



Commissioned Reports

Diet and Nutrition: A Synthesis of review evidence

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EXECUTIVE SUMMARY

The growing incidence of chronic diseases has, in part, contributed to increased political and societal pressures to ensure public funds are allocated to the provision of services with known effectiveness. In other words, there is a call to action to ensure the programs and services implemented across Canada in population and public health are effective, and that they will result in improved health outcomes for Canadians. There is some evidence to suggest that current practices related to the promotion of healthy dietary behaviours may not adequately address inequities in health, and may even increase disparities. The purpose of this paper is to identify and summarize research findings on the effectiveness of population based interventions on community-based diet and nutrition, which was identified as a priority topic area in the annual report of the Ontario Chief Medical Officer of Health to the legislative assembly.

The health-evidence.ca registry was searched for reviews on diet and nutrition in May 2011. A standardized quality assessment tool was used to assess the methodological quality of each identified review by two independent reviewers. All search results were limited to reviews rated as being of strong methodological quality. Extracted data included age of participants studied in the review, research design, methodological quality rating, details of the interventions evaluated, details describing which outcomes were evaluated as well as how they were measured, and outcome data.

The diet and nutrition search identified 33 high quality reviews, 17 of which reported on outcomes of interest to this review. Outcomes evaluated included: improving diet (N=10), weight change (N=5), and body mass index (BMI) (N=5). Participants studied ranged from healthy adults to obese adults and adults diagnosed with pre-diabetes, as well as children, adolescents, and ethnic and low income populations. The interventions evaluated varied significantly across the reviews but can be classified as follows: improving diet, weight management, fruit and vegetable consumption, nutrition education, sodium reduction, cognitive/behavioural change strategies, lifestyle interventions, self-help interventions, and incentives.

Exposure to cognitive/behavioural change strategies results in statistically significant large effects on eating behaviours among adults. The evidence supports the provision of behavioural change interventions, particularly self monitoring plus one other self regulating intervention such as intention formation, feedback on performance, goal setting and review of behavioural goals, to improve healthy eating. While behavioural and education-based nutrition strategies are associated with healthier diets, there is some evidence to suggest that nutrition interventions may be associated with increased health disparities. For example, children from higher income families experience greater improvements in diet (e.g. healthier eating) compared to children from lower income families following exposure to a healthy eating intervention, and that White children consume fewer grams of fat per day compared to Black children. In addition, ethnic minority individuals were reported more likely to drop out of studies than White participants.

The evidence also illustrates that community based interventions significantly increase fruit and vegetable consumption among preschoolers and school-aged children, and among adults when the intervention is implemented in a workplace setting. However, the magnitude of effect may

be insufficient to result in clinically significant health benefits. The most effective community-based interventions provided clear messages about increasing fruit and vegetable consumption; incorporated behavioural theories and goals, provided a consistent framework for implementation and evaluation; provided longer, more intensive interventions rather than one or two contacts; actively involved influential people such as family members; and targeted those whose knowledge and/or fruit and vegetable intake was low. Tailored nutrition education in comparison to general nutrition education appears to be a particularly promising practice among populations with low SES and different ethnicities, but not amongst adults in the general population. Finally, much of the evidence suggests that community-based diet and nutrition interventions are not associated with a positive impact on body mass index among children, adolescents, or adults although there is some evidence to suggest these interventions may be effective among those diagnosed with pre-diabetes.

Overall the evidence suggests that interventions targeted at weight loss are effective, particularly among those who are obese or have established high risk factors (pre-diabetes). However, significant effects, while still present in the medium term, (i.e. 2-3 years post intervention), are not maintained in the long term (5 years). Incentives were effective in reducing weight, although impact in the long term is not known. The impact of incentives on subgroup populations such as those with low socioeconomic status or different ethnicities has not been studied to date.

This review of the literature represents many systematic reviews and meta-analyses, primary studies and thousands of people. To some extent, the results illustrate that many population health and public health programs are associated with benefits to various populations, particularly related to outcomes such as healthy eating. However, there remains cause for concern given some of the evidence suggests that various interventions may in fact widen health disparities. As a result, higher SES and white populations benefit more from certain interventions than those from low SES and non-white populations. Much more research is needed to fully explore if and how interventions impact health outcomes in different sub populations. However, the evidence presented here provides some direction for moving forward with practice, draws attention to some areas that require ongoing evaluation, and identifies some practices that may not be producing the expected impact and therefore should be examined critically in terms of future investment. While a great deal has been accomplished in population and public health programs there is still much work to be done!

BACKGROUND

Community-based Diet and Nutrition

Proper nutrition is essential to the growth and development of children and youth, as well as maintaining health in adulthood. While the Canadian Food Guide suggests a minimum of five daily servings of vegetables and fruit, seven out of 10 children aged 4 to 8 and half of adults are not meeting this recommended minimum [Garriguet, 2004 14818 /id;Health Canada, 2011 14819 /id]. Over 25% of Canadians aged 31 to 50 get more than 35% of their total calories from fat, increasing their health risks, such as increased BMI [Garriguet, 2004 14818 /id]. Since adults in the highest income households are more likely to eat prepared foods (i.e. fast food restaurants), adults in low and lower-middle income households are less likely than the highest income households to get more than 35% of their daily calories from fat [Garriguet, 2004 14818 /id]. Meanwhile, children and adolescents consumption patterns are not as closely associated with household income.

Evidence-Informed Decision Making

Evidence-informed decision making (EIDM) is accepted in Canada as necessary for the provision of effective health care services. The goal of the public health sector in Canada is to promote health and reduce the amount of disease, premature death, and pain and suffering in the population, through health promotion, disease and injury prevention, and health protection [3]. The effectiveness of public health services has direct implications for health system outcomes and expenditures, as the following example illustrates. In 2005, chronic diseases, such as cardiovascular disease (CVD), cancer, emphysema, and diabetes, accounted for 35 million deaths worldwide [4]; had been increasing steadily over the past two decades; and in 2002, the economic burden of CVD and cancer alone in Canada was \$32.7 billion [5]. Overweight and physical inactivity, recognized risk factors for chronic diseases [6,7], have also risen steadily in the past two decades. Canadian data suggests a 10% decrease in sedentary behaviour would result in health savings of \$150 million per year [8].

The growing incidence of chronic diseases has, in part, contributed to increased political and societal pressures to ensure public funds are allocated to the provision of services with known effectiveness. In other words, there is a call to action to ensure the programs and services implemented across the public health sector in Canada are effective, and that they will result in improved health outcomes for Canadians. The purpose of this commissioned work is to identify and summarize research findings on the effectiveness of population based interventions community-based diet and nutrition, which was identified as a priority topic area in the annual report of the Ontario Chief Medical Officer of Health to the legislative assembly.

METHODS

The www.health-evidence.ca online registry is a free, searchable database of quality-appraised systematic reviews evaluating the effectiveness of public health interventions. The health-evidence.ca registry is populated through an extensive ongoing search (1985-present) of seven electronic databases (MEDLINE, EMBASE, CINAHL, PsycINFO, Sociological Abstracts, BIOSIS, SportDiscus), handsearching of 46 journals, and screening the reference lists of all relevant reviews [9]. Reviews are assessed for relevance, and then relevant reviews are indexed by commonly-used public health terms and quality assessed by two independent reviewers who come to agreement on the final rating of each review (strong, moderate, weak). More detail on www.health-evidence.ca has previously been published [9].

The health-evidence.ca registry was used to search for reviews on diet and nutrition, built environment, and social determinants of health in May 2011. The following keywords were used to search for the community-based diet and nutrition interventions in health-evidence.ca: diet, eating behaviour, food intake, fruit or vegetables, and community. All search results were limited to reviews rated as being of strong methodological quality.

Two reviewers used a standardized quality assessment tool to assess the methodological quality of each identified review. Using a ten-point quality assessment tool (available at: http://www.health-evidence.ca/downloads/QA%20tool_Doc%204.pdf), all reviews were assessed by two reviewers independently and disagreements resolved through discussion. The ten criteria used to assess methodological quality were: (1) a clearly focused question; (2) inclusion criteria explicitly stated; (3) comprehensive search strategy; (4) adequate number of years covered in the search; (5) description of level of evidence; (6) assessment of the methodological rigor of primary studies; (7) methodological quality of primary studies assessed by two reviewers and results given; (8) tests of homogeneity or assessment of similarity of results conducted and reported; (9) appropriate weighting of primary studies; and (10) author's interpretation of results supported by the data. Each criterion, worth one point each, was given equal weight in the overall assessment score. Reviews were given an overall score out of 10 and were classified into three categories: Strong, Moderate, and Weak. Reviews receiving an overall rating of eight or more were considered strong, those with a score of five to seven, moderate, and those with four or less, weak. Quality ratings for reviews included in this synthesis project ranged from 8-10.

All outcome data was extracted from all the reviews included in this project and organized into a matrix table. Additional tables were then created according to the most prominent outcomes to further summarize and present the data for each of the topic areas. Data extraction was conducted on strong reviews using a previously developed tool. Extracted data included author and year of publication, methodological quality rating, author's country, number of included studies, research design, population examined, interventions evaluated, details describing which outcomes were evaluated, the effectiveness of the intervention, the results, and additional comments. The data are presented in Tables 1 to 3.

RESULTS

The diet and nutrition search identified 33 high quality reviews, 17 of which reported on outcomes of interest, 13 being systematic reviews and four meta-analyses. Outcomes evaluated in the 17 reviews included: improving diet (N=10), weight change (N=5), and body mass index (BMI) (N=5). Six of the 17 reviews included randomized controlled trials (RCTs) only, seven included both RCTs and other studies (non-RCTs, quasi-RCTs, concurrent controlled trials, reviews, or not specified), two reviews included controlled trials and/or interrupted times series, and two reviews included controlled trials and cohort studies. All of the reviews were of strong methodological quality, with three reviews scoring 10 out of a possible score of 10 on methodological quality, six scoring nine, and eight reviews scoring eight. The majority of the reviews were conducted in the UK (N=8), followed by Canada (N=3), US and New Zealand (N=2), and the Netherlands (N=1). The number of primary studies included in the reviews ranged from 4 studies to 48 and the participants studied ranged from healthy adults to obese adults and adults diagnosed with pre-diabetes, as well as children, adolescents, and ethnic and low income populations. The interventions evaluated varied significantly across the reviews but can be classified as follows: improving diet, weight management, fruit and vegetable consumption, nutrition education, sodium reduction, cognitive/behavioural change strategies, lifestyle interventions, self-help interventions, and incentives.

IMPROVED DIET

Healthy eating - generally

The evidence illustrates that exposure to cognitive/behavioural change strategies results in statistically significant large effects on eating behaviours among adults. Overall, adults exposed to cognitive/behavioural change interventions are 31 times more likely to engage in healthy eating behaviours in comparison to those not exposed. Other evidence illustrates that behavioural change interventions, particularly self monitoring plus one other self regulating intervention were associated with the greatest improvements in healthy dietary changes in adults. Other self-regulatory interventions include: intention formation; feedback on performance; goal setting; and review of behavioural goals.

While the evidence generally suggests that behavioural and education-based nutrition strategies are associated with the consumption of healthier diets, there is some evidence to suggest that nutrition interventions may be associated with increased health disparities. For example, children from higher income families experience greater improvements in diet (e.g. healthier eating) compared to children from lower income families following exposure to a healthy eating intervention, and that White children consume fewer grams of fat per day compared to Black children. In addition, ethnic minority individuals were reported more likely to drop out of studies than White participants. While concerning, these findings must be interpreted with caution given the limited evidence available evaluating differences in intervention impact by socioeconomic status. Further evaluation is needed to determine with greater certainty, if nutrition interventions, as currently delivered, result in greater health disparities.

Fruit and vegetable consumption

The evidence illustrates that community based interventions significantly increase fruit and vegetable consumption among preschoolers, school-aged children and adults, when the intervention was implemented in a workplace setting. Interventions evaluated as part of community-based approaches include: written and verbal dietary advice, publicity campaigns, social marketing and promotion of home gardens, weekly nutrition letters, workshops, peer education, school curriculum, family fun nights at local schools, cafeteria food service changes, and health healthy cooking demonstrations. School children, both male and female, increased fruit and vegetable consumption by 0.33 to 0.99 serving/day whereas among secondary school students, a 0.33 serving/day increase in fruit and vegetables was observed among females only. The most effective community-based interventions provided clear messages about increasing fruit and vegetable consumption; incorporated behavioural theories and goals, provided a consistent framework for implementation and evaluation; provided longer, more intensive interventions rather than one or two contacts; actively involved influential people such as family members; and targeted those whose knowledge and/or fruit and vegetable intake was low.

Tailored nutrition education (delivered through email and print) significantly increases fruit and vegetable consumption among young children, school-aged children, and adults when the intervention was implemented in a workplace setting. Tailored nutrition education in comparison to general nutrition education was associated with a 35% increase in fruit and vegetable consumption, with the true value ranging from a 19% to 52% increase (95% confidence interval). However, when tailored nutrition education was compared to no education, the effect increased dramatically to 59%, with the true value for fruit and vegetable consumption ranging from 21% to 98%. While effect sizes were not calculated, tailored nutrition education was associated with increased fruit and vegetable consumption among individuals with low income as well as among different ethnic groups. Community-based interventions were not associated with significant changes in fruit and vegetable consumption amongst adults in the general population however.

Fat intake

While statistically significant effects were observed, tailored nutrition education in comparison to general nutrition education resulted in a small decrease (2.2%) in fat intake, with the true intake ranging from a 1.4% to 3.0% reduction. When tailored nutrition education was compared to no education, fat intake decreased by 2.45%, with the true value ranging from just under 1% to 4%.

The impact of including parents as part of the intervention in reducing fat intake among children and adolescents was mixed, with approximately half of the studies reporting positive effects and the other half reporting no effect. A statistically significant and positive impact on fibre intake was not observed for patients receiving nutrition education while being notified of medical imaging results.

Pregnant women, women of childbearing age and those with type 2 diabetes, who were exposed to interventions that promoted healthy eating and obesity prevention, reported

statistically significant decreased fat intake, compared to those not exposed. There was also some evidence that those exposed to the intervention had significantly higher fibre intake, and improved carbohydrate consumption in comparison to those not exposed.

BODY MASS INDEX

Generally, much of the evidence suggests that behavioural diet and nutrition interventions are not associated with a positive impact on BMI (i.e. either in reducing BMI or in less increase in BMI over time), among children, adolescents and adults. While most reviews tend to include at least one or two studies reporting statistically significant positive effects, generally, the majority of studies included in reviews report diet and nutrition interventions have no effect on BMI. Furthermore, self-help and guided self-help groups were not associated with positive impacts on BMI, although these studies tended to be small and likely underpowered to detect statistically significant effects. Drug interventions in children and adolescents however were found to be associated with statistically significant reductions in BMI at six months, with effect sizes ranging between 1-2kg/m².

Among individuals with pre-diabetes, a weight loss/management intervention was associated with a statistically significant reduction in BMI in comparison to those not exposed to the intervention. BMI was 1.4kg/m² less in those exposed to the intervention compared to usual care with the true effect ranging from 0.5kg/m² to 2.4kg/m² less.

WEIGHT CHANGE

Several reviews evaluated the impact of interventions on weight change. Interventions included: the promotion of low fat and/or low calorie or very low calorie diets among normal weight and overweight and obese adults; strategies to maintain appropriate weight for age, supplementation of diet with Omega 3 to control weight; and incentives (monetary, provision of free food, price reductions on healthy food) to lose weight.

Overall the evidence suggests that interventions targeted at weight loss are effective, particularly among those who are obese or have established high risk factors (pre-diabetes). However, significant effects, while still present in the medium term (i.e. 2-3 years post intervention), are not maintained in the long term (5 years).

Among adults, including obese adults, interventions that promoted low fat and low calorie diets resulted in statistically significant positive effects on weight loss in the short to medium term (12 months post intervention). The magnitude of effect ranged from approximately 0.8kg to 2.8kg, to 5kg to 7kg, to 13 kg (very low calorie diet). Also among those with identified risk factors for chronic diseases, the promotion of a low fat diet was associated with statistically significant weight loss (4kg) in comparison to those with no recognized risk factors for chronic diseases. The evidence illustrates that positive effects, while maintained at 12, 24 and 36 months, are lost 5 years post intervention. No impact on maintaining weight for age for observed, although there is minimal evidence evaluating this outcomes. Likewise Omega 3 supplementation was not associated with a significant effect on weight loss. Incentives were effective in reducing weight, although impact in the long term is not known at this time. It is

also not clear which components of incentives are associated with the greatest impact. For example, while there is some data to suggest that reducing the price of healthy foods is effective in changing food purchasing behaviour, the impact on long term weight loss is less clear. Furthermore, the impact of incentives on subgroup populations such as those with low socioeconomic status, or different ethnicities has not been studied to date.

CONCLUSIONS

This review of the literature represents many systematic reviews and meta-analyses, primary studies and thousands of people. To some extent the results illustrate that many population health and public health programs are associated with benefit to various populations, particularly related to outcomes such as healthy eating. However, there remains cause for concern given some of the evidence suggests that various interventions may in fact widen health disparities as a result of higher SES and white populations benefiting more from certain interventions than those from low SES and non-white populations. Much more research is needed to fully explore if and how interventions impact health outcomes in different sub populations. However, the evidence presented here provides some direction for moving forward with practice, draws attention to some areas that require ongoing evaluation, and identifies some practices that may not be producing the expected impact and therefore should be examined critically in terms of future investment. While a great deal has been accomplished in population and public health programs there is still much work to be done!

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TABLES

TABLE I: QUALITY ASSESSMENT OF INCLUDED DIET & NUTRITION REVIEWS (N=17)

Study Details		Quality Assessment Criteria* ('x' indicates criteria met)										Total /10	Rating
Author	Year	1	2	3	4	5	6	7	8	9	10		
Avenell	2004	x	x	x	x	x			x	x	x	8	Strong
Bond	2009	x	x	x	x	x	x		x	x	x	9	Strong
Ciliska	1999	x	x	x	x	x	x	x	x	x	x	10	Strong
Ciliska	2000	x	x	x	x	x	x		x		x	8	Strong
Eyles	2009	x	x		x	x	x		x	x	x	8	Strong
Hingle	2010	x	x	x		x	x		x	x	x	8	Strong
Hollands	2010	x	x	x	x	x	x	x	x	x	x	10	Strong
Hooper	2004	x	x		x	x	x	x	x	x	x	9	Strong
Knai	2006	x	x	x	x	x	x	x	x		x	9	Strong
Michie	2009	x	x	x	x	x			x	x	x	8	Strong
Norris	2005	x	x	x	x	x	x		x	x	x	9	Strong
Oldroyd	2008	x	x		x	x	x		x	x	x	8	Strong
Oude Luttikhuis	2009	x	x	x	x	x	x	x	x	x	x	10	Strong
Perkins	2006	x	x	x	x	x	x		x	x	x	9	Strong
Sahay	2006	x	x	x	x	x	x	x	x			8	Strong
van Teijlingen	1998	x	x	x	x	x	x		x	x	x	9	Strong
Wall	2006	x	x	x	x	x	x		x		x	8	Strong

*Criteria for quality assessment: (1) clearly focused question; (2) appropriate inclusion criteria to select primary studies; (3) comprehensive search strategy described; (4) search strategy covered adequate number of years; (5) description of level of evidence; (6) assessment of methodological quality; (7) results transparent (two independent reviewers quality assessed); (8) appropriate to combine/compare studies; (9) appropriate methods for combining results; (10) author's interpretations supported by the data.

TABLE 2: CHARACTERISTICS OF DIET & NUTRITION REVIEWS

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
Avenell (2004)	UK	SR	26 RCTs	Obese adults	Low fat diets, low calorie diets, very low calorie diets, protein sparing modified fasting	Mortality; morbidity; quality of life; economic outcomes; weight changes; cardiovascular risk factors: total cholesterol, low density cholesterol (LDL), high density cholesterol (HDL), triglycerides (TGs), systolic and diastolic blood pressure (SBP and DBP), fasting glucose, glycosylated haemoglobin (HbA1c); drop-outs; adverse events
Bond (2009)	UK	SR	22 (16 reviews, 6 RCTs)	The under fives in OECD (Organisation for Economic Co-operation and Development) countries	Weight management schemes (universal prevention, targeted prevention, weight loss, management of weight gain and treatment of those already overweight or obese) and interventions designed to maintain appropriate weight and or achieve weight loss	Main outcome measures: body mass index (BMI) and weight Other outcome measures: health outcomes, quality of life, objective measures of health behaviour such as accelerometry (not self-reported outcomes) and cost-effectiveness
Ciliska (1999)	CA	SR	15 (CTs and cohort studies)	People four years of age and older	Community interventions to increase fruit and vegetable consumption	Increase of fruit and vegetable consumption
Ciliska	CA	SR	15 (CTs	People four years	Community interventions to	Increase of fruit and vegetable

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
(2000)			and cohort studies)	of age and older	increase fruit and vegetable consumption	consumption
Eyles (2009)	NZ	MA	16 (RCTs or quasi-RCTs)	Adults, including priority ethnic and low-income groups	Tailored nutrition education which included at least one print, e-mail, or other non-face-to-face delivery format	1) nutrition-related health behaviours, which included food and nutrient intake and purchases 2) anthropometric outcomes such as change in body weight, BMI, or waist circumference
Hingle (2010)	US	SR	24 RCTs	Children (2-12 yrs) and adolescents (13-18 yrs)	Parents directly or indirectly supporting or assisting children or adolescents to achieve changes in dietary intake	Child dietary intake as a behaviour change target, (i.e. changing diet, obesity prevention, reducing CVD risk factors, reducing diabetes risk factors, combination of diet improvement and increased physical activity, or a combination of improved diet and obesity prevention
Hollands (2010)	UK	SR	9 RCTs	Clinical populations (patients receiving treatment or disease assessment in a medical setting) and non-clinical populations (healthy populations receiving	Presentation and explanation of an individual's medical imaging results	Engagement in health-related behaviours that have the potential to modify the risk identified: <ul style="list-style-type: none"> • Dietary behaviour; • Physical activity; • Smoking; • Alcohol consumption; • Attendance for screening; • Sun protection behaviours;

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
				information outside of a medical setting for preventive or educational purposes) of adult age (18 years and over)		<ul style="list-style-type: none"> • Adherence to medication; • Use of drugs of abuse. <p>Secondary outcomes: Cognitive and emotional mediators and moderators of behaviour change including:</p> <ul style="list-style-type: none"> • Understanding of the relevant condition and of the risk information they have been given; • Perceived severity and risk of disease; accuracy of perceived risk; • Perceived control over the disease risk; • Perceived effectiveness of the risk-reducing behaviour; • Emotional response, including general anxiety and condition-specific worry; • Acceptability of the intervention. <p>Additional physical/health status outcomes, such as:</p> <ul style="list-style-type: none"> • Blood pressure; • BMI; • Framingham Risk Score; • Level of atherosclerosis

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
Hooper (2004)	UK	SR	48 RCTS, 41 cohorts	Adults (16 years or older) with normal or raised blood pressure	Reduce sodium intake	<p><i>Primary outcomes:</i> mortality and combined cardiovascular events (including fatal and non-fatal myocardial infarction, stroke, angina, heart failure, peripheral vascular events, sudden death and non-scheduled cardiovascular interventions – coronary artery bypass surgery or angioplasty)</p> <p><i>Secondary outcomes:</i> Changes in systolic and diastolic blood pressure (mmHg), quality of life, weight (kg), nutrient intakes, urinary sodium excretion (mmol/24 hours) and numbers and doses of anti-hypertensive medication used</p>
Knai (2006)	UK	SR	15 (11 RCTS, 4 non-RCTS)	Children	interventions promoting a diet high in fruit and vegetable consumption (e.g. dietary advice taking any form (for example, verbal or written nutrition education, single or multiple contacts with individuals or groups), publicity campaigns, social	Primary outcomes: change in fruit and/or vegetable intake

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
					marketing approaches, or by increasing production such as home gardening	
Michie (2009)	UK	MA	18 (CTs and ITS)	Adults (over 18)	Increased levels of physical activity or healthy eating using cognitive or behavioural change strategies	Exercise level, energy expenditure, measures of good and/or poor diet, fat intake, vegetable servings per day in addition to the number of fruit and vegetable servings per day
Norris (2005)	US	MA	9 RCTs	Adults with pre-diabetes	Weight-loss and weight-control using at least one dietary, physical activity, or behavioural intervention, and with a follow-up interval of 12 months	weight, percent weight change (based on individual data), BMI, glycated hemoglobin (GHb), blood pressure, lipid levels, and cumulative incidence of diabetes
Oldroyd (2008)	AU	SR	6 (4 RCTs, 2 CCTs)	low socioeconomic groups (ethnic minorities and those of low income or educational level)	healthy eating delivered at a group level	frequency and portions of food consumed, fruit and vegetable consumption, fat intake, fat-related dietary habits as well as dietary knowledge, behaviours and preferences for healthy foods
Oude Luttikhuis (2009)	NL	SR	46 RCTs	Children and adolescents less than 18 years of age	Lifestyle (dietary, physical activity and/or behavioural therapy interventions), drug (orlistat, metformin, sibutramine, rimonabant) and surgical interventions	Primary outcomes: height and weight (not self reported), body mass index and percentage overweight, and measures of body fatness Secondary outcomes: Measures of body fat

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
						distribution, metabolic changes (or markers of future cardiovascular and endocrinological disease), behaviour change, participants views of the intervention, measures of self-esteem, health status and well being, quality of life, harm associated with the process or outcomes, and cost effectiveness/costs of the intervention
Perkins (2006)	UK	MA	16 (13 RCTS, 3 CCTs)	<p>People with:</p> <ol style="list-style-type: none"> 1) Diagnosis of anorexia nervosa or bulimia nervosa, or 2) Binge eating disorder or an "Eating Disorder Not Otherwise Specified" <p>Other criteria:</p> <ol style="list-style-type: none"> 1) Either gender 2) Children, adolescents and adults 3) Recruited from 	Self-help interventions ("pure" self-help (PSH) or guided self help (GSH))	<p><i>Primary outcomes</i></p> <ol style="list-style-type: none"> (a) Abstinence from bingeing. (b) Abstinence from purging. (c) Weight (body mass index, BMI). <p><i>Secondary outcomes</i></p> <ol style="list-style-type: none"> (a) Eating disorder symptomatology from an eating disorders symptom rating scale, or other purpose developed instrument. (b) Weight restoration (BMI) to within normal range. (c) Proportion of non-completers or "dropouts" due to any reason, and those due

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
				<p>the community or primary, secondary or tertiary clinical units</p> <p>4) Treated in community, primary, secondary or tertiary services</p>		<p>to adverse events.</p> <p>(d) Patient satisfaction (where assessed).</p> <p>(e) Adherence to self-help (e.g. percentage of material read; percentage of homework tasks completed).</p> <p>(f) Side effects or negative effects of therapy (where provided).</p> <p>(g) Additional help seeking (e.g. treatment for eating disorder symptoms or weight loss).</p> <p>(h) General psychiatric and mental state symptomatology (mean scores on any general psychiatric symptom rating scale).</p> <p>(i) Improvement in interpersonal functioning (mean scores on scales measuring social and interpersonal functioning).</p> <p>(j) Mean scores on any scale measuring depressive symptoms.</p> <p>(k) Health care cost.</p>
Sahay (2006)	CA	SR	15 CTs	General population	All intervention types excluding individual	Results for dietary modification must have been

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
					counseling; intervention must have included a dietary component including fruits and vegetables, fiber, grain, or fat consumption; intervention design must be grounded in established behavior change/health promotion theory	reported in the article; studies reporting results based on various assessment methods were included (food frequency questionnaires, recall, and observation)
van Teijlingen (1998)	UK	SR	9 (7 RCTs, 1 non-RCT, 1 unclear design)	Women of childbearing age and/or pregnant	Interventions to promote healthy eating. Interventions to prevent obesity in non-obese women. Interventions to encourage women to consume the recommended supplementation.	Healthy eating, including, <ul style="list-style-type: none"> - total fat intake of 115g or less per day (34% of total energy) (ie. reduction) - an average intake of saturated fatty acids of 50g or less per day (15% of total energy) (ie. reduction) - an average intake of polyunsaturated fatty acids of 18 g or more per day (5% of total energy) (ie. increase) - an intake of less than 30 g of sucrose per day (12% of total energy) (ie. reduction in sugar intake) - maintenance of energy intake through low-fat foods, particularly bread, potatoes, fruit and

Review	Country	Review Type	# of Studies Included	Participants	Intervention	Outcomes
						vegetables) (ie. increase) - an intake of 1 g or less of salt per day (ie. reduction)
Wall (2006)	NZ	SR	5 RCTs	Community based population	Incentives	Food purchases/consumption, weight loss, and anthropometric or dietary measures (e.g., food frequency data)

CA – Canada

US – United States of America

UK – United Kingdom

NZ – New Zealand

AU – Australia

NL – Netherlands

SR – systematic review

MA – meta-analysis

RCT – randomized controlled trials

CBA – controlled before-and-after studies

CCT – concurrent controlled trials

ITS - interrupted time series

CT – controlled trials

* - not specified

TABLE 3: DATA EXTRACTION OF OUTCOMES FOR DIET AND NUTRITION

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
IMPROVED DIET						
Ciliska (1999) *** Same study findings as Ciliska (2000)	x				Four out of four studies found significant improvements in fruit and vegetable intake among the intervention group compared to controls.	Interventions with parents of young children Narrative summary.
	x				Four out of six studies found significant improvements in fruit and vegetable consumption among the intervention compared to control group.	Interventions with school children Narrative summary.
				x	One out of three studies found significant differences in fruit and vegetable consumption among the intervention compared to controlled group.	Interventions with adults (non-worksite) Narrative summary.
	x				Two out of three studies found that fruit and vegetable consumption increased significantly in the intervention compared to control group.	Interventions with adults (work-site) Two studies related to one intervention. Narrative summary.
Ciliska (2000) *** Same study findings as Ciliska (1999)						

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
Eyles (2009)	x				Meta analysis of four trials found that tailored nutrition education intervention groups increased their fruit and vegetable servings 35% per day more than generic nutrition education groups (95% CI 0.19 to 0.52, $P < 0.0001$).	Tailored versus general nutrition education
	x				Tailored nutrition education intervention groups had 2.2% less self-reported intake of energy from fat compared to general education groups (95%CI -3.0 to -1.4, $p < 0.00001$).	
	x				Meta analysis of six trials found that tailored nutrition education intervention groups increased their fruit and vegetable servings 59% more per day than controls (95% CI, 0.21 to 0.98, $p < 0.002$).	Tailored nutrition education versus no nutrition education (control)
	x				Tailored nutrition education intervention groups had 2.45% less self-reported intake of energy from fat compared to controls (95% CI -4.08 to -0.82, $p < 0.0005$).	
	x				One study that focused on individuals with low income reported significantly higher self-reported servings of fruit alone	Narrative summary of priority ethnic groups

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
	x				<p>and fruit and vegetables in the tailored group, compared with the control group at 12 months.</p> <p>Four studies of low-priority ethnic groups found improvements in servings of fruits and vegetables. One study found a significantly ($P < 0.03$) higher fruit and vegetable intake. Two studies found at 18 months a significantly higher ($P < 0.05$) fruit and vegetable intake; at 24 months, a mean difference of 0.85 (SE 0.12) servings per day; a significantly higher servings of fruit per day ($P = 0.001$ at 24 months; $P = 0.02$ at 18 months) and vegetables per day ($P = 0.00003$ at 24 months; $P = 0.03$ at 18 months). None of the studies assessed the efficacy to decrease the percentage of energy from total fat.</p>	Tailored nutrition education groups compared with controls
Hingle (2010)				x	<p>One out of four studies found significant changes in reduced intake of total fat and increased intake of complex carbohydrates among children in the intervention group compared to the control group.</p>	<p>Focus of this review was whether parent involvement enhanced program effectiveness and what type of parent involvement was the most effective.</p> <p>Narrative summary.</p>

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
			x		Two out of four studies reported changes in dietary outcomes that differed by gender. One of these studies found reduced fat intake and percent of energy from fat, as well as lower BMI 2 years post intervention in girls (but not boys), while the other study found girls in the intervention group reported significantly greater decreases in total fat intake compared to boys in the parent group and control girls. In this same study, boys showed significantly reduced sugar intake than girls.	
			x		Seven out of 19 studies using indirect methods to engage parents reported statistically significant changes in the desired directions; seven reported mixed intervention outcomes and five reported no significant intervention effects.	Studies using indirect methods to engage parents in intervention activities. Narrative summary.
			x		Two out of five studies reported positive outcomes and the remaining three mixed effects.	Studies using direct methods to involve parents in the intervention. Narrative summary.
Hollands (2010)				x	One out of one study found no statistically significant difference	Feedback to individuals about images of their own bodies

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					between intervention and control in fibre consumption at 12 months (OR 0.36, 95% CI 0.08 to 1.53) and no statistically significant difference in fat intake at 12 months with an OR of 1.84 (95% CI 0.51 to 6.71).	created during medical imaging procedures on changes in health behaviours. Narrative summary.
Knai (2004)	x				Nine out of eleven studies of primary school children had a significant positive effect on fruit and vegetable consumption. Of the nine effective studies, seven found that the intervention group had higher intake of fruit and vegetables than the control group at follow-up, the difference ranging from +0.3 to +0.99 servings/day p<0.01). Two studies showed a significant positive net effect of +0.3 and +0.7 servings/day.	Results were also examined according to study design, intake measurement method, and major intervention components. Narrative summary.
				x	One of four interventions in secondary school children showed positive results with a higher increase in fruit and vegetable intake in the intervention vs. control group, but only in girls (net effect of +0.32 servings/day)	Narrative summary.
Michie (2009)	x				Meta-analysis of 53 behaviour change interventions designed to	

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					improve healthy eating found an overall effect size of 0.31 (95% CI 0.23 to 0.39) among the intervention compared to control groups.	
Oldroyd (2008)	x			x	<p>Among four studies set in educational settings:</p> <p>One found greater increases in fruit and vegetable consumption in children from high income families after 1 year (mean difference 2.4 portions per day, $p < 0.0001$) than in children in low-income families (mean difference 1.3 portions per day, $p < 0.0003$).</p> <p>One did not report effect sizes but reported the nutrition intervention to be less effective in disadvantaged areas ($p < 0.01$).</p> <p>One found that 24-hour fruit juice and vegetable consumption increased more in children born outside the Netherlands (“non-native”) after a nutrition intervention (beta coefficient = 1.30, $p < 0.01$) than in “native” children (beta coefficient = 0.24,</p>	<p>Narrative summary.</p> <p>The authors concluded that nutrition interventions have differential effects by socioeconomic status, but that this review found only limited evidence that nutrition interventions widen dietary inequalities.</p> <p>Due to small numbers of included studies, the possibility that nutrition interventions widen inequalities cannot be excluded. This needs to be considered when formulating public health policy.</p>

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					<p>$p < 0.05$).</p> <p>One found that the group with better educated participants achieved 34% of dietary goals compared with the group who had more non-US born and non-English speakers, which achieved 60% of dietary goal.</p>	
					<p>Among two studies conducted in primary care settings:</p> <p>One found that the difference in consumption of added fat between the intervention and the control group was 28.9 g/day for blacks and -12.0 g/day for whites ($p < 0.05$).</p> <p>One found greater attrition among the ethnic minority participants than among the white participants ($p < 0.04$).</p>	Narrative summary.
Sahay (2006)	x				<p>Among 15 interventions designed to bring about dietary change 10 showed a positive impact, whereas 5 showed no impact or negative effects.</p>	<p>Narrative summary.</p> <p>Main focus of the review was to identify components common to those interventions that reported a significant positive effect on dietary change in a controlled trial.</p>

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
van Teijlingen (1998)	x				Women of childbearing age: Three studies found a statistically significant difference in change in fat intake in favour of the intervention compared to controls.	Narrative summary.
	x				One study reported a statistically significant difference between the intervention and control groups in terms of carbohydrate intake in favour of the intervention group. One study reported improvements in fibre intake in the intervention compared to control groups (p not provided)	
	x				Three studies reported improvements in energy intake among intervention versus controls; however, the findings were not statistically significant.	
			x		Pregnant women: Two studies found improvements in change in fat intake in favour of the intervention group compared to the control groups, however,	Narrative summary.

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
	x		x		<p>only one of these was significant.</p> <p>Two studies reported improvement between the intervention and control group in terms of carbohydrate intake in favour of the intervention group however, only one of these was significant.</p> <p>One study reported small but not significant improvements in fibre intake in the intervention compared to controlled groups.</p> <p>Three studies reported improvements in energy intake among intervention versus controls however, one of these studies were significant.</p> <p>Four studies reviewed found a positive effect of incentives on healthy eating compared with the control condition.</p>	
BODY MASS INDEX (BMI)						
Bond (2009)			x		<p>One out of three RCTS found a significant difference between intervention and control groups.</p> <p>At 24 months the mean (SD) BMI</p>	<p>Narrative summary.</p> <p>Results are not directly comparable as the children were at different ages when measures</p>

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					was 17.1 (2.5) kg/m ² for the intervention group and 17.9 (3.3) kg/m ² for the control group.	were taken. The positive result was found only in African American study sites, where the children in the intervention group showed significantly smaller increases in BMI from baseline than those in the control group.
Hollands (2010)				x	One study found no statistically significant results regarding BMI at 12 months (MD 0.06, 95% CI - 0.25 to 0.37).	Secondary outcome Feedback to individuals about images of their own bodies created during medical imaging procedures on changes in health behaviours as measured by BMI.
Norris (2005)	x				Among four studies designed to assess the effectiveness of weight-loss and weight-control interventions for adults with pre-diabetes, BMI decreased 1.4 kg/m ² (CI 0.5 to 2.3) compared to usual care at 1-year follow-up.	
Oude Luttikhuis (2009)	x				Among four studies change in BMI-SDS at six months follow up was -0.06 (CI -0.12 to -0.01]	Behavioural interventions in children younger than 12 years
	x				Among three studies change in BMI-SDS at twelve months follow up was -0.04 (CI- 0.12 to 0.04]	
	x				Among three studies change in	Lifestyle interventions in children

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
	x				BMI-SDS at six months follow up was -0.14 (CI -0.17 to -0.12).	12 years and older
	x				Among three studies change in BMI at six months follow up was -3.04 (CI -3.14, -2.94).	
	x				Among two studies change in BMI-SDS at twelve months follow up was -0.14 (CI -0.18 to -0.10).	
	x				Among two studies change in BMI at twelve months follow up was -3.27 (CI -3.38 to -3.17).	
	x				Among two studies change in absolute BMI at six months follow up was -0.76 (CI -1.07 to -0.44).	Drug interventions with Orlistat in children 12 years and older
	x				Among two studies change in absolute BMI at six months follow up was -1.66 (CI -1.89 to -1.43).	Drug interventions with Sibutramine in children 12 years and older
Perkins (2006)				x	No significant differences (-0.70 [CI -3.35, 1.96]) between self-help and guided self-help groups in BMI at end of treatment (2 studies).	All studies included in this set of comparisons are small and almost certainly underpowered.
				x	No significant differences between intervention groups (self-help and guided self-help)	

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					and control (waiting list -0.75 [CI -2.05, 0.55], other formal psychotherapy 0.99 [CI 0.01, 1.97], placebo -2.70 [CI -6.71, 1.31]) in BMI at end of treatment.	
				x	No significant differences (-1.40 [CI -4.76, 1.96]) between type 1 self-help and guided self-help (cognitive-behavioural), and type 2 self-help and guided self-help ((self-assertion, behavioural weight control) in BMI at end of treatment (1 study).	
WEIGHT CHANGE						
Avenell (2004)	x				-5.31 kg (95% CI, -5.86 kg to -4.77 kg)	Weighted mean difference weight change in favour of low fat diet (LFD) at 12 months. Statistical heterogeneity, although the direction of effect was consistent across all studies (P < 0.00001).
	x				-4.80 kg (95% CI, -6.02 to -3.57 kg) compared with -5.44 kg (95% CI, -6.04 to -4.84 kg)	Imputed values were compared with studies with no assumed values.: Low fat diet: 12 months
				x	-1.15 kg (95% CI, -2.76 to 0.45kg)	18 months
	x				-2.35 kg (-3.56 to -1.15 kg)	24 months

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
	x			x	0.70 kg (95% CI, -1.78 to 3.18 kg)	30 months
	x				-3.55 kg (95% CI, -4.54 to -2.55 kg)	36 months
				x	-0.20 kg (95% CI, -2.03 to 1.63 kg)	60 months
	x				-4.20 kg, 95% CI, -4.90 to -3.50 kg; compared with -6.98 kg, 95% CI, -7.83 to -6.12 kg	Low fat diet: 12 month weight loss between CVD risk factors and no risk factors
				x	-0.88 kg (SD: 4.0 kg) for the diet group and 1.3 kg (SD: 3.00 kg) for the control group	Low fat diet: Cluster RCT, weight change at 12 months
	x				-6.25 kg (95% CI, -9.05 to -3.45 kg)	Low calorie diet (LCD): 12 months
	x				-7.00 kg (95% CI, -10.99 to -3.01 kg)	24 months
	x				-6.10 kg (95% CI, -10.71 to -1.49 kg)	36 months
	x				-13.40 kg (95% CI, -18.43 to -8.37 kg)	Very low calorie diet (VLCD): 12 months
		x			1.63 kg (95% CI,)1.26 to 4.52 kg)	Comparing LCD with LFD
	x				-4.70 kg (95% CI, -11.79 to 2.39)	Comparing VLCD with LFD: 24 months

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
				x	-0.15 kg (95% CI, -2.73 to 2.43 kg)	VLCD and LCD: 12 months
				x	-1.13 kg (95% CI, -5.32 to 3.06 kg).	18 months
	x				-3.57 kg (95% CI, -7.36 to 0.22 kg)	PSMF compared with LCD: 12 months
				x	0.69 kg (95% CI, -1.58 to 2.96 kg)	18 months
	x				-2.17 kg (95% CI, -4.88 to 0.54 kg)	24 months
				x	-1.51 kg (95% CI, -5.43 to 2.41 kg)	36 months
				x	0.20 kg (95% CI, -5.68 to 6.08 kg)	60 months
Bond (2009)	x				Two studies found improvements in weight at follow-up. One study showed a smaller increase in weight in the intervention than control groups at 12 and 24 months, but did not report whether these results were significant or not. The other study found a non-significant increase in weight in	Interventions that aim to maintain appropriate weight for age and/or achieve weight loss.

Review (Author (Year))	Positive Effect	Negative Effect	Mixed Effect	No Effect	Main Results (e.g. effect size)	Comments
					the control group compared to the intervention group after 16 weeks.	
Hooper (2004)				x	Meta-analysis of seven RCTs found no significant effect of omega 3 supplementation on weight (weighted mean difference -0.59 kg, 95% CI interval -1.91 to 0.73)	Secondary outcome
Norris (2005)	x				Among four studies weight was reduced by 2.8 kg (95% CI 1.0 to 4.7) compared to usual care at 1-year follow-up.	Interventions designed to assess the effectiveness of weight-loss and weight-control interventions for adults with pre-diabetes
	x				Among two studies weight was reduced by 2.7 kg (95% CI 1.9 to 3.4) compared to usual care at 2-years follow-up.	
Wall (2006)	x				Four studies reviewed found positive effects of incentives on weight loss compared with controls.	