (n=241). This review included 241 studies on 51 separate interventions, most of which were delivered in the US (39/51). The use of specialized physical education teachers made a significant impact on the level of children’s activity. Although the authors report significant increases in physical activity with the replacement of skill development classes with aerobic exercise, meaningful decreases in adiposity were recorded in only four studies.

Research Summaries: Treatment

Atlantis, E., Barnes, E. H., & Singh, M. A. (2006). Efficacy of exercise for treating overweight in children and adolescents: A systematic review. *International Journal of Obesity* (2005), 30(7), 1027-1040.

This systematic review and meta-analysis included 13 papers reporting on 14 randomized controlled trials. The papers addressed the specific role of exercise for treating overweight/obese children and adolescents. Studies were included if they had control groups and pre- and post-testing and if they reported measures of overweight. There was considerable variability in study design. Exercise was found to significantly reduce percent body fat in obese boys and girls but was inconclusive in terms of total body weight. When body weight effects were pooled, a higher dose of aerobic exercise (155-180 min/wk) had a significant and greater effect size than a lower dose (120-150 min/wk) which had a non-significant and smaller effect. The average treatment duration was 16 weeks, and study duration was associated with a larger decrease in body weight of 0.5 kg (non-significant). Most of the evidence stemmed from studies of moderate-to-high intensity aerobic exercise in combination with behavioural interventions for dietary restrictions. The authors note that none of the studies prescribed the full recommended level of 210-360 min/wk.

n. Social Learning Theory posits that people learn new behaviour by reinforcement or punishment or by observation of the same with other people. If people observe positive, desired outcomes in the observed behaviour, they are more likely to model, imitate, and adopt the behaviour themselves. Bandura, A. (1977). *Social Learning Theory*. General Learning Press.

Casey, L., & Crumley, E. (2004). Addressing childhood obesity: The evidence for action

This report summarizes the primary research and review literature pertaining to childhood obesity prevention and treatment. The results are based on a systematic review of meta-analyses, systematic reviews and narrative reviews. The report surveyed publications from 1966 to 2003 and provides a summary of evidence from reviews that were not directly included in this synthesis. The report does not include a meta-analysis of the included studies. The report assesses the strength of evidence for different aspects of obesity interventions and provides recommendations for both research and decision makers. Its key findings are summarized in the table below:

Treatment	Evidence	Recommendation
General	Good evidence that treatment, in general, is effective	Strongly recommended that obese children receive some form of intervention
Exercise + Diet	Fair evidence to support exercise in conjunction with dietary intervention	Recommended that treatment interventions include exercise component
Exercise	Insufficient evidence to support a particular approach to increase physical activity	Recommended that exercise component be tailored to the target group
Parental involvement	Good evidence indicating parental involvement does not improve obesity intervention outcomes	Recommended that obesity programs focus resources towards children, not parents
Behaviour modification	Good evidence to support using behavioural strategies in obesity interventions	Strongly recommended that obesity treatment interventions include a behaviour modification component, for both a change in adaptive behaviour as well as the maintenance of adaptive behaviour
Reinforcement	Insufficient evidence to evaluate role of reinforcement	Recommended that research further investigates the role of reinforcement
Diet	Insufficient evidence to support a specific dietary intervention strategy	Strongly recommended that research further investigates the efficacy of dietary interventions
Setting	Good evidence that treatment delivered in a specialized setting improves outcome	Strongly recommended to base interventions in schools and community settings (instead of home settings)
Duration of treatment	Insufficient evidence to evaluate effect of duration on treatment	Strongly recommended that research further investigates the impact of duration on treatment outcomes
Age	Insufficient evidence to evaluate relationship between age and treatment outcomes	Strongly recommended that research further investigates the relationship between age and treatment outcomes
Initial weight	Insufficient evidence to evaluate relationship between initial weight and treatment outcomes	Recommended that research further investigates the relationship between initial weight and treatment outcomes

Collins, C. E., Warren, J., Neve, M., McCoy, P., & Stokes, B. J. (2006). Measuring effectiveness of dietetic interventions in child obesity: A systematic review of randomized trials. Archives of Pediatrics & Adolescent Medicine, 160(9), 906.

This systematic review assessed the effectiveness of dietetic treatments for obesity for children under 18. It included 17 RCTs in the review and a meta-analysis on eight studies that included appropriate control groups. The pooled effects of those studies showed small but significant post-intervention decreases in body weight and percent body fat. However, a second meta-analysis including those studies with follow-up data showed a diminishing effect from the interventions, from a standardized mean difference of -1.82 to one of -0.64. The individual studies were highly variable in terms of the other components that were included, making it difficult to isolate the effects of dietary interventions. The review did not identify any dose-response or intermediate variables that were significant.

DeMattia, L., Lemont, L., & Meurer, L. (2007). Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. Obesity Review: An Official Journal of the International Association for the Study of Obesity, 8(1), 69-81.

This review specifically addressed targeting sedentary behaviour (SB), defined as screen time (television, video games, computer) not including homework or reading, as an effective intervention strategy to reduce obesity. Twelve studies met a priori criteria and were included in the review. Eleven studies targeted children and one adolescents, and half were clinic-based while the other half were population-based. Interventions to decrease SB were successful overall but modestly so, slowing the increase in BMI relative to age-matched controls. However, variability in other components of the intervention made it impossible to estimate the effect of SB interventions. In the one study targeting adolescents, post-intervention results showed that 56% of the treatment group lowered their BMI z-score^o, compared with 16% of the control group. Dose-response and lasting effects of SB interventions were not identified.

^o. The z-score is a standardized version of a measurement, in this case the BMI, that is equal to subtracting the mean from the observed measurement and dividing the difference by the population standard deviation.

McLean, N., Griffin, S., Toney, K., & Hardeman, W. (2003). Family involvement in weight control, weight maintenance and weight-loss interventions: A systematic review of randomised trials. *International Journal of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity*, 27(9), 987-1005.

This descriptive systematic review examined the nature and effectiveness of family involvement in control, maintenance and loss of weight for overweight/obese children. Twenty-one papers describing sixteen interventions were included in the review, with one targeting adolescents and the rest children aged 6-12. The study on adolescents (Brownell et al.) demonstrated significantly more weight loss at one year follow-up when subjects were targeted separately from their mothers (10.6kg). Increases in the number of successfully taught behaviour changes to both pre-adolescent children and parents were positively associated with more successful intervention outcomes. The studies that were included tended to have small sample sizes and heterogeneous designs, making it difficult to draw more definitive conclusions. There was no apparent link between length of intervention and effectiveness.

Reilly, J. J., & McDowell, Z. C. (2003). Physical activity interventions in the prevention and treatment of paediatric obesity: Systematic review and critical appraisal. *The Proceedings of the Nutrition Society*, 62(3), 611-619.

This highly rigorous systematic review included one RCT, one meta-analysis and a Cochrane review. The authors contend that most published research is prone to bias and has limited value for informing obesity treatment programs. Nonetheless, the authors highlight findings from two studies that show a significant decrease in percentage of overweight children in interventions targeting a reduction in sedentary behaviour compared to those focusing on increased aerobic activity. These findings were significant at a one-year follow-up. The authors did not identify any dose-responses among the interventions.

Snethen, J. A., Broome, M. E., & Cashin, S. E. (2006). Effective weight loss for overweight children: A meta-analysis of intervention studies. *Journal of Pediatric Nursing*, 21(1), 45-56.

This meta-analysis combined seven studies on weight-loss interventions for overweight children. The review was of high quality but had too few studies to draw reliable conclusions. The focus of this review is on middle-school children with a mean age of 12 years. Heterogeneity among the interventions prevented comparing the effectiveness of components. However, the authors find the evidence indicates that structured dietary and physical activity regimens, compared to encouragement or counselling, are more effective in both weight loss and healthy weight maintenance. They also find that intervention consistency will enhance any treatment effect, and that interventions should be multi-component (including diet, exercise, behaviour modification and parental support). Studies of greater length were weakly associated with greater weight loss. The authors did not address the issue of the longer-term effects of the interventions.

Summerbell, C. D., Ashton, V., Campbell, K. J., Edmunds, L., Kelly, S., & Waters, E. (2003). Interventions for treating obesity in children. *Cochrane Database of Systematic Reviews (Online)*, (3)(3), CD001872.

Cochrane reviews are the most rigorous systematic reviews available and generally set the gold standard for the genre. This review, originally produced in 2003 and updated in 2007, included 18 randomized trials for childhood obesity/overweight treatment. The studies included treatments that were based in schools, clinics and communities. Heterogeneity of the interventions precluded carrying out a meta-analysis. The review found a small but significant effectiveness of interventions to reduce sedentary behaviour on BMI. Behaviour modification training for parents is identified as a potential enhancer of childhood obesity interventions. The authors recommend increased physical activity regardless of weight status for the proven health benefits later in life, even though the benefits are not as clear in childhood itself. No dose-response or lasting effects of any intervention components were identified. The authors note that pre-testing of interventions will increase the likelihood of positive outcomes.

Wilfley, D. E., Tibbs, T. L., Van Buren, D., Reach, K. P., Walker, M. S., & Epstein, L. H. (2007). Lifestyle interventions in the treatment of childhood overweight: A meta-analytic review of randomized controlled trials. *Health Psychology*, 26(5), 521-532.

This meta-analysis compared lifestyle interventions with controls who received either no treatment or only information/education. Fourteen studies were included, yielding 19 effect sizes. Lifestyle interventions included diet, parental involvement, behaviour modification and exercise. The review found modest but clinically significant benefits in the short-term from the lifestyle interventions compared to the controls. Treatment effects remained significant at follow-up but were diminished. Dose-response relationships were identified, with effect size increasing with duration of treatment and decaying approximately 10% over two years. No intermediate factors, such as gender, were identified.

Cole, K., Waldrop, J., D'Auria, J., & Garner, H. (2006). An integrative research review: Effective school-based childhood overweight interventions. *Journal for Specialists in Pediatric Nursing : JSPN*, 11(3), 166-177.

This “integrative” review sought to identify theoretical features of effective school-based interventions for child overweight/obesity. The review included 10 studies that used lifestyle, education, dietary or physical activity intervention components that had shown a statistically significant decrease in BMI or body weight. Social Cognitive Theory or a variant of SCT was used in eight of the studies. SCT is a theory that explains behaviour change based largely on observational learning and the influence of peers or social groups on individuals. Based on these findings, the authors concluded that SCT was an effective theoretical framework for childhood obesity/overweight interventions. No dose response or lasting effects were identified.

Dobbins, M., Lockett, D., Michel, I., Beyers, J., Feldman, L., Vohra, J., et al. (2001). The effectiveness of school-based interventions in promoting physical activity and fitness among children and youth: A systematic review.

This systematic review addressed the effectiveness of school-based interventions that promote physical activity (PA) in children aged 6-18. Eleven of the nineteen studies included BMI measures, six for grade-school children only, three for adolescents and two for both. The review found mixed effects for the increase in PA at post-intervention or follow-up, with no consistent combination of factors predicting successful outcomes. The very high level of variability among the interventions made generalizations problematic. No consistent dose responses were identified. However, the review found that the interventions were successful in increasing PA among adolescent girls and that children exposed to PA promotion interventions had greater PA as adults. The authors conclude that, given the absence of harmful or negative effects in any of the studies and small, albeit non-significant, positive effects for PA promotion, public health practice should be encouraged to implement physical activity promotion in schools.

Flynn, M.A., McNeil, D.A., Maloff, B., Mutasingwa, D., Wu, M., Ford, C., et al.. (2006). Reducing obesity and related chronic disease risk in children and youth: A synthesis of evidence with ‘best practice’ recommendations. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, 7 Suppl 1, 7-66.

This “synthesis research study” sought to develop best practice recommendations for the prevention and treatment of childhood obesity. The study selected 158 papers reporting on 147 interventions, but a lack of methodological rigour precluded identifying any models of best practice. The main findings of the study involve a gap analysis of the research. The authors identified a significant lack of population health theory in the development of obesity interventions (21%). They also found that research investigating interventions set in the home (3%) and directed at environmental factors (17%) was lacking. The study identified stakeholder involvement at every stage to be an important component of successful programs, and a lack of upstream investment to be the biggest barrier in changing obesogenic environments. The authors also strongly supported the development of gender-specific interventions for middle school and high school aged children.

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