Interventions to Prevent Obesity

A Systematic Review

December 2005

An update of the chapter on preventing obesity in the SBU Report
"Treating and Preventing Obesity – An Evidence Based Review".
(Originally published in Swedish, 2002. English edition published in 2004.)

The Swedish Council on Technology Assessment in Health Care

SBU • Statens beredning för medicinsk utvärdering

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Interventions to Prevent Obesity

A Systematic Review

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SBU Summary and Conclusions

Introduction

Overweight and obesity are growing problems in much of the world. In Sweden, the number of overweight individuals has nearly doubled during the past 20 years. Obesity negatively affects people's health and their quality of life. Finding strategies to overcome this problem is important for the wellbeing of both the individual and society at large. Obesity, once established, is difficult to treat, and therefore effective preventive interventions are essential. SBU has updated the report "Treating and Preventing Obesity" (2002) to include works published from 2001 through 2004 that address the prevention of obesity in children/adolescents and adults.

The questions investigated include:

- How many studies of acceptable quality have been added to the literature?
- What do the new findings show?
- What are the combined results from previous and new studies?
- How do the results of the SBU review compare with those from other recent, systematic literature reviews?
- Are there important, preliminary research results that can be useful in formulating strategies for society, even if these results may not be fully verified by scientific standards?

Methods

This report reviews the scientific evidence for medical interventions aimed at preventing obesity. Members of the Project Group searched different databases for literature published since 2001. The studies accepted for review do not all offer the same level of scientific quality. The Project Group, therefore, rated study quality as high, medium, or low after appraising study design, the number of subjects included, followup time, dropout, and other factors. The Project Group, after analyzing the quality ratings of the individual studies, graded the strength of the evidence (Evidence Grade) for drawing conclusions.

SBU uses a 3-grade scale to indicate the strength of the scientific evidence:

- *Evidence Grade 1* – Strong scientific evidence
- *Evidence Grade 2* – Moderate scientific evidence
- *Evidence Grade 3* – Limited scientific evidence.

Results

Literature Search

The primary literature search for this update yielded 300 studies, which were then reviewed in various phases. Searching other systematic literature reviews and reference lists in relevant studies yielded an additional 100 studies. After the review process had been completed, 11 original studies on children and adolescents (10 studies on the effects of prevention and 1 study on economics) and 20 studies on adults remained. Several review articles on children were also found. After these articles had been systematically checked and the results compiled they were compared with, and added to, the SBU findings.

Children and Adolescents

The findings related to children and adolescents focus on: 1) identifying studies published in recent years, ie, the material in this SBU update; 2) combining the new findings with those from the earlier SBU report (2002); and 3) considering the results of systematic literature reviews from other countries (having variations in the quality criteria as regards inclusion of studies).

Update by SBU

The literature review yielded 10 studies on children and adolescents that met the inclusion criteria. Furthermore, 1 study on economic aspects was reviewed. One study followed children from infancy. Other children were between 5 and 12 years of age at the outset. Most of the studies included programs to promote physical activity and good dietary habits. The interventions were often school-based, and several studies included components aimed directly at the children's parents. The effects were followed up after 1 to 8 years. Most studies measured the effects of intervention in terms of changes in the percentage of overweight and obese children. Other measures of change included mean BMI or skin fold thickness. All of the studies compared the results of intervention with results in a control group.

Of the 10 studies accepted, 6 were rated as having high or medium quality, and 4 were rated as having low quality. The positive effects of intervention were statistically significant in 3 of the studies while 7 studies reported no differences compared with the control groups. None of the studies reported weight trends that were worse in the intervention than in the control groups.

One of the studies previously included by SBU was subjected to a retrospective economic analysis. The results showed a cost for prevention of approximately 14 US dollars (USD) per student and year. Using model analyses of reduced obesity in adult age groups, and the subsequent cost savings, the interventions were found to be cost effective and resulted in a net savings for society. These findings have not been scientifically veri-

fied. Since uncertainty in the study was high, reliable conclusions cannot be drawn.

Combined Results of the Current and Previous SBU Report

Together with the 14 studies in the previous report (Table 1) the SBU review now includes 24 studies, involving 25 896 children. One third of the studies showed significantly positive results, while the remainder were neutral. None of the studies reported weight trends that were less favorable in the intervention than in the control groups.

Table 1 *Results from the original studies included in the SBU literature reviews from 2002 and 2004 and in literature reviews from other countries. The results of weight trends in the intervention (I) and control groups (C) are compared, and the findings are presented as "better", "no difference", or "worse". Only statistically significant findings were considered.*

Original studies included	Better in I				No difference between I and C		Worse in I	Total	
	Studies		Participants						
	No.	% of total	No.	% of total	No. studies	No. participants	No. studies	All studies	All participants
SBU 2002 + 2004	8	33	8 365	32	16	17 531	0	24	25 896
Studies from other systematic literature reviews	7	47	5 239	66	8	2 717	0	15	7 956
Total	**15**	**41**	**13 604**	**40**	**24**	**20 248**	**0**	**39**	**33 852**

Considering Results from Other Systematic Literature Reviews

Literature reviews from other countries present 15 studies that have not been included in the SBU reports, usually because the children were followed for less than 1 year, ie, a criterion for inclusion in the SBU report.

In total, the reviews include 39 different, controlled studies involving 33 852 children and adolescents (Table 1). In 41% of the studies, involving 40% of the participants, the interventions to prevent obesity showed a confirmed positive effect on weight trends when compared to the control groups. In the remaining studies no effects were confirmed. None of the studies reported results that were worse in the groups receiving special interventions.

Statistically, given the large number of studies included in the SBU review, it is improbable that random chance could skew the results in such a positive direction. The findings by SBU are further strengthened if one also considers the systematic literature reviews from other countries.

Hence, the evidence shows that it is possible to prevent obesity in children and adolescents through limited school-based programs that inform children and promote better habits concerning the intake of food and beverages, often in combination with increased physical activity.

This is a difficult problem area, as indicated by the fact that half or two thirds of the studies do not show a positive effect. Often, the interventions have been limited to school hours and were carried out for short periods. It has not been possible to influence television and newspaper advertising, the accessibility to soft drinks and "junk food", the prices of healthy products, or opportunities for physical activity during free time. Sources of error in the studies also limit the opportunity to demonstrate possible effects. Unfortunately, based on descriptions given in the studies, one cannot reliably determine whether any particular interventions offer a strong potential for good results.

Contributing factors might include:

- start a healthy lifestyle already at a young age
- begin daily physical activity routines
- counteract long-term inactivity, eg, sitting in front of the TV and computer
- promote the intake of fruit and vegetables
- emphasize the benefits of drinking water rather than soft drinks to quench thirst.

Three studies, 2 involving children 8 to 11 years of age and 1 involving teenage girls, investigated whether preventive interventions of this type had negative effects such as increasing the rate of anorexia or inhibiting growth. No consequences of this type were observed.

Adults

The findings related to adults focus on: 1) identifying studies published in recent years, ie, the material in this SBU update; 2) combining the new findings with those from the earlier SBU report (2002).

Update by SBU

Twenty studies met the inclusion criteria. Twelve studies address the prevention of cardiovascular disease, where the prevention of obesity is a subgoal, in a normal population. Five of the 12 studies were population based and 7 addressed special groups (eg, females aged 40 to 50 years) where weight gain is common, or employees in a corporation or the public sector. In addition, 8 studies involved individuals with an elevated risk for developing obesity/cardiovascular disease. Quality was rated as high or medium in 18 of the studies and low in 2 studies.

All types of studies include recommendations aimed at improving lifestyle – mainly intended to improve dietary habits, but also to increase physical activity, quit smoking, reduce alcohol consumption, and avoid stress.

Of the 5 population-based studies, 2 reported favorable effects on weight trends in both men and women. One study reported a greater increase in mean BMI in the intervention region, ie, a negative result. Nevertheless, 1 of the 2 studies with generally neutral outcomes showed a positive initial result for women (Table 2).

Of the 7 studies that addressed special groups, ie, corporate employees, 4 showed that the increase in mean BMI could be prevented. One of these studies reported that the percentage of overweight/obesity also declined. No preventive effects were noted in the other 3 studies. These were short-term studies, and 1 was limited to increased physical activity (Table 2).

Subjects with elevated risk factors (mainly BMI, blood pressure, and cholesterol) were recruited in 8 studies. Also, smokers and high consumers of alcohol were often included. Positive effects of interventions on weight trends were reported in 5 studies while 2 were neutral (no difference between the intervention and the control groups). One study revealed a less favorable outcome in the intervention group.

Table 2 *Results from different types of studies on preventing obesity in adults. Studies from the SBU report in 2002 are included. The results of weight trends in the intervention (I) and control groups (C) are compared, and the findings are presented as "better", "no difference", or "worse". Only statistically significant findings were considered.*

Original studies included, type of study	Better in I				No difference between I and C		Worse in I		Total	
	Studies		Participants							
	No.	% of total	No.	% of total	No. studies	No. participants	No. studies	No. participants	All studies	All participants
Normal population										
SBU 2002 Population	3	31	11 566	24	7	33 615	1	2 206	11	47 387
SBU 2004 Population	2	40	3 613	49	2	2 488	1	1 324	5	7 425
Spec. group	4	57	2 258	44	3	2 908	0		7	5 166
High risk	5	57	2 438	46	2	1 345	1	134	8	3 917
Total	**14**	**45**	**19 875**	**31**	**14**	**40 356**	**3**	**3 664**	**31**	**63 895**

Combined Results of the Current and Previous SBU Report

The previous report presented findings from 11 randomized or controlled trials, all of which are population based and aimed at preventing cardiovascular disease (Table 2). One study reported a lower percentage of overweight individuals in the intervention region. Furthermore, 2 of the large North American studies showed that the weight increase usually observed in the population was somewhat lower in cities where prevention programs had been implemented. The lack of demonstrated effects in the remaining 8 studies can be associated, in part, with so-called "contamination" in the control areas. In the current review by SBU, 2 of the 5 studies were positive.

The SBU review now includes 31 studies on the prevention of obesity in adults, whereof 14 show positive, 14 show neutral, and 3 show negative results (Table 2). Statistically, it is improbable that random chance could skew the results to such an extent. Hence, the evidence shows that interventions against obesity have a positive effect under certain conditions. The ineffectiveness of interventions in half of the studies would suggest that it is difficult to achieve lifestyle changes without a substantial investment.

Conclusions

Since the release of the previous SBU report, the incidence of obesity has continued to increase at an unabated rate, representing a threat to the health and quality of life of the population. Obesity, once established, is difficult to treat. Hence, effective preventive interventions are essential. The following sections from the previous SBU report have been updated.

Children and Adolescents

The effects of intervention programs to prevent obesity in children and adolescents are relatively well studied. Ten works have appeared since publication of the previous SBU report, bringing the total to 24 studies involving nearly 26 000 individuals. Adding the studies found in other systematic literature reviews, but not included in the SBU review, brings the total to 39 studies and 34 000 individuals. From Sweden, only preliminary data are available from an ongoing trial.

- ❑ The consequences of relatively limited interventions lasting one or more years have been studied. Interventions have been based on programs in schools, day care centers, and other settings to increase physical activity and develop good dietary habits. Usually, a full package of interventions has been used. Based on the study descriptions alone, it is not possible to identify the interventions that have the greatest potential for favorable effects.

- Based on the studies in the SBU literature review, the evidence shows that school-based interventions can reduce weight gain and the development of obesity in children and adolescents (Evidence Grade 1). Studies from literature reviews performed in other countries further support this conclusion.

- The fact that two thirds of the studies fail to demonstrate a positive effect may reflect the difficulty of achieving lifestyle changes in children and adolescents with school-based interventions alone that do not include the home environment, free time, and the community at large.

- The extent to which programs that are more long-term and comprehensive (eg, many types of interventions in the community) could be more effective has not been investigated. Extensive changes in society do not facilitate the use of control groups. Effects must be monitored through a reliable registry of weight trends in the population, not least trends among children and adolescents.

Adults

Since publication of the previous SBU report, new studies have appeared on the prevention of obesity as one of several risk factors for cardiovascular disease in a normal population. Also there are new studies analyzing effects in individuals with an elevated risk for cardiovascular disease. Totally, the SBU reports now include 31 studies that involve nearly 64 000 participants.

Interventions to improve lifestyle have included counseling on diets that are low in energy and fat and high in fiber. As a rule, recommendations to increase physical activity have been included, and several studies recommend smoking cessation and lower consumption of alcohol.

- The previous report presented 11 comprehensive, population-based studies, mainly dominated by North American studies. Recently, another 5 studies have been added. Of these, 2 are Norwegian and 1 is a Swedish study implemented in smaller regions, but with a longer time frame (5 to 6 years). Favorable weight trends were achieved in half of these studies, which was a better result than earlier reported. The findings give reason for greater optimism concerning the potential to prevent obesity in the adult population. Involving adults is also important considering their influence on the next generation.

- Special groups that are now being studied in normal populations include, eg, employees in companies or individuals in age groups at risk. Most of the studies show that weight gain can be prevented in these groups (Evidence Grade 3).

- Interventions have had a positive effect on mean BMI in most of the studies aimed at individuals with an elevated risk for cardiovascular disease.

- Based on all of the studies involving adults, obesity can be prevented by interventions that improve diet and physical activity (Evidence Grade 2).

- The lack of effects in nearly half of the studies may be explained by the difficulty in achieving lifestyle changes, that the interventions have been too limited or they were limited to recommendations focusing only on increased physical activity.

1. Introduction

Overweight and obesity are growing problems in much of the world. In Sweden, the number of overweight individuals has nearly doubled during the past 20 years. Obesity has a negative impact on health and quality of life. From the perspective of both the individual and society it is therefore essential to identify strategies for managing this problem. Once present, obesity is difficult to treat, making effective preventive intervention all the more important.

In 2000, SBU published a report in Swedish (later published in English) entitled "Preventing and Treating Obesity" that reviewed the scientific evidence on interventions to prevent and treat obesity [1].

The Swedish Government has charged the National Food Administration (NFA) and the National Institute of Public Health (NIPH), in consultation with SBU and other organizations, with developing an action plan to promote good dietary habits and to increase physical activity in the population. The target date for completing the action plan was December 31, 2004.

To assure that the action plan would be based on the most recent evidence concerning the value of preventive interventions against obesity, SBU decided to update the sections on children/adolescents and adults from the earlier report. The new information would include publications released between 2001 and 2004 that addressed the prevention of obesity.

Key questions included:

- How many studies of acceptable quality have appeared since the previous SBU report was published?

- What do the most recent results show?

- What are the findings after weighing the results from the previous and more recent studies?

Moreover, the following questions were considered in designing the action plan so it would not be limited solely to evidence-based interventions:

- How do the findings from the SBU review compare with results from other systematic literature reviews in recent years?

- Are there important, preliminary research results that can be of interest for strategies in society, even if they are not scientifically verified?

Reference

1. SBU report no 160. Obesity – problems and interventions. The Swedish Council on Technology Assessment in Health Care, SBU, Stockholm; 2002.

2. Methods

Literature Search and Review

A search in PubMed and the Cochrane Library identified literature published from January 2001 to May 2004. Table 2.1 presents the search terms and combinations. Additional studies were found in reference lists of relevant articles, in recently published medical journals, and in other review articles.

To find articles related to health economics, the NHSEED and PubMed databases were searched using the search terms "obesity" and "overweight" in combination with "prevent" (using different endings). In PubMed, the search terms also included "cost" and "cost analysis".

The studies should meet the following inclusion criteria:

- The study should address prevention of overweight or obesity in both children/adolescents and adults (see concept definitions in Figures 1 and 2).

- Followup in the study should be at least 12 months.

- The study must include a control group.

- The study must include relevant outcome measures, primarily the percentage of overweight/obese individuals, BMI, or skinfold thickness (in children). The aim of preventive programs should be to reduce the occurrence of overweight/obesity, either as the primary objective or as one of the risk factors for cardiovascular disease. Since studies involve healthy individuals and growing children, the aim in the intervention group often is not weight loss but achieving a healthier weight trend in the intervention group than in the control group.

However, it not possible to specify a minimum difference that would make the findings relevant. Among military conscripts in Sweden, for example, mean BMI increased 1.4 units during more than 20 years. During the same period, the percentage of overweight individuals increased from 6.9% to 16.3% [1]. Hence, the changes, eg, in mean BMI, for a few years may appear to be relatively insignificant, but nevertheless represent a major increase in the obesity problem among the population.

- To be considered "prevention" the study must address a normal population, ie, participants should not be selected, but should represent a normal group such as a school, workplace, or population in a particular area. The search also included studies of high-risk groups, eg, those genetically predisposed to obesity, ethnic groups with a high prevalence of obesity, or individuals with a combination of cardiovascular disease risk factors. Studies that included participants selected only for the risk factor of overweight/obesity were, however, considered to be treatment studies and were not included.

- As regards prevention in adults, some studies involve total population groups. Here, two different models are used to assess the effects of prevention:

Cohort studies: These studies follow two groups of people for a specific period and compare their weight trends. One of the groups comes from an area where a preventive intervention program has been conducted and the second from a control area. The disadvantage of the method is that the groups are not randomized, and hence might not be fully comparable.

Cross-sectional studies: A study of several people carried out at a particular time. For example, studies may use a randomly selected group of individuals from trial and control areas at the start of the study. A new cross-section is then taken from both areas at the end of the study to determine if the prevention has had any effect on weight trends in the trial area.

The studies were reviewed and classified using the following 3-phase process:

Phase 1

Abstracts were used to classify each study. Two reviewers independently evaluated the abstracts. Their aim was to identity irrelevant studies, ie, studies that did not address the topic of obesity, studies that did not answer the questions posed by the project, studies that did not distinguish the problem of obesity from other issues addressed in the study, case-descriptions, editorials, commentaries, animal experiments, etc. The following languages were accepted: Swedish, Norwegian, Danish, English, German, and French. Studies identified in other languages were also included if they were particularly relevant. When the results from the two independent reviewers were compared, those studies found to be "of possible relevance" by one or both reviewers were moved on to the second phase. The full text of the published article was ordered for the second phase in the review.

Phase 2

Both reviewers evaluated the full text of the articles. Again, the aim was to identify irrelevant studies. Reasons for rejecting studies were recorded in this phase of the review. The previously specified inclusion criteria were used to accept a study for the third phase of the literature review.

Phase 3

Studies found by either of the two reviewers to meet, or possibly meet, the inclusion criteria were moved on to the final review. Only a few of these studies were eliminated in the final review.

Quality Review

The quality and relevance of the studies were rated according to a 3-grade scale (high, medium, low). When the reviewers' assessments did not concur, in some instances the differences were resolved through discussion. The reviewers used the following criteria to assess quality (the criteria within each category appear in rank order from high to low).

Type of Study

- Randomized studies
- Studies with matched controls/ecological controls
- Studies with poorly defined control groups.

Followup Period

- More than 5 years
- 3 to 5 years
- 1 to 2 years.

Dropout Rate

- Below 20%
- 20% to 30%
- 30% to 40%.

Study Size, Total Patients Followed Up

- Over 1 000
- 500 to 1 000
- 25 to 500.

Studies with high values in most of the variables were assessed to be of *high quality* and studies with low values were assessed to be of *low quality. Medium quality* was assigned to those in the mid-range. If the study did not include essential information, the grade could be lowered by one level. In the evaluation process, studies with nonrandomized control groups could receive a high score, eg, when they involved prevention programs in schools. It is not feasible to randomize some students to an intervention of special diet and exercise and others in the same school or class to a control group. Therefore, schools that were similar from a socioeconomic standpoint were selected and then randomized. Few studies discuss the extent to which this is addressed in the statistical analysis. Instead, some controlled clinical trials (CCT) have matched similar schools with each other and used one as the trial and other as the control. In practice, these two methods do not differ greatly.

Recording Facts

Two individuals extracted the facts from all studies of high, medium, and low quality and relevance. The results of the studies were compiled and analyzed. An intervention was assumed to have positive effects when the percentage of obese subjects decreased, or when weight, BMI, or skinfold thickness were lower in comparison to the results in the control group. Only statistically significant differences were considered ($p<0.05$). The absence of such a difference does not mean that the method has no effect, but that no such effect could be demonstrated.

Conclusions

The main conclusions of the report were graded based on the strength of the scientific studies, and ranked as follows:

- *Evidence Grade 1* – Strong scientific evidence. At least two studies of high quality and relevance, or a good systematic review. Nothing of substance contradicts the findings.

- *Evidence Grade 2* – Moderately strong scientific evidence. One study of high and at least two studies of medium quality and relevance. Nothing of substance contradicts the findings.

- *Evidence Grade 3* – Limited scientific evidence. At least two studies of medium quality and relevance. Nothing of substance contradicts the findings.

No conclusions were drawn when the scientific evidence failed to achieve at least Evidence Grade 3.

BMI (Body Mass Index) = body weight in kilograms divided by height in meters squared.

For example:

$$\frac{90 \text{ kg}}{1.70 \text{ m} \times 1.70 \text{ m}} = 31 \text{ kg/m}^2$$

Overweight BMI 25–29.9
Obesity BMI 30–

The lower thresholds for obesity at the following heights are:

160 cm → 77 kg
170 cm → 87 kg
180 cm → 97 kg

Figure 2.1 *Definition of overweight and obesity in adults.*

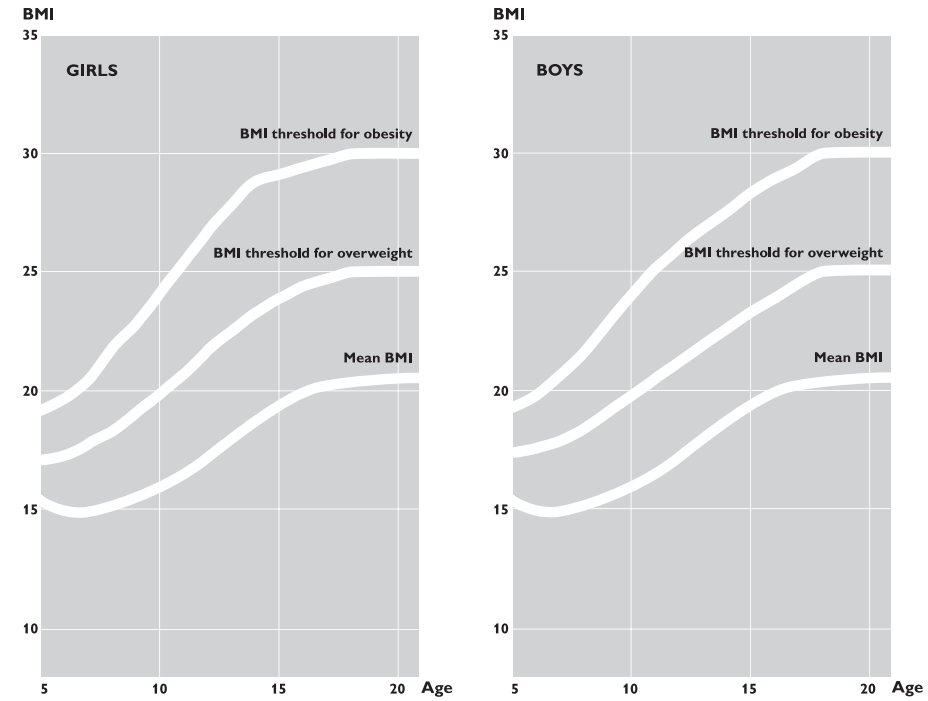

Figure 2.2 *Definition of overweight and obesity in children and adolescents. The curves are age-adapted for girls and boys. Mean BMI is based on data concerning French children, published in 1982 [2]. The thresholds for overweight and obesity for children of different ages are estimated to correspond to BMI 25 and 30 respectively in adults, according to Cole [3]. For example, the threshold values for a 10-year-old girl are BMI 20 for overweight and BMI 24 for obesity.*

Table 2.1 *Main search terms and combined terms used to search the literature on preventing obesity in children/adolescents and adults.*

MEDLINE / PubMed 2001–2004							
Obesity / Prevention & Control	AND	Clinical trial (PT) Epidemiologic Studies Cohort (TW)					
Body Weight (MeSH:NoExp) Obesity (MeSH:NoExp) Body Mass Index Weight Gain Weight Loss Skinfold Thickness BMI (TW) Weight (TW) Body fat (TW) Skinfold thickness (TW) Skinfolds (TW) Obesity (TW) Overweight (TW)	AND	Health Promotion Health Education (MeSH:NoExp) Patient Education Handout (PT) Patient Education Health Behavior (MeSH:NoExp) Health Knowledge, Attitudes, Practice School Health Services Community Health Services (MeSH:NoExp) Child Health Services Community Health Nursing Social Environment Consumer Participation Counseling (MeSH:NoExp) Preventive Health Services (MeSH:NoExp)	AND	Clinical Trial (PT)		
Body Weight (MeSH:NoExp) Obesity (MeSH:NoExp) Body Mass Index Weight Gain Weight Loss Skinfold Thickness BMI (TW) Weight (TW) Body Fat (TW) Skinfold thickness (TW) Skinfolds (TW) Obesity (TW) Overweight (TW)	AND	Physical Education Training Physical Fitness Exertion Sports Exercise Movement Techniques Motion Therapy, Continuous Passive Leisure Activities (MeSH:NoExp) Dancing Play and Playthings (MeSH:NoExp) Television	AND	Clinical Trial (PT)	Selected relevant ref for 2–18 years AND Risk Risk Assessment Risk Factors Risk Management / prevention & control	For 19–64 years the following additional limits were used:

Table continues on next page.

Table 2.1 *Continued*

Body Weight (MeSH:NoExp) Obesity (MeSH:NoExp) Body Mass Index Weight Gain Weight Loss Skinfold Thickness BMI (TW) Weight (TW) Body fat (TW) Skinfold thickness (TW) Skinfolds (TW) Obesity (TW) Overweight (TW)	AND	Nutrition Assessment Nutrition Policy Nutrition Nutrition Therapy Food Habits Food Services Food Preferences Food Labeling Appetite Regulation Food Industry (MeSH:NoExp) Diet Records Eating Food and Beverages Dietary Carbohydrates	AND	Risk Risk Assessment Risk Factors Risk Management / prevention & control reduction (TI) reducing (TI) decreasing (TI) decrease (TI)	AND	Clinical Trial (PT) Limit: 2–64 years
Body Weight (MeSH:NoExp) Obesity (MeSH:NoExp) Body Mass Index Weight Gain Weight Loss Skinfold Thickness BMI (TW) Weight (TW) Body fat (TW) Skinfold thickness (TW) Skinfolds (TW) Obesity (TW) Overweight (TW)	AND	I. Motivation Cognition Behavior Therapy Counselling Behavior Parents / education II. Cardiovascular diseases / prevention & control Yielded 1 relevant reference, which via related articles yielded another apparently relevant ref	AND	Clinical Trial (PT)		
Obesity Overweight (TW)	AND	Prevent*	AND	Costs and Cost Analysis	NOT	Letter (PT) Editorial (PT) News (PT)
NHSEED 2001–2004 (Oct)						
Obesity (Ti, Ab) Overweight (Ti, Ab)	AND	Prevent* (Ti, Ab)				

Unless otherwise specified, MeSH terms (Medical Subject Headings) were used in the PubMed search. Subgroups in the MeSH hierarchy and subheadings (/) have been included (with exception of "MeSH:NoExp").
Ab= Abstract, PT= Publication Type, Ti= Title, TW= Text Word

References

1. Rasmussen F, Johansson M, Hansen HO. Trends in overweight and obesity among 18-year-old males in Sweden between 1971 and 1995. Acta Paediatr 1999;88:431-7.

2. Rolland-Cachera MF, Sempe M, Guilloud-Bataille M, Patois E, Pequignot-Guggenbuhl F, Fautrad V. Adiposity indices in children. Am J Clin Nutr 1982; 36:178-84.

3. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240-3.

3. Results of the Literature Search

The primary literature search, ie, Phase 1, yielded 304 articles on preventive interventions against obesity in both adults and children/adolescents. From these abstracts, 210 were excluded since they did not focus on prevention or were debate articles, editorials, or studies without control groups. In Phase 2, the 94 remaining publications were reviewed in their entirety (Figure 3.1). Moreover, 104 additional works found in other systematic literature reviews and in reference lists of relevant studies were included in the review process. In Phase 3, the reviewers selected 88 works (43 on adults and 45 on children and adolescents).

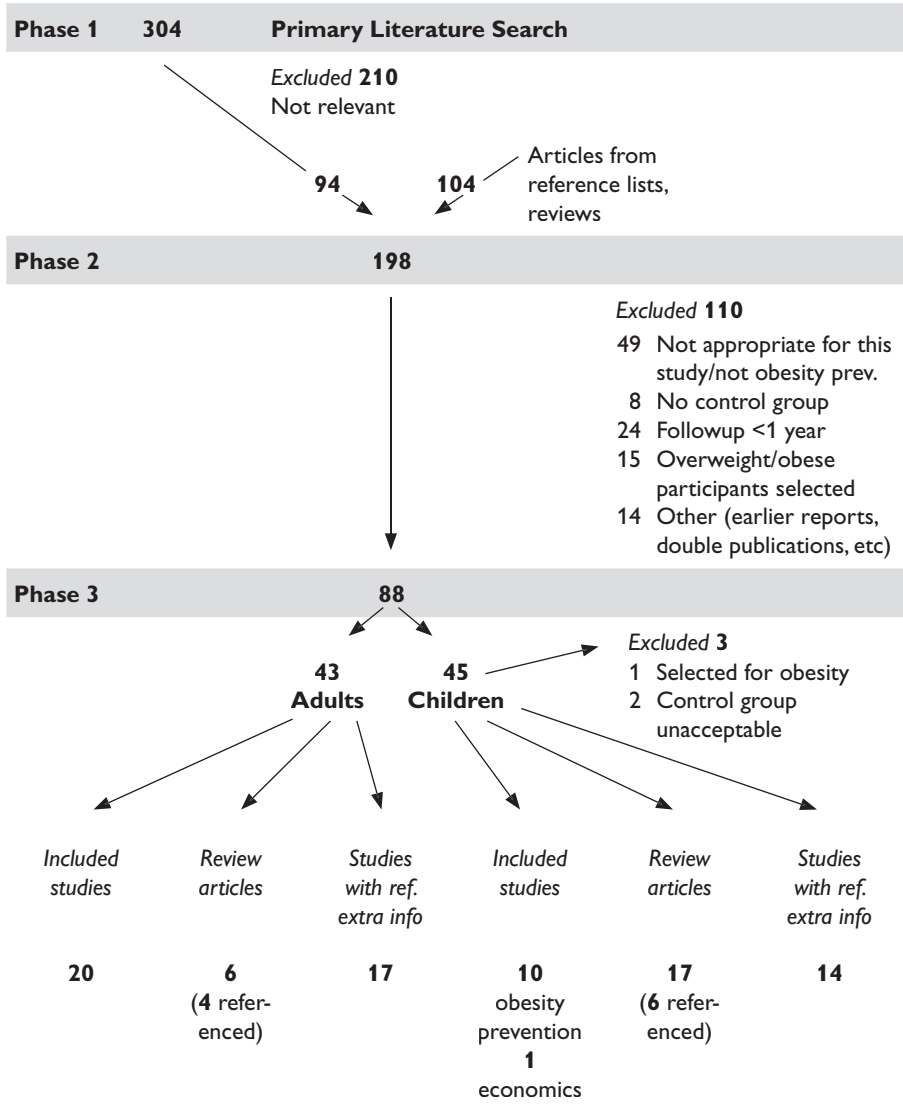

Figure 3.1 *Flowchart of literature search and review in different phases. Reasons for exclusion from Phase 2 and Phase 3.*

4. Preventing Obesity in Children and Adolescents

Recent Studies

In Phase 3, the reviewers selected 45 studies on children (Figure 3.1). Three of the studies were excluded after closer analysis because they did not meet the inclusion criteria [1–3]. Ten studies on the effects of obesity prevention and one study on the cost of intervention were included.

Of the 10 studies, 9 address a normal population and 1 addresses participants with elevated risk for obesity and cardiovascular disease. Three studies used the percentage of overweight and obese participants as the outcome measure. Otherwise, either mean BMI or triceps skinfold were used. One study was of high quality, 5 were of medium quality, and 4 were of low quality.

Four of the studies were published prior to the earlier SBU report, but had not been identified at that time [4–7]. The area is difficult to search comprehensively because in some cases obesity is not specifically mentioned even though it is one of several risk factors that a study attempts to influence. Therefore, we thoroughly checked other review articles and included all studies that met our criteria.

Müller's et al study was published during the final phase of the previous report [8]. Although it was mentioned in the report, it was given a low quality rating and was not included in table. This study, however, has been included in the present report. The results of the previously mentioned study by Luepker et al [9] were followed up for 5 to 6 years [10]. Neither initially, nor after extended followup, were any differences found in weight trends between the intervention and the control groups.

The new studies are presented briefly by year of publication (Table 4.1).

Alexandrov et al published a study in 1988 concerning 11-year-old boys and girls in Moscow [4]. In one district, they worked with children, parents, and teachers in all of the schools. Another district comprised the control group. They targeted all risk factors for cardiovascular disease and obesity. Health education was provided via printed material, through lectures, and in discussion groups. The children were followed up regularly for 3 years. The final results showed an increase in skinfold thickness that was statistically significantly lower in the treatment group than in the control group. The study was added to the group with positive results, despite the fact that the lower BMI registered in the intervention group was not statistically significantly different from that in the control group.

Another study by Alexandrov et al was published in 1992 [5]. This study compared 11- and 12-year-old schoolboys in two different school districts in Moscow. The intervention group received training in nutrition, a change in school meals, increased physical activity, and smoking prevention. The interventions were intensive for the boys with risk factors (smoking, elevated blood lipids, hypertension, and high BMI). The results did not show any difference in mean BMI between the trial and control groups. However, after 3 years, 9% fewer smokers were found in the intervention group.

The two studies by Alexandrov et al are similar to a study by Bal et al [11] in the previous SBU report. In the final phase of the work with this report we were successful in contacting Professor Alexandrov who confirmed that 3 separate studies were involved. The study with Bal as a first author was included in the previous report, and we have now included both studies by Alexandrov.

In 1992, Nader et al presented a study of Anglo-American and Mexican-American families [6]. The aim was to study the effects of family intervention programs on cardiovascular disease risk factors (hypertension, BMI, blood lipids). The study lasted 1 year, and the intervention involved cultural adaptation, nutritional counseling, and instruction

on the importance of diet and increased physical activity. The results showed no difference in BMI between the intervention and control groups.

An American study by Howard et al 1996 randomized school classes to intervention or control groups [7]. Children aged 9 to 12 years were included, The intervention consisted of 5 sessions addressing heart physiology, smoking, elevated blood pressure, diet, and physical activity. After-school exercise programs and educational material with audio-visual aids were also included. Followup continued for 1 year, but no statistically significant difference was found between the intervention and control classes as regards BMI or skinfold thickness. No more than 98 pupils were included, and therefore the results are uncertain.

In 2001, a German study by Müller et al focused on school children aged 5 to 7 years [12]. The parents, teachers, and students were trained in nutrition and encouraged to live a healthy life style. The study lasted 1 year and the authors found a significantly lower increase in skinfold thickness in the intervention group compared to the control group. The study suffered from relatively few participants, high dropout, and vague reporting.

In 2003, an American study by Caballero et al was published that focused on Native American Indian children who were at substantially higher risk for obesity [13]. The study addressed dietary change, increased physical activity, and health education. It lasted for 3 months and included 1 704 participants at the outset. At followup, no differences in mean BMI were observed between the intervention and control groups, nor were any differences observed between the groups as regards the percentage of underweight children.

Warren et al published a study in 2003 that compared 4 groups of school children aged 5 to 7 years [14]. One group received nutritional education (eat smart), a second physical activity (play smart), and a third the combination including both. A control group received education about food, but without specific nutrition and energy perspectives. The followup was conducted after 14 to 16 months and showed no difference in BMI

among the groups. However, an increase in the consumption of fruit and vegetables and a better awareness about nutrition were observed. The increased intake of fruit was statistically significant in the "eat smart" group and in the control group. Knowledge about nutrition increased in all groups. A distinct intervention effect could not be observed, and the authors speculated about the possibility of "contamination", ie, that the message might have spread among the groups.

A Finnish study by Saariletho et al in 2003 followed a group of infants until 8 years of age [15]. Intervention families received regular dietary advice and health education. The aim was to achieve a diet containing a low level of cholesterol and saturated fat. The control groups were followed up twice per year. After 8 years, no significant difference was observed in the percentage of overweight individuals among the groups. Likewise, no difference was observed in the percentage of underweight children, or in growth and neurological development.

A California study by Sallis et al was conducted in 24 schools, and included just over 1 000 students at each school [16]. Both the trial and control groups were randomized, and the study continued for 2 years. The goal was to increase energy utilization through physical activity and to reduce the number of grams of fat in the diet that was purchased at, or taken to, school. Interventions were aimed at changes in the environment, such as extra exercise sessions and access to low fat snacks. BMI was studied before and after the intervention in randomly selected groups. The estimates were based on reported height and weight. Correlation to the measured values was shown to be 64% in a test group, and consequently the results are uncertain. A statistically significant positive weight trend was found among the boys, but not among the girls in the trial schools in comparison with the control schools. With the information reported, overall results from the study cannot be calculated. Given this and other uncertainties, we found the study to be neutral, ie, a statistically significant difference was not found between the intervention and control groups.

In 2004, James et al published a study of 644 school children [17]. The instructions focused on preventing children from drinking carbonated beverages, including "light" drinks. A substantial effort was made to formulate the message concerning the goals so it could be communicated in a positive way. This was done eg by allowing the children to create music with a health message, to try different types of sweet fruit, and to observe how Coca-Cola affected a tooth. In this study, a significant difference was observed in the percentage of overweight participants in the intervention compared to the control groups. At followup, the children in the intervention group also consumed a lower volume of carbonated drinks.

Economic Aspects

The earlier SBU report did not find any cost data related to the prevention of obesity. None of the studies on preventive programs reviewed by SBU presented a cost analyses. Nor was such information found in any of the other literature reviews. A new, broad search of the literature yielded one article that attempted to analyze cost effectiveness in a school-based obesity prevention program for children [18].

A preliminary OECD report published in 2004 on the cost effectiveness of interventions against obesity and diabetes presents results from a current literature search. It found the same study on children mentioned above, but otherwise nothing that would shed light on the cost effectiveness of the type of school-based program presented in the SBU report.

The study on children [18] analyzed a randomized clinical prevention trial by Gortmaker et al that was discussed in the previous SBU report [19]. Costs were estimated retrospectively for interventions, eg, exercise, teacher time, for the entire group of included children. The estimated cost was 14 US dollars (USD) per student and year. The effect achieved among the girls was extrapolated to show that obesity could be avoided in 1.9% of adult women. This would be followed by lower healthcare costs and less production loss. Using this method, the authors arrived at a cost of 4 305 USD per quality-adjusted life-year, and net savings to society. Hence, the preventive interventions were found to be cost effective, and was so in most cases in sensitivity analyses. The study contains several uncertainties. Findings that appear to favor preventive interven-

tions need to be confirmed by other research and should be based on more reliable data.

Overall Results of the Previous and New Literature Reviews by SBU

In summary, 3 studies show that interventions have had a positive effect on preventing obesity. In 7 studies, no differences were observed between the groups. Intervention was not found to have a negative effect in any of the studies, as summarized in Table 4.2. This table also includes the studies presented in the previous SBU report. Together, both of the reviews contain 24 studies involving 25 896 children and adolescents. In 8 of the studies, 33% (32% of the study participants) reported that the interventions had a positive effect on weight. In the rest of the studies there was not a statistically significant difference between the groups. In no instance was a negative weight trend reported in an intervention group. Positive results are not found at a higher rate in studies of low quality than in studies of high and medium quality.

Systematic Literature Reviews by SBU and Other Organizations

Since the problem of obesity occurs throughout the world, systematic literature reviews have been performed in many places to address studies on preventing obesity, particularly in children and adolescents. This fact was highlighted in the previous report. A comprehensive and systematic Canadian review of other systematic reviews was published in 2004 [20]. The review was a collaborative effort by three organizations, the Canadian Association of Pediatric Health Centers, the Pediatric Chairs of Canada, and the Canadian Institute of Health Research (CIHR) Institute of Nutrition. They identified and approved the quality of 6 relatively concurrent systematic reviews, one of which is the previous SBU report. Table 4.3 presents the 6 review articles and the studies included. We have checked each study, added the number of participants and the followup times, and corrected any errors. Some studies were excluded since we required that studies use certain outcome measures, ie, skinfold thickness, BMI, or percentage of overweight/obese participants. Furthermore, we included new studies and studies not identified in other reviews. None of the articles attempted to synthesize the results or analyze the probability for the outcome distribution.

The major difference among the different review articles concerns the requirements established for accepting a study. Some have required randomized studies, while we also accepted nonrandomized studies (the reasons are presented in the section on "Methods"). Another characteristic that distinguishes the reviews is the followup time of at least 1 year, as required by SBU. Even a year is a short time to follow up health effects in children and adolescents. The studies that established lower thresholds for followup probably did not view these time differences to be decisive. Furthermore, the reviews missed some studies in their searches for scientific literature.

The results in Table 4.3 are presented in three columns, based on the outcome in comparing the intervention and control groups. Only statistically significant results have been considered. The left column presents studies where interventions have had a positive effect on weight trends, the middle column found no statistically significant difference between the intervention and control groups, and the right column presents studies where the weight trend in the intervention group was less favorable than the trend in the control group.

Resnicow identified 4 studies with positive results, 9 neutral studies and no studies with negative results [21]. The corresponding figures in Hardeman's et al review were 1 positive study, 2 neutral studies, and no negative studies [22]. Campbell et al used the Cochrane method and presented 5 studies with positive results, 5 neutral studies, and no negative studies [23]. Reilly et al presented 1 positive study, 2 neutral studies, and no negative studies [24]. A more comprehensive review by Schmitz presented 11 positive studies, 14 neutral studies, and no negative studies [25]. Finally, the SBU synthesis presented 8 positive studies, 16 neutral studies, and no negative studies. The percentage of positive studies was similar in all reviews and independent of whether higher or lower stand-

ards were placed on the appraisal of the study design, followup time, number of subjects, and dropout.

Combined, the systematic literature reviews present 15 different studies with positive results, 22 neutral studies, and no studies with negative weight trends in the intervention groups. Hence, 41% of the studies (40% of the participants) showed a more positive weight trend with intervention than without.

Statistical Analysis

A formal meta-analysis is difficult to perform since the studies used different outcome measures. Results expressed as skinfold thickness, BMI, or percentage of obese participants must therefore be recalculated into "effect size", which is controversial. Moreover, many studies do not contain the information that would enable this. Hence, other methods of statistical analysis are needed to help interpret the results.

The SBU review includes 24 studies (Table 4.2). Of these, 8 showed a significantly positive result for the intervention group and 16 showed no difference. Negative results were not shown in any study. The fact that 16 of 24 were unable to show any significant improvement indicates that it can be difficult to achieve effects. The fact that 8 studies are positive, however, suggests that under certain conditions it is possible to achieve a good result. A test of statistical significance can be used to assure that the positive results did not arise by chance. A significance test is based on a null hypothesis. In this case the null hypothesis may be formulated as follows:

H_0: Intervention against obesity, as designed in the 24 studies, has no effect.

Under this hypothesis, possible significances (positive and negative) appear only because of random chance. If the studies use a significance level of 5%, under the null hypothesis we could expect 1 significant result (0.05 x 24 = 1.2). Also, under the null hypothesis it is equally probable that we would obtain a positive (+) significant result as a negative (–) significant result. Hence, we can reformulate the null hypothesis as follows:

$H_0: P(+) = P(-)$

where P stands for probability. To test whether the observed data correlates with this hypothesis we can use a sign test. This test shows that it is highly probable that the observed results (8+ and 0–) could not have occurred by random chance, p-value = 0.0078.

The compilation of all systematic literature reviews presents results from 39 studies. Of these studies, 15 were positive (+), 24 did not show any significant effect, and none were negative (–). Estimates using the sign test based on the results 15 (+) and 0 (–) also show that the observed results are unlikely to be a random chance phenomenon (p = 0.000061).

Another way to view the results is that most studies are designed to use a 5% significance level (2.5% in each "tail"). If there is no effect, one should get a positive significant result by random chance in approximately 2.5% of the studies. Of 39 studies, just under 1 should show a positive significant result (0.025 x 39 = 0.98). Fifteen positive studies show beyond a reasonable doubt that it is not a matter of "chance significance".

The review of the 24 (respectively 39) studies clearly shows that intervention under certain conditions can have a positive effect. The dominance of positive results is statistically significant, indicating that the difference was not due to chance. This is the case even if the results considered are limited to those compiled by SBU. Including the literature reviews from other countries further strengthens the findings.

Factors of Potential Importance in Preventing Obesity

The earlier SBU report noted interesting observations in studies that failed to meet the inclusion criteria. Studies in this review also present findings which have not been replicated by other researchers, and

thereby are not considered to be scientifically verified. The proposal to be submitted for a national action plan shall, however, consider findings that have not been fully confirmed. Factors of potential importance in preventing obesity in children and adolescents will be discussed below.

Physical Activity

Increased inactivity, eg, watching TV, using a computer, has been associated with the increased level of obesity in various populations. In 1996, Gortmaker et al reported a 4.6 times higher risk for overweight in adolescents who watched TV more than 2 hours per day compared to those who watched 0–2 hours [26]. A study by Robinson was referenced in the previous SBU report [27]. An attempt was made to teach children to watch TV with greater discretion and to introduce TV-free weeks. Children and adolescents could keep track of their TV viewing through a monitoring unit that was placed with the family, without cost. This unit showed how much TV was watched by the different family members. After 7 months, children in the trial group had reduced their TV viewing, had a significantly lower increase in BMI, and less subcutaneous fat compared to the control group.

Hence, several findings suggest that it might be possible to limit sedentary activity and then rely on a child's natural spontaneous need for movement to achieve a higher level of energy utilization.

Food and Beverages

Several reports gave particular attention to fruit and vegetable intake. In a study by Epstein et al, both children and parents increased their intake of fruit and vegetables in the intervention group [28]. Among the parents, an increased fruit intake had a greater effect on weight than did the recommendation to reduce fat and sugar. One review article suggested that the effect on intake was greater if one used many different strategies, if the family were involved, if the trial was long-term and intensive [29]. A study by Warren et al in 2003 found that children increased their intake of fruit and vegetables in the intervention groups and that they had greater dietary knowledge [14]. Social learning theory was applied to enhance the experience that it was valuable to change behavior, including advantages in the short-term. Children also were given the opportunity to taste healthy foods and received recognition and small rewards for achieving success.

Several findings support the concept that it is possible to increase fruit and vegetable intake among children and that this would have a positive impact on weight trends.

The increasing consumption of sugar-sweetened beverages, eg, soda and other soft drinks, by children and adolescents is another important aspect of the overweight problem. In the United States, it has been noted that 50% of all children consume soft drinks before school age, and this figure gradually increases to 65% during school age and rises to 82% among adults. From the ages from 2 to 18 years, it was found that those with a high consumption of soft drinks also had a greater daily energy intake than those with low consumption [30]. In California, TV viewing and soft drink consumption was found to increase the risk for obesity [31]. In 2001, Ludwig et al presented a major review of childhood obesity and consumption of sugar-sweetened drinks [32]. In American 12-year-olds, a higher intake of sugar-sweetened drinks was associated with gradually increasing BMI. Total consumption was found to have increased by 500% over the past 50 years. Sugar-sweetened drinks are now the leading source of extra sugar in the diet, amounting to 36 grams per day for girls and 58 grams for boys. Reference is made to several studies showing that the compensatory mechanism for satiety and the normal reduction in intake that occurs after higher energy intake becomes weaker when the intake is in liquid form [33]. This may contribute to the negative effects that sugar-sweetened drinks have on the risk for overweight.

The study discussed earlier in this report from Great Britain by James et al, published in 2004, also addresses the harmful effects of soft drinks [17]. After the intervention, the authors observed a 7.7% lower share of overweight and obese children in the intervention group than in the

control group. This study was oriented mainly toward reducing the intake of carbonated drinks, both sugar-sweetened beverages and "light" alternatives. The study showed that a feasible and limited intervention of this type could be effective when consumption is high. An attempt was made to bring the message to life instead of simply lecturing about nutrition. The methods were simple, but suggestive, and engaged the children's creativity through music, art, and dramatic experiments. The main message was –"When thirsty, drink water!".

Child Age

Observations from the earlier SBU report suggested that prevention should start early. In a study from Thailand, Mo-suwan et al investigated the effect of increased physical activity among preschool children (mean age of 4.5 years) [34]. The trial groups took a 15-minute walk in the morning and had 20 minutes of aerobatic dance exercises in the afternoon 3 times per week. A positive weight trend in was shown in the study, although followup was limited to 6 months.

Simonetti et al worked with children aged 3 to 9 years [35]. Here too, a positive weight trend was observed after 1 year in the intervention groups compared to the control group.

An age range of 5 to 7 years is used in the ongoing "KOPS" study in Germany [8] and in Warren's et al study from Great Britain [14]. Both reported positive results and are among the new studies in this review. Hence, the findings suggest that involvement of preschool-aged children is associated with a better outlook for success. It also seems reasonable to assume that the earlier one starts, the easier it is to establish a healthy lifestyle. This has been interpreted to mean that interventions can be promising for younger children.

Two ongoing studies incorporate this approach. One, called "Magic", comes from Great Britain and is projected to conclude in 2005. It involves children aged 3 to 4 years through pediatric units [24]. An American study "Hip-Hop to Health Jr" also addresses preschool children aged 3 to 5 years [36]. This study primarily involves African-American and Latino-American communities where the risk for obesity is high.

Of course, encouragement of good habits is needed throughout the entire period of childhood development, not least during the teenage years. At that time, young people look outward and are confronted with new eating and drinking customs. Concurrently, their physical activity tends to diminish.

Possible Negative Effects of Preventive Interventions

In the previous report we were unable to find any facts to answer the question on whether preventive interventions could have negative consequences, eg, higher risk of anorexia. Since then, the Finnish study "STRIP" has been published [15]. This study followed children for 8 years, starting from 7 months of age. Individual dietary and lifestyle rules were given to the intervention families while the control groups received usual followup. At 8 years of age there were no signs of any negative body perception, dissatisfaction with one's own body, or the desire to be thinner. Neither growth nor development were worse in the intervention than in the control groups.

This issue was also addressed by Caballero in the "Pathways" study through intervention among American Indian children at high risk for obesity [13]. At the outset, and in followup after 3 years, less than 1% were underweight in both the intervention and control groups. Both of the related studies had a positive effect on weight trends, but did not achieve statistical significance.

A study using special tests found improved body perception and satisfaction in the intervention group compared to the control group after followup [3].

Three studies reported no increase in anorexia rates, negative body perceptions, or self image problems in children exposed to lifestyle

influences from interventions against overweight. Two of the studies did not follow the participants beyond 10 years of age, when the risk is not particularly high, while the third study found a low risk even among teenage girls.

A controlled study investigated performance in several different classes. Despite the fact that 1.25 hours per day of regular school time was allocated to physical activity, no signs of lower classroom performance were found in the trial group [37].

Discussion

In line with findings from the earlier SBU review, many recent studies also used mean BMI or skinfold thickness as an outcome measure. However, several studies also used the percentage of overweight and obese children. Since the studies used different outcome variables and different intervention and followup periods it is not possible to combine the results by meta-analysis. Hence, the only option is to total the number of studies and the study participants with significantly better weight trends in the intervention group than in the control group, as well as the neutral and negative results, respectively. In total, the earlier and present SBU reviews include 24 studies involving 25 896 participants. Hence, the topic has been thoroughly studied. Table 4.2 shows that 33% of the studies, involving 32% of the participants, reported positive effects from intervention while no significant differences were found in the other studies. None of the studies reported results that were significantly worse in the intervention group than in the control group.

The data suggest that it is possible to prevent the development of overweight and obesity through preventive interventions in children and adolescents. This was also found in an ongoing Swedish study, STOPP (Stockholm Obesity Prevention Project), that preliminarily reported favorable results in the intervention group after 2 years [38]. Many of the studies did not show positive effects, which can be interpreted to mean that it is difficult to successfully implement a program based only on limited interventions in schools. When effects have been reported, they have been modest, eg, the difference of a few BMI units between the intervention and the control groups. However, this could correspond to a major difference in the percentage of overweight people in the population, at least in the long term. We have been unable to identify any particular features that characterize the positive studies and distinguish them from others. Likewise, it is not possible to determine whether some studies had planned to implement the interventions fully, but were unsuccessful, while other studies were able to implement them fully.

Risks of Preventive Intervention

Previously, no reports addressed the risks involved in preventive programs. Several of the recent studies have followed up the rates of underweight, anorexia, and deterioration in body perception and self-confidence among the children and adolescents that participated in intervention programs. Harmful effects were not found in any of the studies, which is reassuring information for future plans and projects.

High-risk Groups

The earlier SBU report found no studies that targeted children and adolescents at high risk for obesity. The present review, however, includes Caballero's et al study on Native American Indian children [13]. Epstein's study of children with obese parents compared two strategies, one including more fruit and vegetables in the diet and one involving lower amounts of fat and sugar [28]. One of the studies by Alexandrov also involved somewhat of a high-risk strategy since the boys with multiple risk factors for cardiovascular disease received more intensive prevention than the other participants [5]. None of these studies reported a significant positive effect from intervention. The ongoing study "Hip-Hop for Health Jr" aims at ethnic minority groups with a higher risk for obesity, in this case, relatively small children [36]. However, up to now, the high-risk strategy has been tested to a limited extent only and without confirmed beneficial effects. Possibly, special interventions for exposed groups might be effective.

Publication Bias

The question could be raised whether distribution of positive and neutral studies, and the lack of negative findings, might possibly be due to "publication bias"[1]. However, many studies have been included. Several of the studies failed to show positive results, but were published nevertheless. Many experts from different countries have been involved in the literature search. Cochrane, for example, is known for its rigor in finding unusual sources and unpublished material. Obesity researchers have participated in the assessment and are often aware of other researchers and studies.

Furthermore, schools, teachers, and students are often involved in studies in numerous locations that are financed through public resources. In these situations it is difficult to avoid presenting the results, positive or negative. Even if the interventions have no effect, positively significant results should appear in approximately 2.5% of all studies conducted. To randomly find 15 studies with positive results, 600 studies would need to be performed (15/0.025 = 600). Hence, there is very little risk that publication bias would lead to any major misinterpretation of the findings in this report.

Future Perspective

All studies are relatively small and have covered short time periods, despite the required followup time of 1 year. Considering health aspects, studies should be carried on for several years to determine outcomes and whether these findings can have positive long-term effects for public health. Interventions to date have been relatively limited. They have consisted of more education, more physical exercise, and promotion of healthy eating and drinking habits. All have been school-based and carried out for short periods of time. Concurrently, many events in society, and in the world of children and adolescents, are unrelated to any particular study, but could have a major influence on behavior, eating habits, and physical activity among young people. "Contamination" between the intervention and the control areas might possibly dilute the results. Since students move between schools and classes, this could also weaken the results since the "purity" of the groups is compromised. Nevertheless, a substantial share of the trials reported positive effects, which is promising.

A combination of long-term, mass interventions to promote good eating habits and physical activity in society at large can potentially have effects that are different from, and greater than, the limited interventions in the studies presented here. The outcome might be quite different if the interventions discussed in this report were promoted on all fronts in combination with mass media involvement, political action to encourage or discourage consumption of particular items, and actions to facilitate greater physical activity. Targeting high-risk groups might be an effective way to use resources. Naturally, there is a risk that the interventions could weaken with time, or that people would resume their poor diets and lower levels of physical activity after the initial enthusiasm had worn off. Therefore, all interventions need to be sustained and goal oriented.

Mass interventions of this type have not been followed up in any studies. Moreover, it is difficult to conceive of such a study design since the interventions would have a similar impact on the potential control groups. Weight trends in the population, monitored by reliable methods in relevant sample groups, therefore represent the most important outcome measure. An inspiring and educational example in this context is the gradual and successful decline in smoking achieved in the population through multiple, concurrent methods [39].

[1] The skewing of published results in studies because the researcher, or possibly the journal editor, selects to publish studies that show positive results, eg, show that a treatment has an effect. Studies that have no effect go largely unrecognized, and thereby the view that treatment is of value becomes gratuitously favored.

Table 4.1 *New studies on preventing obesity in children and adolescents.*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Treatment/ Extra followup period	No. patients followed up/ Dropout	Results Weight change	Results/ Other	Study quality Comments
Alexandrov A 1988 [4] Russia	CCT	Schools from 2 districts in Moscow. Boys and girls 11 years	I: Children, parents, teachers received health education via printed material, in meetings, and in discussion groups. Regular followup. C: Usual school education	3 years	4 213 total Dropout not reported	Skinfold thickness: Improved in I*. No significant difference in BMI	Improved blood pressure and blood lipids in I*	Medium
Alexandrov AA 1992 [5] Russia	CCT	Schools from 2 districts in Moscow. Boys 11–12 years	I: Counseling, nutrition education, changed diet, physical activity and smoking prevention. Children and parents. Repeated during 1 year. More intensive if higher risk (smoking, hyperlipidemia, blood pressure, and high BMI)	3 years	766 Dropout 24%	BMI 1 year 3 years I: 18.0* 19.7 C: 18.4 19.7 No difference after 3 years	Less smoking after 3 years I: 17%* C: 26%	Medium
Nader PR 1992 [6] USA	RCT	Families with children in 12 elementary schools, grades 5 and 6. Two groups: Anglo-Americans I+C Mexican-Americans I+C Children 11–12 years	I: Nutrition education, changed diet with low fat and salt content and increased physical activity for 3 months. Reminders during 9 months. C: Usual education Intervention was culturally adapted	1 year intervention. Followup 4 years	206 families. 323 children. Dropout 18% for adults and children. No info on dropout of children only	No significant difference in BMI between I and C among either Anglo- or Mexican-Americans	Higher BMI in Mexican-Americans than in Anglo-Americans	Medium
Howard JK 1996 [7] USA	RCT	School classes 9–12 years	I: Lifestyle education, diet, physical exercise, antismoking. 5 modules C: Usual education	Education 1 month, followup 1 year	83 Dropout 15%	No significant difference in BMI or skinfold thickness (triceps skinfold)		Low Few participants

Table continues on next page.

Table 4.1 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Treatment/ Extra followup period	No. patients followed up/ Dropout	Results Weight change	Results/ Other	Study quality Comments
Müller MJ 2001 [8] Germany KOPS study	CCT	I: 3 schools C: 3 sociodemographic matched schools. Aged 5–7 years	I: Nutrition education and health promotion for students, parents and teachers. Repeated information sessions for 3 months. C: Usual program	1 year	297 Dropout 28%	Lower increase in skinfold thickness (triceps skinfold) in the intervention group. I: from 10.9 to 11.3*. C: from 10.7 to 13.0	Intervention group showed significant increase in nutrition knowledge, increased physical activity, increased intake of fruit and vegetables, increased intake of food with low-fat content and reduction in TV viewing	Low Unclear information on several aspects
Caballero B 2003 [13] USA Pathway study	RCT	School children, American Indian >90% 41 schools randomized. Aged 7.6±0.6 years	I: Changed diet. Increased physical activity. Health education. Family involvement. C: Reference schools 12 weeks/y incl 4 components: Classroom lectures Support school kitchen staff Exercise + recess activities + free-time Family involvement	3 years	1 409 Dropout 17%	BMI I: 22.0 C: 22.2 NS	No significant difference in % body fat between I and C. Underweight not more frequent in any of the groups. No significant difference in physical activity	High
Warren JM 2003 [14] Great Britain	RCT	School children from 3 schools in Oxford. Randomized to 3 intervention groups and 1 control. Aged 5–7 years	I1: "Eat Smart": Dietary education. I2: "Play smart": Physical activity program. I3: Combination of "Eat Smart" and "Play Smart". C: Education on food without nutritional perspective. Education for 8 weeks each term. Total length of intervention 20 weeks	14–16 months	181 Dropout 17%	No significant difference in % overweight between groups	In all groups increased dietary knowledge and intake of fruit and vegetables	Low Few participants in each group

Table continues on next page.

Table 4.1 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Treatment/ Extra followup period	No. patients followed up/ Dropout	Results Weight change	Results/ Other	Study quality Comments
Saarilehto S 2003 [15] Finland STRIP study	RCT/ CCT	Families with 5 months infants were recruited in Helsinki. The studies were started when the children were 7 months	Intervention families received regular dietary advice. Aim was low content of cholesterol/saturated fat. Contact with physician/ dietician/nurse: 1–3 months interval. After 2 years: every 6 month	8 years/ongoing	658 Dropout 38% Followed for 8 years. 435 of 658 now studied. Dropout 34%	Overweight % Girls Boys I: 9.6 6.2 C: 15.8 7.7 NS Underweight % Girls Boys I: 1 2 C: 0.9 3.4 NS	Intervention program did not have negative influence on body perception, growth, or neurological development of the children	Medium Initially RCT. In followup CCT
Sallis JF 2003 [16] USA	RCT/ CCT	Children in 24 middle schools were randomized. Aged 11–14 years	I: Increased physical activity before, during, and after school. Reduced fat in school diet, student restaurants. C: No special interventions	2 years	Cross-sectional study. Before I: 1 678 After I: 1 484	BMI change Girls Boys I: +0.12 –0.28* C: +0.21 +0.36	Increased physical activity in I	Low
James J 2004 [17] Great Britain Chopps study	RCT	Children in 6 primary schools. Cluster randomized. Aged 7–11 years	I: Education 1 hour 4 times, same person. Drink water, no carbonated or "light" drinks. Tooth in Coca-Cola, music with health message, various fruit. C: No special interventions	1 year	574 Dropout 11%	Overweight and obesity %, change I: –0.2%* C: +7.5%	Fewer carbonated drinks. I: –0.6* glass C: +0.2 glass	Medium

* = Statistically significant difference between intervention and control group
C = Control group
I = Intervention group
NS = No statistically significant difference (nonsignificant)

Table 4.2 *Studies on preventing obesity in children and adolescents in SBU's literature review in 2004 and combined with the studies reported in 2002. The results of weight trends in the intervention group are compared with the control group. Only statistically significant results were considered.*

Study quality	Better in intervention group			No difference, intervention group compared to control group		Worse in intervention group	Total	
	Studies Year Reference	Number participants	% of all participants	Studies Year Reference	Number participants	Studies	Number studies	Number participants
Year 2004								
High + Medium	James 2004 [17] Alexandrov 1988 [4]	574 4 213		Alexandrov 1992 [5] Nader 1992 [6] Caballero 2003 [13] Saarilehto 2003 [15]	766 323 1 409 1 062	0		
Total	2	4 787	57	4	3 560	0	6	8 347
Low	Müller 2001 [8]	297		Howard 1996 [7] Sallis 2003 [16] Warren 2003 [14]	83 1 484 181	0		
Total 2004	**3**	**5 084**	**49**	**7**	**5 308**	**0**	**10**	**10 392**
Year 2002								
High + Medium	3	2 728	26	5	7 777	0	8	10 505
Low	2	553	11	4	4 446	0	6	4 999
Total 2002	**5**	**3 281**	**21**	**9**	**12 223**		**14**	**15 504**
Total 2002 + 2004	**8**	**8 365**	**32**	**16**	**17 531**	**0**	**24**	**25 896**

Table 4.3 *Overview of review articles. Studies containing weight-related findings were included: weight, BMI, skinfold thickness, percent overweight or obese. Results of weight trends in the intervention group were compared with the control group. Only statistically significant findings were considered. Studies with ≥1-year followup are indicated by + and shorter followup by –. Number of participants also reported.*

	Better in intervention group			No difference, intervention group compared to control group			Worse in intervent	Total	
First author Year Reference	**Studies Year Reference**	**≥1 year**	**Number participants**	**Studies Year Reference**	**≥1 year**	**Number participants**	**Studies**	**Number studies**	**Number participants**
Resnicow K 1997 [21]	Harrell 1996 [40]	–	1 274	Alexandrov 1992 [5]	+	766			
	Killen 1988 [41]	–	1 447	Bush 1989 [44]	+	687			
	Tamir 1990 [42]	+	406	Donnelly 1996 [45]	+	200			
	Lionis 1991 [43]	+	147	Luepker 1996 [9]	+	4 019			
				Resnicow 1992 [46]	+	1 209			
				Vandongen 1995 [47]	–	1 147			
				Walter 1988 [48]	+	1 765			
				Puska 1982 [49]	+	851			
				Tell 1987 [50]	–	543			
Total studies + participants	**4**		**3 274**	**9**		**11 187**	**0**	**13**	**14 461**
Hardeman W 2000 [22]	Simonetti 1986 [35]	+	1 321	Donnelly (see above)	+				
				Stolley 1997 [51]	–	105			
Total studies + new participants	**1**		**1 321**	**2**		**105**	**0**	**3**	**1 426**
Campbell K 2003 [23]	Flores 1995 [52]	–	49	Donelly (see above)	+				
	Gortmaker 1999 [19]	+	1 295	Epstein 2001 [28]	+	60			
	Müller 2001 [8]	+	297	Mo-suwan 1998 [34]	–	292			
	Robinson 1999 [27]	–	192	Sahota 2001 [53]	+	595			
	Simonetti (see above)	+		Stolley (see above)	–				
Total studies + new participants	**5**		**1 833**	**5**		**947**	**0**	**10**	**2 780**
Reilly JJ 2003 [24]	Gortmaker 1999 (see above)	+		Luepker (see above) [9]	+				
				+ 2003, Sahota (see above)	+				
Total studies + new participants	**1**			**2**			**0**	**3**	**–**

Table continues on next page.

Table 4.3 *Continued*

First author Year Reference	Better in intervention group: Studies Year Reference	≥1 year	Number participants	No difference, intervention group compared to control group: Studies Year Reference	≥1 year	Number participants	Worse in intervent: Studies	Total: Number studies	Total: Number participants
Schmitz KH 2002 [25]	Alexandrov 1988 [4]	+	4 213	Bush (see above)	+				
	Dwyer 1983 [37]	−	500	Donelly (see above)	+				
	Flores (see above)	−		Fardy 1996 [55]	−	346			
	Gortmaker (see above)	+		Luepker (see above)	+				
	Harrell (see above)	−		Mo-suwan (see above)	−				
	Killen (see above)	−		Resnicow (see above)	+				
	Lionis (see above)	+		Sallis 1997 [56]	+	547			
	Robinson (see above)	−		Vandongen (see above)	−				
	Simonetti (see above)	+		Walter (see above)	+				
	Tamir (see above)	+		Tell (see above)	−				
	Worsley 1987 [54]	−	456						
Total studies + new participants	**11**		**5 169**	**10**		**893**	**0**	**21**	**6 062**
Total no. different studies and participants in all reviews	***12***		***11 597***	***16***		***13 132***	***0***	***28***	***24 729***
SBU 2002 + 2004 [57]	Gortmaker (see above)	+		Bush (see above)	+				
	Lionis (see above)	+		Donelly (see above)	+				
	Müller (see above)	+		Alexandrov 1992 (see above)	+				
	Tamir (see above)	+							
	Alexandrov 1988 (see above)	+		Luepker (see above)	+				
				Resnicow (see above)	+				
	Manios 1998 [58]	+	962	Sahota (see above)	+				
	Manios 1999 [59]	+	471	Sallis (see above)	+				
	James 2004 [17]	+	574	Walter (see above)	+				
				Puska 1982 [49]	+	851			
				Bal 1990 [11]	+	2 350			
				Nader 1992 [6]	+	323			
				Howard 1996 [7]	+	83			
				Saarilehto 2003 [15]	+	435			
				Caballero 2003 [13]	+	1 409			
				Warren 2003 [14]	+	181			
				Sallis 2003 [16]	+	1 484			
Total studies + new participants	**8**		**2 007**	**16**		**7 116**	**0**	**24**	**9 123**
Total no. different studies and participants in all reviews incl. SBU's	***15 (41 % of all studies)***		***13 604 (40 % of all participants)***	***24***		***20 248***	***0***	***39***	***33 852***

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5. Preventing Obesity in Adults

New Studies – Normal Populations

The inclusion criteria were met by 20 studies, whereof 12 address cardiovascular disease prevention in a normal population. Obesity prevention comprises a subgoal in these studies. Of the 12 studies, 5 were population based, and 7 concerned special groups, eg, women aged 40 to 50 years (where weight gain is common) or employees in a company or the public sector. Moreover, 8 studies addressed preventive interventions against obesity in individuals with an elevated risk for cardiovascular disease.

The 12 studies on preventing obesity in normal populations are discussed below and presented in Table 5.1. One of the 5 population-based studies was published in 1997, prior to the first SBU report on obesity. The study was conducted from 1983/1984 to 1993/1996 in two regions of Italy, one of which was a reference region [1]. The goal was to investigate the extent to which an intervention program could reduce the occurrence of cardiovascular risk factors. The plan was to randomly select, from each region, 200 individuals per 10-year age group (20–69 years) and from each gender (in total 4 000 participants). Detailed information about good dietary habits and physical activity was broadly disseminated through the mass media and in conjunction with community- and church-related activities. Initially, about 1 600 participants in the intervention region and 2 000 in the control region were studied. At 10-year followup, only about 600 and 1 400 participants respectively from the regions participated, due to financing problems. Hence, the intended statistical power of the study was markedly reduced. At followup, no difference was found between the groups as regards mean BMI. A subgroup analysis showed that mean BMI declined for women in the intervention group. The difference was 1.2 BMI units, which was statistically significant compared to the control group.

Employees from mid sized factories participated in a controlled study in New Zealand. They were recommended low fat, high-fiber foods and regular physical recreational activity [2]. Initially, 40% were overweight. After one year, mean BMI and mean bodyweight were unchanged in both study groups.

The Women's Healthy Lifestyle Project Clinical Trial tested the hypothesis that reduced fat and cholesterol intake, combined with increased physical activity, would prevent weight gain and an increase in LDL cholesterol among women during menopause [3,4]. The randomized trial showed that bodyweight had declined in 55% of the intervention group and 26% of the control group after 54 months. The mean weight had increased in the control group, and the net difference was 2.5 kg.

Women aged 35 to 50 years participated in a 2-year controlled trial [5]. Nearly 50% were overweight, but did not have cardiovascular disease, diabetes, or other specified diseases. The authors did not report why the intervention group initially had approximately 70% more participants than the control group. The program aimed to improve dietary habits and increase physical activity. Information was given to groups (45 minutes) every second month during the first half year and less frequently, at times by letter, during the second half year. Self-reported fat intake declined in the intervention group, but no difference was reported in the mean values for BMI, body weight, or the waist/hip circumference ratio.

A population-based study involving 3 intervention regions and 1 control region was carried out in central New York State [6]. Approximately 62% of the 1 000 people invited (mainly Anglo-Americans and those with poor education) started in the program. Participants were informed about lifestyle improvement methods (diet, physical activity, smoking cessation) through the mass media and local health committees, schools, and other organizations. After 6 years, mean BMI had increased significantly in both the intervention and the control groups, without any difference separating them. Measurement values were not reported. Dropout was 29% and 37% respectively.

The effects of a national health promotion program (introduced in 1981) to prevent cardiovascular disease were assessed among 200 randomly selected pilots and navigators (aged 20–54 years) in the Australian Air Force [7]. At followup after 2 and 8 years, the results were compared with findings from matched controls in a national registry of people with risk factors for cardiovascular disease. The selection procedure was not reported in detail. After 8 years, the percentage of overweight or obese people decreased by 8% in the intervention group and increased by 7% in the control group. The greatest differences appeared in those over 40 years of age. Favorable effects on cholesterol were also noted.

All males in a Danish corporation were invited to participate in a study aimed at reducing the prevalence of cardiovascular risk factors through a range of different interventions to improve life style. These were individually adapted based on interview responses and medical examination [8]. Although the authors did not describe the randomization process, 56 men were randomized to the initial intervention group and 29 to the control group. Total dropout was 23%. After 1 year, mean BMI and mean weight had dropped in the intervention group. The differences in comparison to the control group were significant.

Of 2 000 people aged 30 to 50 years who had been randomly selected through general health screening at a primary care unit in Ebeltoft Denmark, around 1 500 (75%) accepted to participate. They were randomized into 3 study groups [9]. Individual counseling on lifestyle improvement was given in conjunction with two health exams in the intervention groups. One group also included annual consultations. After 5 years, the mean BMI in the intervention groups was significantly lower than in the control group. No differences were observed in a subgroup analysis of overweight participants only.

Effects of physical activity were studied in people aged 40 to 70 years who self-reported less than 2 hours of physical activity per week [10]. One of the study groups was recommended to participate in activities such as swimming, racket sports, and aerobics. The other group was

instructed to participate also in a lay-led walking program. The latter method resulted in a substantial increase in self-reported physical activity. No differences were observed in mean BMI, blood pressure, or cholesterol.

Two identically designed intervention studies were conducted for 6 years in Norway (Finnmark), a region that relies mainly on fishing [11,12]. Young people, randomly selected (15%), and everyone aged 40 to 62 years were recruited as cohorts from intervention and matched control regions respectively. One of the goals was to use individually adapted information at health centers to reduce the occurrence of cardiovascular disease risk factors. In one of the studies, mean BMI increased less in the intervention group [12]. Based on a special rating scale for the risk of myocardial infarction, other risk factors were also shown to decline. In the second study, the mean BMI increased more in the intervention group than in the control group [11]. The authors noted that the economic situation was difficult in the region, but otherwise offered no explanation for the outcome of the study.

Population-based interventions in combination with a health program, "Live for Life", were assessed among people aged 30 and 35 years respectively in Skaraborg, Sweden. One of the studies (nonrandomized) investigated the occurrence of risk factors in people aged 35 years and living in 4 intervention and 4 reference communities [13]. Political decisions and local resources were determining factors in whether or not the communities participated in the intervention. The individual-based health program included advice on diet, exercise, alcohol habits, smoking cessation, and reduction of mental stress. In this cross-sectional study, 800 people from the intervention communities participated during 1989 to 1991 and just over 650 people participated during 1994 to 1996. In the reference communities, there were 1 850 and 1 450 participants respectively. The health promotion program resulted in a lower increase in the percentage of overweight women (14% compared to 36%) after 5 years. The percentage of overweight men decreased by 8% in the intervention communities compared to an increase of 24% in the control areas. Positive effects from intervention were also observed on cholesterol levels and systolic blood pressure. Participation rates averaged 71% during 1990 to 1991 and 57% during the latter 3 years [14].

In summary, 5 *population-based* studies were conducted in Italy [1], the United States [6], Norway (2 in Norwegian Finnmark) [11,12], and Sweden (Skaraborg) [13]. All studies are of medium quality. Two of the studies reported positive effects from the intervention programs [12,13]. Two studies reported neural results [6], whereof one reported positive subgroup results in women [1]. One study reported results that were worse in the intervention group [11].

Studies of special groups in a normal population included participants at different workplaces [2,7,8] and participants who were 30 to 50 years of age and at risk for becoming obese [4,5,9,10]. In this category, 4 of the 7 studies reported positive effects [3,7–9] and the remainder reported neutral results.

Studies of Interest that did not Meet the Inclusion Criteria

A 16-week health program for younger couples was developed against the background that weight gain often occurs when couples start living together. The couples had lived together less than 2 years and were contacted through announcement [15]. Initially, 61% of the men and 28% of the women were overweight. One of the intervention groups received mailed information and advice on diet and exercise, while the other group also received personal contact. Hence, the interventions were of low intensity, and the control group received no intervention. The results after 1 year are consistently negative, without differences compared to controls regarding mean BMI, percentage of overweight or obesity, physical activity, smoking and alcohol habits, blood pressure, and blood lipids.

Polley et al studied the effects of dietary advice and increased physical activity during pregnancy. The interventions started prior to week 20 and in low-income employees with BMI ≥20 [16]. By the time of birth, the observation period averaged 29 weeks. In initially normal-weight

women, fewer in the intervention group than in the control group had gained more weight than recommended. The results were the opposite in women who were overweight at the outset. In followup 8 weeks after delivery, when dropout was high, no differences were found between the study groups. However, there was a strong relationship between high weight gain during pregnancy and high weight later.

New Studies: Preventing Obesity in People at Greater Risk for Cardiovascular Disease

Eight studies on high-risk individuals met the established inclusion criteria (Table 5.2). In the Oslo Diet and Exercise study (ODES) [17,18] 26 000 people, aged 40 years, were screened for the concurrent hypertension and cholesterol, elevated triglycerides, and reduced HDL cholesterol. Just over 200 individuals having a mean BMI of 28.8 were randomized to 3 intervention groups and a control group:

I1. Dietary advice (low energy, low fat, high fiber)
I2. Increased physical activity (aerobics, jogging, or brisk walking for 1 hour 3 times per week)
I3. Dietary advice and physical activity
C. Control group.

A strength of the study is that the maximum oxygen uptake capacity in stress testing was followed as a measure for participation in the exercise program. Weight loss was noted in the group that received combined interventions (5.7 kg). As in the diet group (3.7 kg) and the exercise group (1.9 kg), it was significantly greater than in the control group. Other risk factors were improved, mainly after combined intervention [17]. A report from the same study group included 186 men with metabolic syndrome and focused on plasma leptin concentrations [18]. In terms of mean BMI, the findings were better in the intervention groups.

Within the framework for the National Breast and Cervical Cancer Early Detection (WISEWOMAN PROJECTS), low-income participants were recruited in North Carolina and Massachusetts [19,20].

In North Carolina, just over 2 100 women with high blood pressure or cholesterol participated. An intervention program of dietary information and increased physical activity was carried out for a half year at 17 cancer screening centers. The control groups at 14 matched centers received minimal information [20]. The percentage of obese women was 44%. After 1 year, mean BMI remained unchanged in both of the study groups. Cholesterol and diastolic blood pressure had decreased and HDL cholesterol had increased, with no difference between the intervention and the control groups.

Nearly 1 600 women in Massachusetts were randomized, independent of risk factors, at 6 centers to intervention and at 5 centers to controls. The results from this region were not presented separately, but together with the findings from North Carolina [19]. After 1 year, neither mean BMI nor the percentage of obese persons had changed. However blood pressure had improved and smoking had decreased. Dropout was approximately 20%, and only 50% participated fully in the intervention program.

A Finnish primary care study included participants (<65 years) with one or more of the following risk factors: high-level BMI, blood pressure, cholesterol, and smoking, and low-level physical activity [21]. Cardiovascular disease was present in 68%. In total, 150 people with a mean BMI of 27.8 were randomized to individually adapted dietary counseling combined with physical activity in groups. Followup took place after 6 and 12 months. The control group received only the health brochure that had been distributed to the intervention group. After 2 years, mean BMI had declined marginally in both study groups. They also reported similar reductions in risk score, cholesterol, and systolic blood pressure.

Participants in a randomized study from Japan were middle-aged male corporate employees presenting at least one cardiovascular disease risk factor (high BMI, blood pressure, blood glucose, or lipid disorder) [22]. Mean BMI was 24.7. The program started with a 4-day residential course covering theoretical and practical education on diet and physical exercise in groups. Thereafter, up to 8 seminars were held during the following 18 months. Twelve people were transferred from the control to

the intervention group when new cardiovascular disease was diagnosed. Mean BMI fell by 0.5 in the intervention group, and the percentage of overweight individuals decreased from 39% to 27%. No changes were observed in the control group. Moreover, systolic blood pressure, cholesterol, and triglycerides dropped.

The goal of a Swedish randomized study of middle-aged, female public employees in Helsingborg was to use lifestyle interventions to reduce the risk factors for cardiovascular disease (lipid disorders, high blood pressure, and smoking) [23]. The program included dietary information through 16 group meetings per year and individual contact with a nurse at primary care centers. The authors estimated that the project leaders used 680 hours for the 128 participants recruited. The control group received only written information about the risk factors. Mean BMI declined by 0.5 units in the intervention group compared to the control group. The interventions also resulted in decreased diastolic blood pressure and LDL cholesterol. Smoking also decreased and "good" HDL cholesterol increased. Dropout was relatively high, ie, slightly above 30%.

In a primary prevention study from the Netherlands, the inclusion criteria were 40 to 70 years of age, type 2 diabetes, hypertension, and hypercholesterolemia [24]. Participants were randomized at the healthcare unit level. Patients at five family practice clinics received dietary information from a dietician and advice on increased physical activity, while the patients at four units (one clinic dropped out after randomization) comprised the control group. They received health brochures and some also received brief information from their family physician. Most of the approximately 140 participants were married women with a low level of education, a mean age of 58 years, and mean BMI of 28.7. After 1 year, the mean BMI and mean weight was marginally, but significantly, lower in the control group. After the first half year the findings had been the opposite. Blood pressure, blood lipids, and the percentage of smokers did not change in any of the study groups. Dropout was minor (9%). The authors discussed the need to specially design educational material for people with a low level of education.

The Oslo Diet and Antismoking Trial (ODAT) included middle-aged men who were screened (1972–1973) for hypercholesterolemia and elevated risk for cardiovascular disease [25,26]. The program included over 600 participants who were randomized to the intervention group that received education about a healthful diet and advice on smoking cessation. The control group did not receive any special interventions. A small subgroup analysis showed that the intervention program led to a reduction in mean BMI, which remained unchanged in the control group [25].

Recently, results from the ODAT were analyzed using a substantially larger database with consideration to the triglyceride level after 5 years. Compared to the controls, the mean BMI decreased in the intervention group – regardless of the triglyceride level [26].

An ambitious, conventional intervention program at 45 worksites in Finland was carried out for employees with elevated blood pressure [27]. After randomization just over 350 participants received initial education at a residential course, which was followed up after 4 and 8 months. After 1 year, the mean BMI, mean body weight, and blood pressure were significantly lower in the intervention group. Physical activity increased, but cholesterol and smoking remained unchanged.

In summary, different models were used to recruit individuals with one or more risk factors for cardiovascular disease. The Oslo studies [17,18,25,26] and the WISEWOMAN PROJECTS [19,20] screened large populations, while other studies were limited to, eg, corporations or smaller health service regions. Elevated BMI alone was not an inclusion criterion, but a large percentage of the participants were overweight or obese, as reflected by a mean BMI between 25 and 30. Positive outcomes were noted in the 5 of the 8 studies, negative in 1 and neutral in 2.

Studies of Interest that did not Meet the Inclusion Criteria

A controlled trial of employees at 12 corporations included those with cholesterol exceeding 5.1 mmol/l [28]. The 95 participants in the intervention group received counseling concerning low-energy, low fat, high-fiber food and about increased physical activity (swimming, jogging, or brisk walking 30 minutes at least 3 times per week). Results for 74 reference individuals were studied retrospectively at other corporations, although information on BMI was missing for 23 of them. After slightly more than 1 year, mean BMI had increased insignificantly in both study groups. Cholesterol decreased significantly in the intervention group. Dropout was 43%, and the groups were not comparable at the outset.

The Institution for Health Sciences in Luleå, Sweden, recently presented a randomized trial in primary care. Of the 340 people invited, 52% participated under the following inclusion criteria: aged 18 to 65 years, high blood pressure, type 2 diabetes, blood lipid disorders, or obesity. The 3-month intervention program included dietary counseling and physical exercise, ie, both endurance training and a lighter type of bodybuilding. At 1-year followup, waist circumference and diastolic blood pressure, but not BMI, were lower in the intervention group. Dropout after the randomization date was 23% [29].

Statistical Analysis

The SBU review now includes 31 studies on preventing obesity in adults (Table 2, SBU Summary). Nearly 64 000 individuals have been included. Significantly better weight trends were reported in the intervention groups than in the control groups in 14 of the studies, ie, in 45% of all studies, involving 31% of all participants. In equally as many studies it was not possible to demonstrate any difference between the groups, and in 3 studies, involving 6% of all participants studied, the results were significantly worse in the intervention than in the control groups.

Results in the adult studies have been analyzed statistically using the same method as presented in the section on children and adolescents. The question is whether or not the distribution of 14 positive and 3 negative adult studies might have occurred by chance. Calculations show this to be very improbable (p-value 0.0128).

The conclusion is that, under certain conditions, interventions against obesity have a positive effect in adults. Difficulties in achieving lifestyle changes may explain the lack of effects reported by approximately half of the studies. Furthermore, some of the interventions have been very short and limited, or have focused only on recommendations to increase physical activity.

Discussion

Normal Populations

Several extensive population-based studies were carried out during the 1980s, mainly in North America. They aimed at preventing cardiovascular disease by reducing the occurrence of risk factors, eg, elevated blood pressure, elevated cholesterol, obesity, and smoking. A favorable effect on weight trends was reported from a small intervention region in Jerusalem. Also, two of the North American studies were positive in cross-sectional analysis, but not in cohort analysis (see definition in Chapter 2, Methods, Literature Search, and Review). Studies using a cross-sectional design examine randomly selected individuals from both the intervention and the reference regions at regular intervals. This method provides greater power to determine changes, but has the disadvantage that repeated examinations might influence the results in both the experimental and the control groups. Study quality is high when both cross-sectional and cohort analyses point in the same direction.

The remainder of the North American studies show that mean BMI increased to the same extent in the 6 intervention cities and the 6 reference cities [30]. A key explanation for the results is that obesity was not the main focus of the trials. The effects on the other risk factors were marginal. This illustrates the problem with prevention studies of this type. Preventive interventions are rather limited and often become known in the reference areas. A so-called "contamination" effect may appear. Although the findings on weight trends reported in the recent

studies are somewhat more positive, it is not yet possible to draw reliable conclusions on the effects of programs of varying intensity for entire population groups.

Studies of Special Groups

Many studies focus on preventing obesity among people in whom weight gain is common, including women during and after pregnancy [16]. One study showed that substantial weight gain could be prevented in women with normal weight prior to pregnancy, but not in those who were overweight or obese at that time. After childbirth, only a small percentage of women were followed up, and only for a short time. Hence, the effects could not be assessed. Swedish studies suggest that weight gain in conjunction with pregnancy is a decisive factor in the incidence of obesity [31,32]. The percentage of women who are overweight/obese 18 to 24 months after childbirth was markedly higher in those reporting substantial weight gain during pregnancy. One reason is unsatisfactory dietary and exercise habits [33,34]. This is an important target group for preventive interventions against obesity. Also, interventions must be monitored to assure that they do not have negative effects on the fetus or newborn.

Other interesting target groups for trials to prevent weight gain include menopausal women [4,5,20] and couples starting to live together [15]. Many workplaces and organizations for occupational health services may also be a good base for prevention, not least where overweight problems are common.

Studies of People at High Risk for Cardiovascular Disease

Several studies in this obesity report concern individuals identified as having an elevated risk for cardiovascular disease. Screening has been used in large populations, among employees of corporations, or among patients at primary care centers. Blood pressure, blood lipids, and BMI have been investigated, often complemented by interviews on smoking and alcohol habits. Several intervention programs have also been implemented under the direction of primary care [9,10,24].

Studies based at places of employment have been conducted with and without identifying individuals at higher risk for cardiovascular disease. The experiences have been consistently positive, but major resources such as individual followup and residential training programs have often been included. A review article presents the advantages of treating obesity in a workplace: 1) close proximity to health providers facilitates and increases participation, 2) better results are achieved through higher participation, and 3) it is in the interest of a company to reduce sick leave [35]. The same also applies to preventing obesity.

Diet and Physical Activity

The dominant dietary recommendation in the studies presented is to reduce total energy intake through reduction in fat, primarily saturated fat, and to increase fiber content through, eg, fruit and vegetables. None of the studies compared the effects of different types of dietary regimens.

There are, however, several studies that examine the correlation between fat intake and BMI in the population. A review article shows that comparative cross-sectional studies in various countries suggest a positive correlation between the amount of fat in the diet and BMI [36]. Prospective studies on changes in body weight in relation to fat content in the diet have yielded controversial results. Finally, randomized but short-term trials show that reduced fat intake has a positive impact on weight trends.

A new, comprehensive review of 30 observational studies was published in 2004 [37]. Diets high in fat, energy, and sugar were compared with low fat diets that included an abundance of fruit and vegetables. Eleven of the studies reported no correlation between BMI and different dietary patterns. Other studies yielded uncertain results that were difficult to assess. The studies in the review do not show whether or not a correlation exists between BMI and *changes* in the diet. Interpretation of the results is difficult because of several factors that can influence the results

but are difficult to study, eg, genetic predisposition for obesity and different levels of physical activity, which are usually self-reported.

Although the correlation between fat content in the diet and weight change over time is uncertain, other favorable health effects can be achieved through a low fat diet. Meta-analysis, eg, has shown that reduced fat intake leads to a 10% lower incidence of cardiovascular disease [38]. However, no change was found in total mortality.

The suspicion that sugar-sweetened beverages strongly contribute to a higher incidence of obesity, even in adults, was confirmed in a recently published study, ie, the Nurses' Health Study [39]. This study shows that increased consumption of soft drinks, from once per week to once per day during a 4-year period resulted in an average weight gain of 4 kg.

Several studies show that high alcohol consumption comprises a risk factor for obesity. In addition to alcohol increasing the total energy intake, it has been shown that the appetite is stimulated several hours after alcohol intake (for an overview see [40]). The uncertainty in self-reporting may explain why all of the studies do not point in the same direction.

The only comparative study in the area shows that increased physical activity combined with improved dietary habits has a more positive effect on weight trends than dietary counseling alone [17]. However, increased physical activity as the sole intervention has no, or only a marginal, effect. These findings fully agree with those concerning the treatment of obesity and interventions for maintaining achieved weight loss after treatment.

Over 6 200 individuals were interviewed in a cohort study from Finland about their exercise habits at age 14 and 31 years respectively [41]. In every fifth man and every sixth woman physical activity declined from moderate to "inactive" defined as less than 1 exercise session per week. During the period, the percentage of overweight/obesity and abdominal obesity increased among these individuals. The statistical analysis considered the influence of other variables (confounders) such as alcohol consumption, smoking, and maternal weight prior to pregnancy.

In a large review presented studies concerning the effects of mass media and environmentally based information aimed at improving lifestyle, particularly diet and physical activity [42]. Only a single controlled study of sufficient duration (1 year) evaluates the effects of a mass media campaign. The goal was to promote the purchase of low fat dairy products. Sales had increased significantly, which agreed with information obtained in telephone interviews. Of 23 environmentally based studies, only 1 was controlled and continued for an acceptable period of time. The intent was to inform people about foods that could help reduce cardiovascular disease risk factors. Information was conveyed through posters, health brochures, and a distinctive symbol (green keyhole) to label low fat, high fiber foods. The results showed that the change in dietary habits was not statistically significant, but there was a shift in the right direction in 8 of the 9 food categories.

Economic Aspects

Currently, there is little scientific knowledge as regards cost estimates and cost effectiveness in this area. Costs were carefully estimated in the WISEWOMAN PROJECTS [19,20], and the additional expenses for the expanded intervention program were compared with the minimum program [13]. The average additional cost per individual was 116 US dollars (USD), or 603 USD compared to 487 USD, in the group receiving the expanded intervention. Effects on the incidence of cardiovascular disease during a 10-year period were estimated only on the basis of the results regarding cholesterol, HDL cholesterol, and blood pressure. However, these effects were not found to be statistically significant, and therefore cost effectiveness cannot be calculated.

The study of high-risk patients among public employees in Helsingborg, Sweden showed that participation in the project had required 680 hours in total. It continued for 18 months and included 128 individuals in the trial and control groups [23]. Based on a cautious estimate of the average annual cost for dietitians and nurses, the 680 hours would cost approximately 150 000 Swedish crowns (SEK). This includes the costs for the control group and administration of the study.

A preliminary OECD review on the cost effectiveness of preventive interventions generally lacked information on the primary prevention of obesity. However, it contained more information on the prevention of diabetes and its complications [43]. Hence, there are data to show the cost effectiveness of improved diet and exercise habits in preventing or delaying the onset of type 2 diabetes among individuals at risk because of genetic predisposition and overweight/obesity [44].

Table 5.1 *Studies on preventing obesity in adults in a normal population.*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Giampaoli S 1997 [1] Italy	CCT	200 selected per gender and 10-year age groups (20–69 years) in 2 regions 1983–1984 M W I: 739 859 C: 942 1045 Mean BMI M: 26 W: 29	I: Information via mass media, church, and sports activities. Less saturated fat, more vegetables, smoking cessation, physical activity C: Controls	10 years	Cross-sectional M W I: 307 304 C: 704 748 (1993)	BMI difference before–after M: –0.1 W: –1.2* Mean BMI M W I: 26.5 29.1 C: 26.5 28.9	Blood pressure, lipids no significant difference. Lower S-glucose in men	Medium Fewer investigated in I at followup 1993 due to poor financial support
Cook C 2001 [2] New Zealand	CCT	Male hourly employees (>200) at mid sized factories Obesity found in 40%, hypertension in 30%, high fat intake 60%	I: Diet: fruit, vegetables, low-fat, less alcohol, increased physical activity (30 minutes 1/month x 6 in group) C: Controls	1 year	I: 1 321 C: 1 211 Dropout: 11%	BMI difference before–after I: 0 C: 0 Weight I: 0 C: 0	I: Increased fiber intake and physical activity, lower fat intake and systolic blood pressure	Medium
Kuller LH 2001 [4] USA Simkin-Silverman LR 2003 [3] USA	RCT	Women not receiving sex hormone treatment (44–50 years) BMI: 20–34 Chol: 3.6–6.7 mmol/l LDL cholesterol: 2.1–4.1 mmol/l	I: Energy and fat-reduced diet + physical activity C: Controls	4.5 years	I: 246 C: 263 Dropout 5%	Weight I: –0.1 kg* C: 2.4 kg Weight loss % participants I: 55%* C: 26%	I: Smaller waist circumference, lower TG, higher reported physical activity. LDL cholesterol: no difference	Medium
Miller SL 2001 [5] USA	CCT	Women (35–50 years) BMI <40, no cardiovascular disease, high blood pressure, diabetes etc. Ads, posters etc I: 174 C: 103	I: Group information 45 minutes every second month for 6 months. During following 6 months personal and postal contact C: Controls	2 years	I + C: 188 Dropout 32%	BMI I: –0.1 C: 0	I: Self-reported lower fat intake	Low Selection unclear I compared with C

Table continues on next page.

Table 5.1 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Nafziger AN 2001 [6] USA Otsego-Schoharie	CCT	Mass media recruitment of people (20–69 years) in 3 regions randomly selected by 10-year age group and sex. One reference region. Participants: 62% of 1 016 invited	Information via mass media, schools, organizations, and 24 health committees. Dietary habits, increased physical activity, smoking cessation	5 years	Cross-sectional I: 289 C: 259 Cohort I: 257 C: 167 Dropout 32%	Cross-sectional BMI not reported Cohort BMI increased significantly in both study groups. No values reported	Cross-sectional Reduced smoking in I Cohort Reduction in systolic blood pressure and smoking in I	Medium
Peel GR 2001 [7] Australia	CCT	Randomly selected male pilots and navigators (25–54 years) 1980 and 1983 and (20–54 years) 1989	National health program for prevention of cardiovascular disease I: Pilots and navigators C: Matched in national health register	2 years, 8 years	Cross-sectional 1980 I: 277 C: 364 1983 I: 293 C: 516 1989 I: 342 C: 271	Percentage overweight/obese I: 41–36–33%* C: 54–56–61%	Blood pressure dropped in both study groups. Cholesterol dropped ≤40 years	Medium Selection to C not clearly described
Andersen LB 2002 [8] Denmark	RCT	All men (n=152) 25–45 years in a company. 85 (56%) participated	Individual intervention after interview and blood lipids. Participation in one or more programs, diet, physical activity, smoking cessation I: 56 C: 29	1 year	I: 20 C: 23 Dropout 23%	BMI I: –0.1* C: 0.4 Weight I: –0.2 kg* C: 1.4 kg	Improved physical work capacity	Low Randomization procedure not described

Table continues on next page.

Table 5.1 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Engberg M 2002 [9] Denmark	RCT	Randomly selected patients (30–40 years) in primary care. 1 507 (75%) of 2 000 participated. Mean BMI: 25	Individual (diet, physical activity, alcohol, smoking cessation) I1: 2 health visits on lifestyle I2: Ditto + 45 minutes consultation/year C: Controls	5 years	I1: 346 I2: 378 C: 369 Dropout 27%	<u>BMI</u> I1+I2: 25.9* C: 26.5 <u>Percent BMI >27.5</u> I1+I2: 30.8% C: 35.0%	Percent with elevated risk for cardiovascular disease and high cholesterol lower in I group	Medium
Lamb SE 2002 [10] England	RCT	Primary care patients (40–70 years) with <2 hours of physical activity per week <u>Exclusion</u>: Physical and mental impaired ability for physical activity. 438 of 2 000 participated. Randomized: 260	I: Group instruction on physical activity and health walk C: Counseling only	1 year	I: 95 C: 93 Dropout 28%	<u>BMI</u> I: –0.09 C: –0.06	Physical activity increased more in I. No difference in cholesterol and blood pressure	Medium
Lupton BS 2002 [12] Norway Finnmark Intervention Study	CCT	North Cape (I) and 3 control areas (C) with same age structure and ethnic background <u>Participants</u>: All 40–62 years plus 15% of aged 20–39 years	I: Information on improved lifestyle at health centers (diet, physical activity, smoking cessation) C: No special intervention	6 years	I: 725 C: 960 Dropout 30%	<u>BMI</u> <u>M</u> <u>W</u> I: –0.2* 0.4* C: 1.1 1.4	Reduced smoking in women	Medium

Table continues on next page.

Table 5.1 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Lupton BS 2003 [11] Norway Finnmark Intervention Study	CCT	Båtsfjord (I) and 3 control areas (C) with same age structure and ethnic background Participants: All 40–62 years plus 15% of aged 20–39 years	I: As above	6 years	I: 364 C: 960 Dropout 33%	BMI M W I: 1.5* 1.9 C: 1.1 1.4	M: Increased physical activity, reduction in blood pressure W: Reduction in blood pressure	Medium
Lingfors H 2001 [13,14] Sweden	CCT	People (30 and 35 years) in 4 intervention and 4 reference municipalities were studied 1989/91 to 1994/96 Participants: M W 1990/91: 64% 77% 1994/96: 51% 62%	I: Population and individual based after determining diet, physical activity, smoking, alcohol, mental stress, and cholesterol C: Reference municipalities	5 years	1990/91 M W I: 390 409 C: 900 952 1994/96 M W I: 228 243 C: 676 781	BMI M W I: –0.1* 0.3* C: 0.8 1.0 Percent BMI ≥25 M W I: –8%* 14%* C: 24% 36%	Percent with high cholesterol and systolic blood pressure dropped in both men and women in I. Physical activity and smoking increased in women	Medium

* = Significant between the study groups, if not otherwise stated
I = Intervention group
C = Control group
M = Men
W = Women
Cohort = A study of a group of people with certain defined characteristics in common.
Cross-sectional = A study of a number of people carried out on a single occasion.

Table 5.2 *Studies on preventing obesity in adults with risk factors for cardiovascular disease.*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Anderssen SA [17,45] 1995, 1993 Norway Oslo Diet and Exercise Study	RCT	Screening of people aged 40 years with concurrent BMI >24, diastolic blood pressure 86–99 mm Hg. Cholesterol 5.2–7.74 mmol/l. HDL cholesterol <1.2 and TG >1.4 mmol/l. Mean age: 45 years Mean BMI: 28.8	I1: Diet (energy and low fat, unsaturated fat, vegetables and low salt if elevated blood pressure). Followup after 3 and 9 months. I2: Physical activity (aerobics, jogging, or brisk walking) 1 hour, 3 times/week. I3: I1+I2 C: Controls	1 year	I1: 52 I2: 49 I3: 65 C: 43 Dropout 5%	Weight (kg) I1: –3.7* I2: –1.9* I3: –5.7* C: 0.9	I1: Triglycerides decreased. I3: Triglycerides and blood pressure decreased. HDL cholesterol increased	Medium
Reseland JE 2001 [18] Norway Oslo Diet and Exercise Study	RCT	Followup study of men with metabolic syndrome Mean age: 45 years Mean BMI: 29	As above	1 year	I1: 43 I2: 47 I3: 54 C: 36 Dropout 3%	BMI I1: –1.3* I2: –0.3 I3: –1.8* C: 0.3	1: Reduction of S-leptin and body fat that correlated to reduction in fat or total energy intake	Medium
Rosamond WD 2000 [20] USA WISEWOMAN[1] PROJECT	CCT	North Carolina: 17 centers with I and 14 as C. Cholesterol ≥200 mg %. Blood pressure ≥140/≥90. Obesity 44%. Anglo-Americans 50%. Low-income women	I: Structured program with diet, physical activity. C: Direct advice on dietary habits and physical activity and some followup	1 year	I: 475 C: 728 Dropout 16%	BMI I: –0.2 C: 0	No improvement in physical activity, smoking, lipids, and blood pressure	Medium

Table continues on next page.

Table 5.2 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
Ketola E 2001 [21] Finland	RCT	Cardiovascular disease ≥4.5 points (high BMI, blood pressure, cholesterol, smoking, low physical activity) in people <65 years at Helsinki Northern Health Center. Mean BMI: 27.8	I: Individual dietary counseling for weight reduction, physical activity in groups, and health brochures. C: Health brochures	2 years	I: 71 C: 71 Dropout 5%	BMI I: –0.07 C: –0.06 Weight I: –3.0 C: –1.7	Cholesterol, systolic blood pressure, and cardiovascular disease decreased and physical activity increased in both study groups. No difference between the groups	Medium
Muto T 2001 [22] Japan	RCT	Men at construction company (20% office workers) with ≥1 risk factor (high BMI, high blood pressure, high lipids, high fasting glucose). Mean age: 42 years Mean BMI: 24.7	I: 4-day residential course with theoretical and practical dietary counseling + physical activity. Seminars during 1st year ≤6 and 2nd year ≤2. C: Controls	18 months	I: 152 C: 150 Dropout 7% 12 people with new heart disease transferred from C to I	BMI I: –0.3* C: 0.2 Weight (kg) I: –1.0 C: 0.5 Percent BMI ≥25 I: –12%* C: 1%	I: Systolic blood pressure, cholesterol, and triglycerides decreased	Medium
Nilsson PM 2001 [23] Sweden	RCT	Cardiovascular disease ≥9 points in public employees (mainly women 40–50 years). 128 of 454 randomized. Mean age: 50 years Mean BMI: 28.7	I: Lifestyle intervention via 16 group meetings per year + individual nurse check-ups at health centers. Total time 680 hours. C: Written + oral information on risk factors for cardiovascular disease	18 months	I: 43 C: 46 Dropout 30%	BMI I: –0.5* C: 0	I: HDL cholesterol increased, diastolic blood pressure, LDL cholesterol, and smoking decreased	Medium

Table continues on next page.

Table 5.2 *Continued*

First author Year Reference Country	Study design	Inclusion criteria (Recruitment)	Intervention method Study groups	Follow-up period	Number followed up Dropout	Results BMI and weight	Results/Other	Study quality Comments
van der Veen J 2002 [24] Holland	RCT (at care unit level)	40–70 years with type 2 diabetes, hypertension or elevated cholesterol	I: Oral and written information on diet (energy and low fat, high in unsaturated fat). C: Health brochures and some physician contact	1 year	I: 67 C: 67 Dropout 9%	<u>BMI</u> I: 0 C: –0.2* <u>Weight</u> I: 0.2 C: –0.6*	I: At 6 months greater weight loss than C	Medium
Hjermann I 1981 [25] Ellingsen I 2003 [26] Norway Oslo diet and anti-smoking study	RCT	Men at risk for cardiovascular disease and high cholesterol in otherwise healthy men (40–49 years) screened 1972–1973. Mean BMI: 25.1	I: Individual and group dietary information with consideration to blood lipids. Female relatives participated. 6-month followup. C: Controls	5 years	I: 604 C: 628	<u>BMI</u> I: –0.8* C: 0	Higher mortality from cardiovascular disease after 23 years in people with elevated triglycerides	Medium
Mattila R 2003 [27] Finland	RCT	Employees (n=731) with hypertension at 45 work sites, (140–179/90–109 mm Hg) or in treatment. Mean age: 50 years Mean BMI: 29	I: Residential course 5 days initially + 2 days after 4 and 8 months. Diet + physical activity. Group meetings. C: No information	1 year	I: 331 C: 304 Dropout 10%	<u>BMI</u> I: –0.7* C: –0.2 <u>Weight (kg)</u> I: –1.4* C: 0	I: Increased physical activity and greater reduction in blood pressure. Best effects in men and those with hypertension treated with drugs	Medium

[1] Well-Integrated Screening and Evaluation for Women Across the Nation
* = Significant between the study groups, if not otherwise stated
I = Intervention group
C = Control group

Table 5.3 *Combined results from studies on preventing obesity in adults in a normal population.*

	Better in intervention group			No difference, intervention group compared to control group		Worse in intervention group		Total	
Study quality	**Studies**	**Number participants**	**% of all participants**	**Studies**	**Number participants**	**Studies**	**Number participants**	**Number studies**	**Number participants**
Medium	Kuller 2001 [4]	509		Giampaoli 1997 **P** [1]	2 064	Lupton 2003 **P** [11]	1 324		
	Peel 2001 [7]	613		Cook 2001 [2]	2 532				
	Engberg 2002 [9]	1 093		Nafziger 2001 **P** [6]	424				
	Lupton 2002 **P** [12]	1 685		Lamb 2002 [10]	188				
	Lingfors 2003 **P** [13]	1 928							
Total	5	5 828	47	4	5 208	1	1 324	10	12 360
Low	Andersen 2002 [8]	43		Miller 2001 [5]	188			2	231
Total	**6**	**5 871**	**47**	**5**	**5 396**	**1**	**1 324**	**12**	**12 591**

P = Population based

Table 5.4 *Combined results from studies on preventing obesity in adults with elevated risk for cardiovascular disease.*

Study quality	Better in intervention group			No difference, intervention group compared to control group			Worse in intervention group			Total	
	Studies	Number participants	% of all participants	Studies	Number participants	% of all participants	Studies	Number participants	% of all participants	Number studies	All participants
Medium	Muto 2001 [22]	302	8	WISE-WOMAN (Rosamond) 2000 [20]	1 203	31	van der Veen 2002 [24]	134	3		
	ODES (Anderssen) 2001 [17]	180	5	Ketola 2001 [21]	142	4					
	Nilsson 2001 [23]	89	2								
	ODAT (Ellingsen) 2003 [26]	1 232	32								
	Mattila 2003 [27]	635	16								
Total	**5**	**2 438**	**62**	**2**	**1 345**	**35**	**1**	**134**	**3**	**8**	**3 917**

Table 5.5 *Combined results from studies on preventing obesity in adults; included in the SBU literature reviews from 2004 and 2002.*

	Better in intervention group			No difference, intervention group compared to control group		Worse in intervention group		Total	
Study quality	**Studies**	**Number participants**	**% of all participants**	**Studies**	**Number participants**	**Studies**	**Number participants**	**Number studies**	**All participants**
2004	Kuller 2001 [4]	509		Giampaoli 1997 [1]	2 064	van der Veen 2002 [24]	134		
	Muto 2001 [22]	302		WISEWOMAN (Rosamond) 2000 [20]	1 203				
High and Medium	Nilsson 2001 [23]	89				Lupton 2003 [11]	1 324		
	ODES 2001 [17]	180		Cook 2001 [2]	2 532				
	Peel 2001 [7]	613		Ketola 2001 [21]	142				
	Engberg 2002 [9]	1 093		Nafziger 2001 [6]	424				
	Lupton 2002 [12]	1 685		Lamb 2002 [10]	188				
	ODAT 2003 [26]	1 232							
	Lingfors 2003 [13]	1 928							
	Mattila 2003 [27]	635							
Total	10	8 266	51	6	6 553	2	1 458	18	16 277
Low	Andersen 2002 [8]	43		Miller 2001 [5]	188	0		2	231
Total 2004	**11**	**8 309**	**51**	**7**	**6 741**	**2**	**1 458**	**20**	**16 508**
2002									
High and Medium	3	11 355		6	31 512	0		9	42 867
Low	1	211		2	2 103	1	2 206	4	4 520
Total 2002	**4**	**11 566**	**24**	**8**	**33 615**	**1**	**2 206**	**13**[1]	**47 387**
Total 2002 + 2004	**15**	**19 875**	**31**	**15**	**40 356**	**3**	**3 664**	**33**	**63 895**

[1] Two studies presented both cross-sectional and cohort analyses

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