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Costs of lifestyle interventions within health care and the amount of weight loss achieved

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Abstract

Costs of lifestyle interventions within health care and the amount of weight loss achieved

Lifestyle counselling in health care with respect to diet and physical activity can reduce body weight at reasonable costs. A weight loss of 5% after one year can be achieved at a cost of around €150 per patient (with an uncertainty range up to €300-€400). Each extra investment of €100 results in an additional loss of weight of one per cent. Extra investments above the €1000 do not result in more weight loss. The most effective interventions – where costs are kept constant - seem to be those in which a lower calorie diet is prescribed (and not only dietary advice), along with the possibility of behavioural therapy. These conclusions are based on 73 interventions described in 42 original articles; all interventions had a dietary and a physical activity component. Intervention costs were assessed according to a standard procedure and compared to the reported weight loss one year after an intervention had been started. Quality-related study characteristics such as participant drop-out did not have an effect on the outcome. The fact that more expensive interventions are associated with more weight loss most probably reflects higher intensities of more expensive interventions. Weight loss also appeared to be associated with intervention costs after two years, but the number of interventions for this analysis was low. Further research into the long-term health effects, interpersonal variation and optimal intervention is recommended. Although our study did not indicate that *supervised* physical activity is associated with more weight loss, physical activity remains important because of its relationship with other favourable health effects.

Key words: overweight, obesity, interventions, weight loss, health care, costs, diet, physical activity, behavioural therapy

Rapport in het Kort

Kosten van leefstijlinterventies binnen de gezondheidszorg en het bereikte gewichtsverlies

Leefstijlbegeleiding binnen de gezondheidszorg rondom voedings- en beweeggedrag kan het lichaamsgewicht tegen redelijke kosten verminderen. Een gewichtsverlies van 5% na een jaar kan bereikt worden met begeleidingskosten rond de €150 per patiënt (met een onzekerheidsrange tot €300-€400). Elke extra besteding van €100 levert een gewichtsvermindering van één procent op. Boven een bedrag van ongeveer €1000 leidt meer begeleiding niet tot extra gewichtsverlies. Begeleidingstrajecten waarin deelnemers een dieet met een verlaagde hoeveelheid calorieën wordt voorgeschreven (en niet alleen dieetvoorlichting krijgen) en waarin gedragstherapie wordt aangeboden lijken –bij gelijkblijvende kosten– het meest effectief.
Dit blijkt uit een analyse van 73 begeleidingstrajecten beschreven in 42 originele publicaties, die alle gericht waren op zowel voeding als bewegen. De kosten van de trajecten zijn op een gestandaardiseerde manier berekend en vergeleken met het gewichtsverlies na één jaar. Studiekenmerken die samen kunnen hangen met de kwaliteit van onderzoek, zoals uitval van deelnemers, hadden geen effect op de uitkomsten.
Dat duurdere begeleidingstrajecten tot meer gewichtsverlies leiden komt waarschijnlijk doordat de kosten zijn gerelateerd aan de intensiteit van het programma. Ook na twee jaar leek gewichtsverlies samen te hangen met de programmakosten, maar het aantal begeleidingstrajecten in deze analyse was laag. Er is verder onderzoek nodig naar de gezondheidseffecten op lange termijn, variatie tussen personen en het optimale programma. Ondanks dat de huidige analyse er niet op wijst dat bewegen *onder begeleiding* meer gewichtsverlies oplevert, blijft lichaamsbeweging belangrijk omdat dit andere gunstige gezondheidseffecten kan hebben.

Trefwoorden: overgewicht, obesitas, interventies, gewichtsverlies, gezondheidszorg, kosten, voeding, lichamelijke activiteit, gedragstherapie

Preface

This report was produced by the centre for Prevention and Health Services Research of the Dutch National Institute for Public Health and the Environment, within the 'prevention overweight'- project, as issued by the Dutch Ministry of Health, Welfare and Sports[1].
This report presents an in-depth analysis of the costs and effects of more than 70 international interventions aimed at prevention of overweight; organised within a health care setting. Further research will focus on the effects, costs and reach of interventions in other settings.

Wanda Bemelmans,
Project leader.

[1] Within programme 2 'Policy Support Public Health and Health Care' ('Beleidsondersteuning Volksgezondheid en Zorg')

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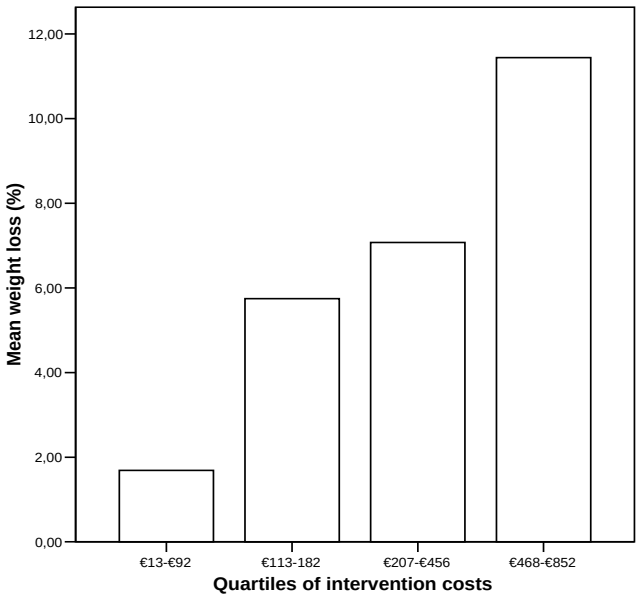
Samenvatting

Kernboodschap
Het is effectief en relatief goedkoop om patiënten te adviseren over hun voedings- en beweeggedrag met als doel gewichtsverlies. Een klinisch relevant gewichtsverlies van 5% kan bereikt worden voor een bedrag van rond de €150 per patiënt (met een onzekerheidsrange tot €300-€400). Voor elke extra besteding van €100 per persoon is een gewichtsvermindering van ongeveer 1% te verwachten. Dit geldt tot een bedrag van ongeveer €1000, waarboven weinig extra gewichtsverlies lijkt op te treden. Dit rapport presenteert één van de eerste uitgebreide analyses over kosten en effecten van interventies gericht op gewichtsvermindering.



Gemiddeld gewichtsverlies (in %) per kostencategorie.
1: €13 – €92 (n=15); 3: €207 – €456 (n=15);
2: €113 – €182 (n=15); 4: €468 – €852 (n=16)

Een nadere beschouwing van de interventies wees uit dat –onafhankelijk van de kosten– interventies waarin een energiebeperkt dieet wordt voorgeschreven en waarin deelnemers gedragstherapie volgen meer effect sorteren dan interventies zonder deze componenten. Het aanbieden van een beweegprogramma onder toezicht lijkt niet te leiden tot meer gewichtsverlies na een jaar, vergeleken met de interventies zonder een begeleid beweegprogramma. Voor dit laatste punt was de statistische 'power' van de analyse echter laag.

Resultaten na twee jaar voor 18 interventies suggereren nog steeds een verband tussen kosten en gewichtsverlies. Verder wetenschappelijk onderzoek is nodig naar de (gezondheids)effecten op langere termijn, de additionele kosten die nodig zijn voor langdurig behoud van het gewichtsverlies, de verschillen tussen personen (o.a. om specifieke doelgroepen te kunnen onderscheiden) en de optimale interventiemix.

Beleidsrelevantie
Dit rapport maakt duidelijk dat het begeleiden van patiënten rond hun leefstijl kan leiden tot een klinisch relevant gewichtsverlies na een jaar. Bijkomend voordeel is dat andere positieve gezondheidseffecten te verwachten zijn van het verbeterde eet- en beweeggedrag. De kosten zijn laag – rond de €150 in het eerste jaar; zeker in vergelijking met gewichtsreducerende medicatie. Deze kost rond de €75 per maand en leidt tot een vergelijkbaar gewichtsverlies na een jaar (echter zonder de positieve neveneffecten van een verbeterde leefstijl).
Het verdient daarom aanbeveling om de mogelijkheden te inventariseren voor uitgebreidere implementatie van leefstijlbegeleiding binnen de reguliere gezondheidszorg. In onderstaand kader staat een fictief voorbeeld van een interventie die €150 per persoon kost.

*Mogelijke inhoud van een interventie van €150**

- duur interventie: 6 maanden
- 45 minuten individuele bijeenkomst met een diëtist
- maandelijks een uur voedingsinstructie door een diëtist in een groep van 10 patiënten
- maandelijks een uur gedragstherapie door een psycholoog in een groep van 10 patiënten
- twee uur beweeginstructie door een fitness-instructeur in een groep van 10 patiënten
- ondersteunend materiaal à €35 per patiënt

* Dit is een voorbeeld gemaakt op basis van kosten van interventiecomponenten zoals beschreven in Appendix D; voor het vaststellen van de optimale inhoud van een interventieprogramma is nader onderzoek nodig.

Methoden

De analyses zijn gebaseerd op 80 recente interventies afkomstig uit 49 artikelen[2], die werden geselecteerd uit zes overzichtsartikelen. Het tekstblok presenteert de inclusiecriteria.

Inclusiecriteria voor artikelen/interventies

- het artikel rapporteert lichaamsgewicht en/of BMI aan het begin van de interventie en een jaar en/of twee jaar na aanvang van de interventie
- de interventie is gericht op verandering van zowel voedings- als beweeggedrag
- de interventie vindt plaats binnen de gezondheidszorg of bij mensen met overgewicht, en/of is uitgevoerd door personeel uit de gezondheidszorg
- de publicatiedatum van het artikel is 1 januari 1990 of later
- het artikel verschaft voldoende informatie om de kosten van een interventie te kunnen bepalen op een gestandaardiseerde manier
- de interventie bevat géén medicatie of operatie

De kosten van een interventie zijn afhankelijk van de intensiteit en duur van een interventie. Van elke interventie werden op gestandaardiseerde wijze de kosten berekend per jaar dat de interventie duurde. Dit werd gedaan door voor materiaalkosten en personeelskosten steeds dezelfde eenheidsprijzen te hanteren. De kosten in het eerste jaar werden vervolgens gerelateerd aan de effecten één jaar na aanvang van de interventies.

Nuancering

De analyses wezen uit dat de kosten gerelateerd zijn aan het percentage gewichtsverlies na een jaar, waarschijnlijk omdat de kosten de intensiteit van de begeleiding weergeven. Hierbij is uitvoerig nagegaan of deze relatie beïnvloed wordt door inclusie van onderzoek met een lagere kwaliteit, bijvoorbeeld door hoge uitval van deelnemers of een laag aantal patiënten. Op basis van diverse analyses werd geconcludeerd dat studiekwaliteit geen belangrijke rol speelt in de relatie tussen kosten en gewichtsverlies. Echter, uitsluiting van bepaalde soorten onderzoeken had wel invloed op de geschatte kosten voor een gewichtsdaling van 5%, die dan op kunnen lopen naar €300 à €400. Dit is dan wel weer gebaseerd op minder interventies en bovendien lagen de kosten voor een gewichtsdaling van 10% consistent rond de €700, ongeacht de selectie naar type onderzoek.
Een ander aandachtspunt betreft de berekening van de kosten, waarbij uitgegaan werd van volledige deelname aan de interventieonderdelen. De werkelijk gemaakte kosten per

[2] Hiervan werden voor 73 interventies beschreven in 42 artikelen resultaten na één jaar gerapporteerd.

deelnemer in relatie tot gewichtsverlies kunnen zowel hoger als lager uitvallen als deelnemers voortijdig stoppen met een programma of minder consulten bezoeken dan aangeboden. Verder moet bedacht worden dat de resultaten werden behaald bij deelnemers aan een wetenschappelijk onderzoek, met een bepaalde mate van gemotiveerdheid. Mogelijk wijken de resultaten in de 'echte praktijk' wat af. Daarnaast betreft het hier de *gemiddelde* kosten die gemaakt worden voor een *gemiddeld* gewichtsverlies van 5%. Dat wil dus niet zeggen dat íedereen die de interventie krijgt aangeboden inderdaad ook dit gewichtsverlies bereikt.
Het feit dat *begeleide* beweegprogramma's niet tot extra gewichtsverlies leken te leiden, wil niet zeggen dat lichaamsbeweging geen rol speelt. Er moet op gewezen worden dat in alle interventies in meer of mindere mate lichaamsbeweging gestimuleerd werd. Bovendien is uit de literatuur bekend dat lichaamsbeweging een rol kan spelen bij het behoud van gewichtsverlies en dat bewegen diverse andere gunstige effecten op de gezondheid heeft. Daarnaast was door het kleine aantal interventies met een begeleid beweegprogramma de statistische 'power' voor dit onderdeel van de analyses laag.
Tot slot is niet helemaal duidelijk of het verband tussen interventiekosten en gewichtsverlies op lange termijn blijft bestaan of dat het verloren gewicht er weer bijkomt. We wijzen er echter op dat een periode van een jaar al geldt als een 'lange termijn' in een proces van afvallen/gewichtsbehoud. Bovendien leek het erop dat bij interventies met een relatief groot gewichtsverlies na een jaar, ook na twee jaar het gewichtsverlies nog relatief groot was. Er moet echter wel op worden gewezen dat voor een langdurig behoud van het gewichtsverlies extra investeringen nodig kunnen zijn.

Conclusie
Het is effectief en relatief goedkoop om patiënten te adviseren over hun voedings- en beweeggedrag met als doel gewichtsverlies. Een klinisch relevant gewichtsverlies van 5% kan bereikt worden voor een bedrag van rond de €150 per patiënt. Voor elke extra besteding van €100 per persoon is een gewichtsvermindering van één procent te verwachten, tot een bedrag van ongeveer €1000. Interventies waarin een energiebeperkt dieet wordt voorgeschreven en waarin gedragstherapie wordt aangeboden, lijken –bij gelijkblijvende kosten– het meest effectief te zijn. Hoewel het onderzoek niet aantoonde dat lichaamsbeweging onder begeleiding leidt tot extra gewichtsverlies, blijft het stimuleren van lichamelijke activiteit zonder meer belangrijk, vanwege andere gunstige gezondheidseffecten.

Aanbevelingen
- Inventarisatie van mogelijkheden voor uitgebreidere implementatie van leefstijlbegeleiding binnen de reguliere gezondheidszorg;
- Verder wetenschappelijk onderzoek naar de (gezondheids)effecten op langere termijn, de kosten die nodig zijn voor langdurig behoud van het gewichtsverlies, de verschillen tussen personen (onder andere om specifieke doelgroepen te kunnen onderscheiden) en de optimale interventiemix.

1. Introduction

The prevalences of obesity are increasing worldwide and reversing the current trends belongs to the targets of health policy in many countries. Overweight (body mass index [BMI] 25-30) and obesity (BMI≥30) are important risk factors for the development of type 2 diabetes mellitus, coronary heart diseases, and other chronic diseases (1), and increase the number of life years with disabilities and medication use (2). Successful preventive strategies and treatment of overweight therefore are likely to result in lower incidences of these diseases. Physical inactivity and an unbalanced dietary energy intake contribute to the development of overweight (3). Interventions targeted at influencing these behaviours may therefore succeed in decreasing body weight in the longer term.
In literature many interventions have been described which were organised within a health care setting. Most of these interventions are aimed at influencing lifestyle and incorporate a dietary and physical activity component in their program, and many include behavioural therapy.

Example of the content of an intervention [a]

Diet:	Diet calculated to contain approximately 20% of the energy from fat and with a relatively high fibre content. The recommended portion sizes were calculated to give a daily energy intake of 7.6 MJ in men and 6.3 MJ in women.
Exercise programme:	Aerobic physical exercise of low to moderate intensity daily for 2.5 h, e.g. brisk walks, gymnastics, cycling and swimming.
Behavioural therapy:	Useful and health promoting coping strategies together with stress management and relapse prevention techniques. Participants were stimulated to make detailed plans on how to incorporate new and healthier habits in everyday life.

[a] Reference: Lindahl B, Nilsson TK, Jansson JH, Asplund K, Hallmans G. Improved fibrinolysis by intense lifestyle intervention. A randomized trial in subjects with impaired glucose tolerance. J Intern Med. 1999;246(1):105-112.

Several reviews (4, 5) concluded that such interventions can be effective in reducing weight. The individual interventions as included in these reviews varied largely in terms of effects and approach (e.g., diet, physical activity, behaviour therapy), intensity, duration and health care provider. Furthermore, in health care policy the decisions about organising care are not based solely on the effects of potential interventions, but also on the costs, which depend on the intensity and the duration of an intervention. With respect to costs, limited information is available for these types of behavioural interventions targeted at weight reduction, and it is recommended that the cost-effectiveness of intervention programs be evaluated (6).
The primary objective of the present report is to investigate the relationship between the costs and the weight changes in recently published behavioural interventions, performed in a health care setting or in overweight people (secondary prevention). For this, the costs of 80 interventions described in 49 articles[3] were calculated in a standardised way. A secondary objective was to explore the variation in effects of interventions with similar costs, in order to obtain

[3] Intervention and control conditions within an article were considered as separate interventions. The effects and costs of each intervention group were assessed. For 73 interventions (42 articles) weight changes after one year were reported.

insight in the optimal intervention characteristics. Weight changes were evaluated as the average loss in body weight one year after the start of an intervention.

2. Methods

2.1 Selection of interventions

The selection of interventions was based on six literature reviews (see Table 1) which included interventions specifically targeted at weight reduction or interventions likely to result in weight loss. Further details on inclusion criteria of these reviews can be found in Appendix A. From the reviews we selected studies that fulfilled the following inclusion criteria:

- the article reports on body weight and/or BMI at baseline and either one year or two years after the start of the intervention;
- the intervention incorporates both a dietary and physical activity component;
- the intervention is carried out in a health care setting or in an overweight population and/or is carried out by health care professionals;
- the publication date of the article is 1 January 1990 or later;
- the article provides sufficient information to estimate costs of an intervention in a standardised way.

Interventions were excluded if they incorporated pharmacological or surgical treatment. A total of 49 original articles (describing 80 interventions) were selected. These articles described weight loss after one year for 73 'interventions' (42 articles), and weight loss after two years for 27 interventions (21 articles). Seven interventions (seven articles) reported weight loss after two years but not after one year. Table 1 shows the topics of the reviews and the number of articles from each review that were included in the present analysis. An example of a study that was excluded is a study described by Elder et al. (7). In this intervention obese persons were referred to community agencies which were not included in the protocol, and therefore not all the costs for the obese could be calculated. None of the interventions from the review by Eakin et al. fulfilled our inclusion criteria.

Table 1. Reviews used for the selection of interventions

Author	Years search	Topic	N articles in reviews	N articles in present report
McTigue et al. (8)	1994-2003	Screening and interventions for obesity in adults	18	10
Anderson et al. (4)	1970-1999	Long-term weight loss maintenance	29	10
Avenell et al. (9)	1966-May 2001	Obesity treatment in adults	51[a]	27
Wilcox et al. (5)	1980-2000	Effects of lifestyle counselling in health care on CVD risk factors	39	4
Eakin et al. (10)	1980-1998	Primary care-based interventions for increasing physical activity	15	0
Ashenden et al. (11)	up to May 1995	Effects of lifestyle advice provided in a general practice setting	12	2
Total[b]				49

[a] excluding articles about surgery and pharmacological interventions.
[b] four studies were reported in two reviews.

Appendix B presents a list of the original articles which were included for the present study. Since not all articles included a 'control group' and because of the variety in control groups (e.g. usual care or a less intensive intervention) weight changes were considered *within* groups that received an intervention, and not between groups. In the text box an example of the selection of interventions, and subsequent methodology, is presented.

Example of the selection of interventions from an article

Aim of study:	Comparing the effects of an intensive lifestyle program (intervention group) to a leaflet with health information (control group)
Number of interventions:	Two interventions included for present report
Methodology:	a) calculating costs of the intervention for each group; b) assessing amount of weight loss after one year, as compared to baseline, for both groups. For example, the intervention group may have lost 5% of their initial weight, on average, and the control group may have lost 1% after one year.

If a control group was used in a study the above listed inclusion criteria were also applied. For example, if a group of patients received only a pamphlet with health information, this information had to concern diet and physical activity to be included.

2.2 Outcome measures

The primary outcome measure was the change in weight from baseline to post-intervention, with a minimum of one year follow-up. Change in weight was calculated as the percentage of weight change from baseline to follow-up. Most articles reported weight changes for the participants for whom weight loss data were available after the intervention –excluding participants who dropped out during the study period– and therefore results were extracted for participants who completed both baseline and follow-up measurements if this information was available.

2.3 Assessment of intervention costs

In assessing costs of an intervention a distinction can be made between fixed and variable costs. The fixed costs do not depend on the number of persons in an intervention programme, and include for example the training of the health care provider. In our report only the fixed costs for providing group sessions during an intervention were considered, but further fixed costs were not considered because of insufficient information about these costs in literature. For example, the time used to develop and start an intervention is usually not mentioned in the literature. Furthermore, it is difficult to allocate such fixed costs to individual patients. Hence, our report was limited to the variable costs, which consist of material costs (i.e. costs for materials for the patients such as a training manual) and labour costs (i.e. the salary of the health care providers if patients are counselled individually). Thus, the calculated costs only included costs for (broader) implementation of the intervention. Further, we assumed an optimal implementation of the intervention. This means that e.g. subjects participate in all sessions that are offered and use all the materials. We calculated the costs per percent weight

loss per participant who started an intervention. This is equivalent to the *planned* intervention costs per person.
The present study is a cost-outcome description (see Drummond et al. (12)) in which intervention costs were compared to weight loss. The intervention costs included direct health care costs but for some interventions also essential direct non-health care costs were included. These were costs of meal replacements such as Modifast, which may or may not be paid by the patients themselves.

For calculating intervention costs, resource use (volumes) and unit prices of these resources were determined. Details about resource use and the content of the interventions were retrieved from the papers. Examples of resource use are the time that a moderator spends on a group session and the amount of group sessions in a certain intervention. Authors of the original papers were contacted in case of uncertainties about the precise content of the programmes. For example, uncertainties could remain about the exact duration of consults, the type of health care provider or the exact number of persons participating in group sessions. However, despite our enquiries assumptions about some of these issues had to be made to calculate costs. The assumptions made per intervention are described in Appendix C. Subsequently, resource use had to be multiplied by unit costs. The costs of interventions were calculated in a standardised way. Hence, the same costs were attributed to similar components of different interventions, e.g., an equal salary was attributed to a dietician in intervention A and one in intervention B. Standard cost prices per unit are described in Appendix D.
The costs of an intervention were expressed as costs per participant and were calculated for the first, second, third et cetera year that an intervention lasted. In addition to the costs per year, cumulative costs were calculated until the end of each year of follow-up. All costs were calculated in 2004 euros and were rounded off to the nearest euro.

2.4 Statistical analysis

2.4.1 Overview

The key characteristics of the interventions were entered into a database. Subsequently, the data were analysed in three phases:

Step 1: quality examination of research → exclusion of low quality research;
Step 2: primary analysis → association between costs of interventions and amount of weight loss after one year;
Step 3: secondary analysis → impact of intervention characteristics on outcome;

More detailed information about these steps is provided in the next paragraphs.

2.4.2 Step 1: quality of research

With respect to research trials, a study is considered as ‘high quality’ when the number of participants is high (‘sufficient power’), loss to follow-up is low, and participants are randomly allocated to treatment conditions[4]. The characteristics of a study or the quality of a research design may confound the relationship between the costs of interventions and the amount of weight loss after one year. For example, the same intervention could lead to different outcomes if the effects are investigated in study populations which have a different motivation to lose weight.

[4] Another quality criterium is that researchers and interveners are blinded to the condition of the participants. Since this is not possible for research on the effects of lifestyle counseling this criterium was not considered.

In step 1 the potential confounding effects of the following study characteristics were investigated: the study size, drop-out (attrition) of participants during the study ('loss to follow-up'), randomised controlled trial (RCT) versus other (non-randomised or non-controlled trial), recruitment of study population (volunteers as attracted by media attention or inclusion in health care procedures) and the use of self-reported body weight vs. measured body weight. For attrition we used the percentage of participants that was assessed at one year, i.e. 100% - % attrition.
Potential confounding by study characteristics was examined in a few steps, because it turned out that study characteristics, intervention costs and weight loss were interrelated. First, correlation coefficients between study characteristics, weight loss and intervention costs were calculated. Second, using linear regression analysis, the influence of study characteristics on weight loss adjusted for intervention costs was determined per study characteristic (univariate analyses). Third, in a multivariate model with a stepwise elimination procedure the most influential study characteristics in addition to intervention costs were identified. Fourth, this analysis was repeated after adding baseline weight to the model. Regression coefficients for intervention costs from the various univariate and multivariate models were compared and associations between weight loss and the most influential study characteristics were explored graphically. To finally determine if study characteristics confounded the association between intervention costs and weight loss, interventions with a high drop-out percentage were excluded and the regression coefficient for costs was compared with the coefficient from the analysis which included these interventions.

2.4.3 Step 2: association between weight changes and costs

The primary analysis, as performed during step 2, was focused on the association between weight changes and costs of interventions. Some articles reported results for men and women separately. Therefore, it was first checked whether the relationship between intervention costs and weight changes was the same for men and women. This turned out to be the case, and therefore data were used for men and women combined. If combined results were not reported the results were pooled.
The relationship between costs and effects of interventions was graphically explored in scatter plots. Correlation coefficients between costs and weight changes were calculated, and linear regression analysis was used to estimate the weight change associated with an increase in intervention costs of €100 per person. The regression model was adjusted for body weight at baseline. The costs were also categorised and the mean weight change per category depicted in a bar chart. Since the large majority of studies reported weight changes one year after baseline, the above mentioned analyses were performed for the one-year weight changes. One year was defined as being between 0.75 and 1.25 years.

2.4.4 Step 3: influence of intervention characteristics

Finally, in step 3 it was examined which intervention characteristics were associated with higher weight reduction while the costs remained the same. Analyses were done per quartile of intervention costs, so that interventions could be compared with respect to their characteristics irrespective of intervention costs (intensities). Cross-tabulations and t-tests were performed to assess if weight changes differed between interventions with the following content:

- containing a prescribed diet, i.e. subjects were required to consume a limited, defined amount of energy (e.g., a very-low-calorie diet (VLCD)), and were not just encouraged to reduce their energy intake;
- containing a supervised exercise programme, e.g., participants trained in the presence of an exercise trainer;

- containing a behavioural therapy programme;
- individual and/or group meetings.

An example of an intervention that contained all of the above components is shown in the text box below.

Example of the content of an intervention [a]

Prescribed diet:	Individualised moderately energy restricted diet designed to reduce usual energy intake by 500 kcal with a minimum intake of 1000 kcal/24 h.The diet prescription was composed of 50-55 energy per cent (En %) carbohydrate, approximately 25 g fibre, 30 En % fat, emphasising the use of unsaturated fat and the reduction of dietary cholesterol below 300 mg/day, and 15 En % protein.
Supervised exercise programme:	Three periods of 3-month duration each, in a group format, with five to six patients, led by two physiotherapists. Sessions consisted of a 5-min warm-up period, followed by training on a bicycle ergometer for 30 min at an intensity of 60-80% of maximal heart rate. During the final 30 min a variety of sports activities were performed followed by a 5-min cool-down period.
Behavioural therapy:	Behavioural modification sessions conducted in a group format, with 8 to 10 patients, led by a psychologist experienced in eating disorders. Behavioural strategies taught included self-monitoring, stimulus control techniques, self-reinforcement, cognitive restructuring approaches, and relapse prevention methods.

[a] Reference: Blonk MC, Jacobs MAJM, Biesheuvel EHE, Weeda-Mannak WL, Heine RJ. Influences on weight loss in type 2 diabetic patients: little long-term benefit from group behaviour therapy and exercise training. Diabet Med. 1994;11(5):449-457

2.4.5 Relationship between costs and weight loss after two years

For those interventions that reported second year outcomes, results for two years after baseline were graphically explored, and regression analysis was used to estimate the relationship between costs of an intervention and weight loss.
As an indication of what part of the budget was spent in the second year, the costs that were spent in the second year were divided by the total costs in the first two years and multiplied by 100 to obtain a percentage. These percentages were tabulated to examine if the spreading of the intervention costs over the years influenced the weight loss after two years.

2.4.6 Success rate

For some interventions the success rate was reported, that is the percentage of the participants who lost 5% or 10% of their initial weight. Since the number of interventions reporting the success rate was low, this information was only tabulated and no further statistical analysis was performed.

3. Results

The analysis was limited to 62 interventions costing < €1000, as this was the range in which the cost – weight change curve was linear (see section 3.2), and another intervention was excluded because this was an outlier in the regression analyses (see section 3.2). Thus, the final sample included 61 interventions.

3.1 Quality of research

The mean number of participants at baseline was 190, ranging from eight to 3440 participants. The mean drop-out percentage was 18%, ranging from zero to 49%. Of the 61 interventions, 26 were performed within a randomised controlled trial design. For 32 interventions the population was recruited via the media (e.g., via newspaper adds), and for 13 interventions recruitment was done via the health care system. Since no studies used self-reported weights after one year of follow-up, this was not further considered as a confounding factor[5]. Appendix E shows the characteristics of the studies.

Several study characteristics which potentially could influence weight changes were correlated with each other (Table 2).

Table 2. Spearman correlation coefficients[a] between intervention costs, weight changes, study size and drop-out (n=61)

	Intervention costs in first year	**Weight loss (%)**	**Mean weight at baseline**	**No. participants at baseline**
Weight loss (%)	0.64*			
Mean weight at baseline	0.37*	0.64*		
N participants at baseline	-0.17	-0.39*	-0.41*	
Percentage assessed at measurement year	0.11	-0.03	0.12	-0.04

* $p<0.01$.

[a]: a negative association means that higher values of one variable are associated with lower values of the other variable.

Table 2 shows that higher costs (i.e. intensities) of an intervention were associated with more weight loss. Table 2 further shows that a larger study size is associated with a lower mean body weight at baseline, and less weight loss after one year. The drop out rate (percentage assessed) was not associated with the other characteristics.

Univariate regression models showed that the study design (randomised controlled trial [RCT] vs. non-RCT) and the study size (number of participants at baseline) were significantly associated with weight changes (in addition to costs; see Appendix I-1). RCTs and larger studies were associated with less weight loss.

A stepwise regression analysis in which all study characteristics and costs were considered simultaneously yielded study design as a significant study characteristic. With respect to study design, the mean percentage weight loss observed in RCTs was 3.1% (t-test, p=0.005)

[5] After 2 or more years of follow-up five studies used self-reported body weight;

lower than in non-RCTs. However, the effect of adjustment for study design on the regression coefficient for intervention costs was marginally (the coefficient changed from -0.013 to -0.012 after this adjustment; Appendix I-1). Study size and drop-out percentage were also plotted against weight changes (Appendices I-3 and I-4) to visualise the association with weight changes; inspection of the plots did not suggest an association with weight changes.

When baseline weight was added to the set of predictors (model B in Appendix I-2) and a stepwise selection procedure was done again, the percentage of the participants that was assessed was selected in the final model (Appendix I-2). After exclusion of five interventions with the highest drop-out percentage (results not shown), the coefficients for intervention costs (with and without adjustment for baseline weight) did not change.

Based on the plots and the small influence on the regression coefficient for intervention costs of adding study characteristics to the model, it was decided that study characteristics did not substantially change the relationship between intervention costs and weight changes. However, it must be emphasised that study characteristics, intervention costs and weight changes were highly interrelated. Therefore, the primary analysis was also performed in a selection of articles where the quality of research can be considered as high, i.e. RCTs only and studies with N>60 only.

3.2 Association between weight changes and costs

Figure 1 plots the relationship between the estimated costs made in the first year of the intervention and the percentage weight reduction one year after the start of the programme for 73 interventions. Inspection of scatter plots with various ranges of costs revealed that the relationship between costs and weight changes was linear up to €1000 (Figure 2). Therefore further analyses were done in this cost range, which included 62 interventions. Examples of extremely expensive interventions were those by Hakala, consisting of a two week in-patient treatment in a rehabilitation research centre, and by Torgerson, which used many individual appointments with health care providers. One intervention (Narayan 2) was excluded because this interventions were outliers, so that the analysis was based on 61 interventions.

The interventions that were included are summarized in appendices E and F. The mean baseline weight was 91 (SD 11) kg. The mean costs made after one year amounted to €290 (SD €239) and the mean percentage weight reduction at one year was 6.6 (5.2), ranging from a 21% reduction to a one percent increase in weight. Pearson's correlation coefficient for the correlation between intervention costs and weight changes was -0.60, and Spearman's r was -0.64. Linear regression analysis (Table 3) showed that after adjustment for baseline weight, each increase in costs of €100 was associated with an extra weight reduction of 1.0% (95% CI: 0.6% – 1.4%). The model explained 59% (=adjusted R^2) of the variation between interventions in the percentage weight change. Models based on various selections of interventions yielded similar estimates for the relationship between weight changes and intervention costs.

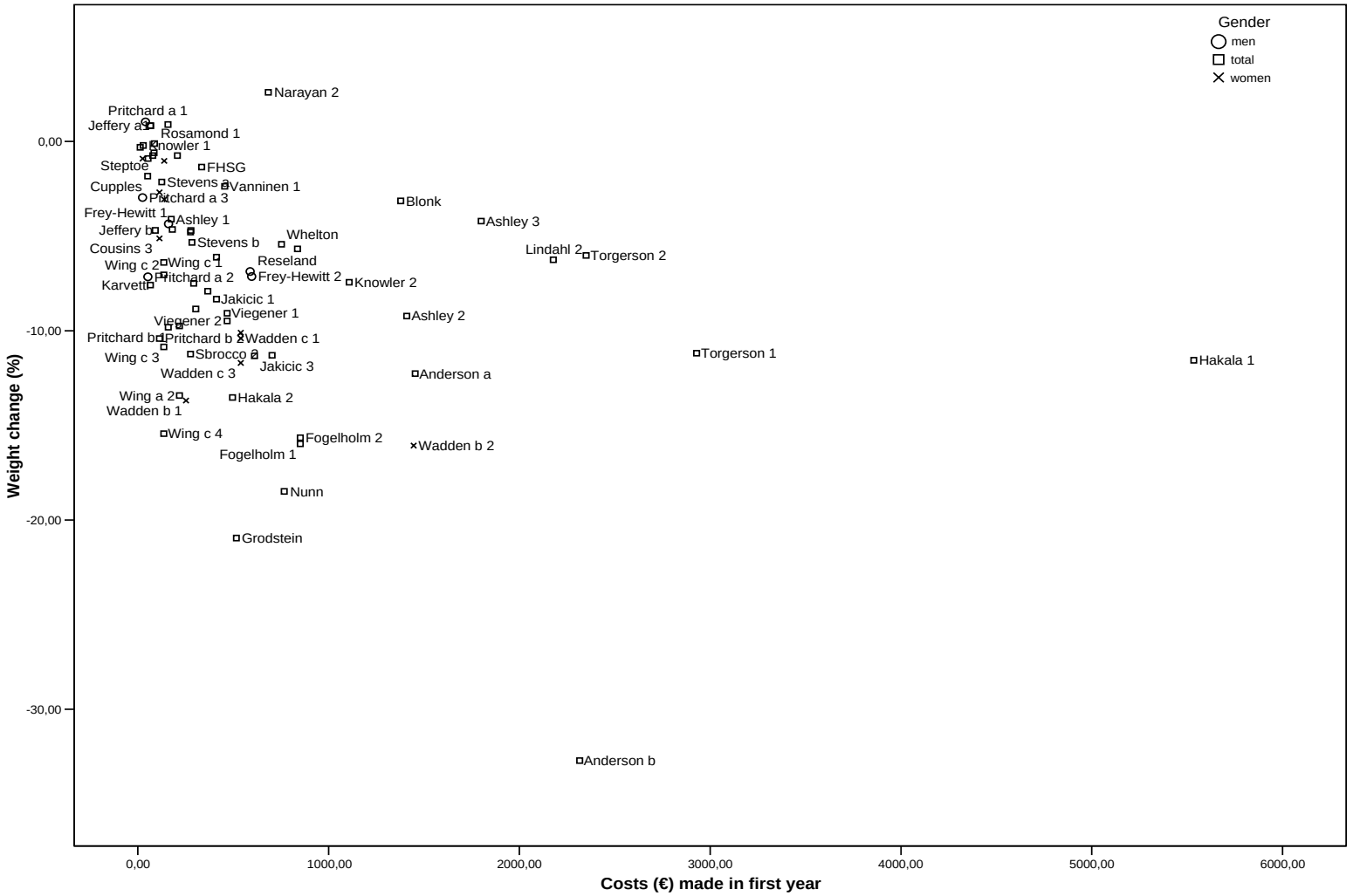


Figure 1. The relationship between costs of an intervention and percentage change in weight one year after the start of an intervention (n=73)

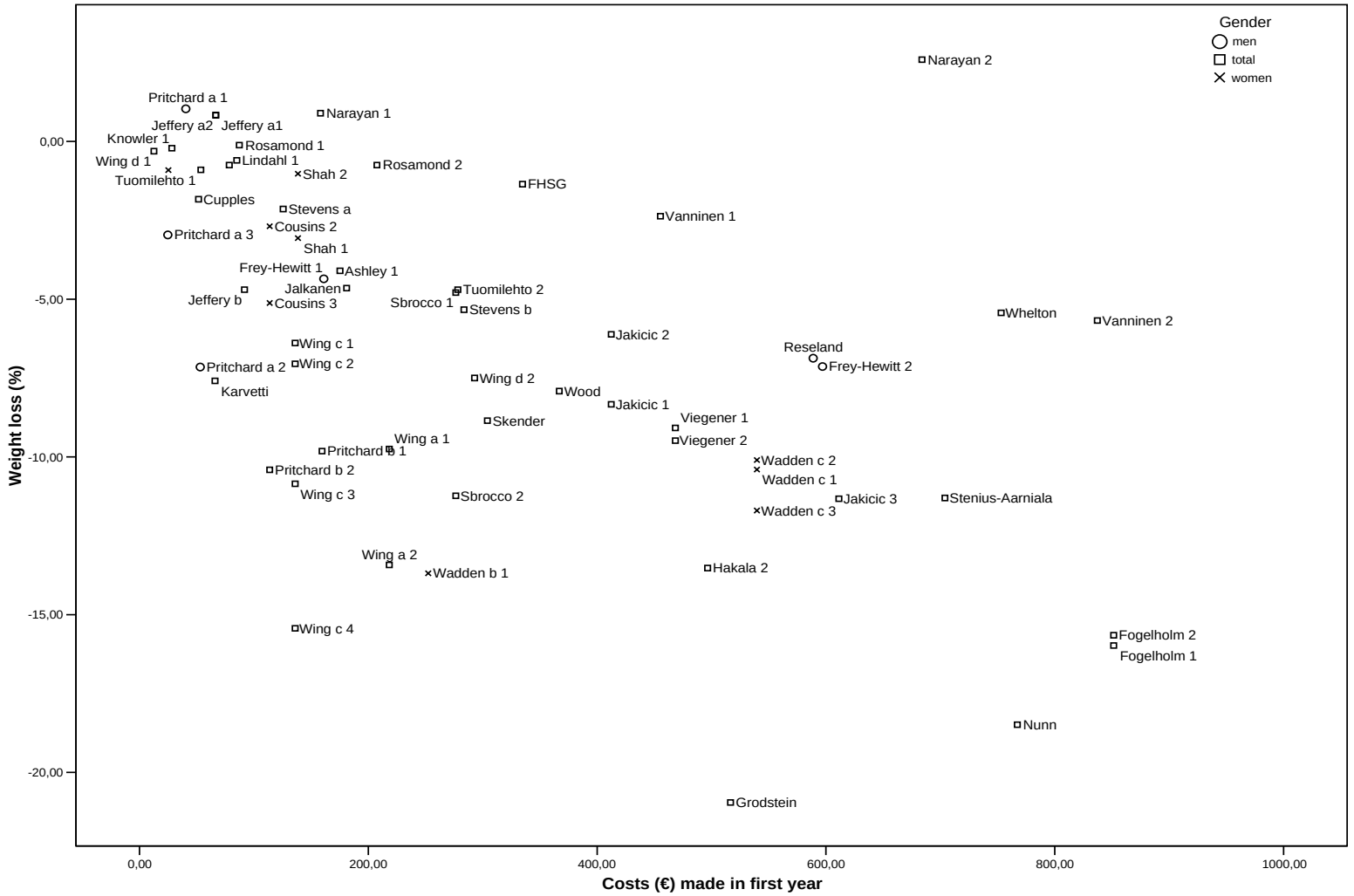


Figure 2. The relationship between costs of an intervention and percentage change in weight one year after the start of an intervention for those interventions costing less than €1000 per person (n=62)

Table 3. The relationship between intervention costs and percentage weight reduction after one year for interventions below €1000

Model	No. interventions	% Weight loss per increase of €100	95% Confidence Interval	Adjusted R^2 of model
Adjusted for baseline weight	61[a]	1.0	0.6 – 1.4	0.59
Unadjusted	61[b]	1.3	0.9 – 1.8	0.35
Excluding drop-out > 40%[c]	56	1.0	0.6 – 1.4	0.61
RCTs only [c]	26	1.1	0.7 – 1.6	0.65
N baseline > 60 [c]	21	0.9	0.0 – 1.9	0.58

[a] the weight loss per €100 increase was 0.7% and the R^2 was 0.41 when two outliers were included in the analysis.
[b] the weight loss per €100 increase was 1.1% and the R^2 was 0.18 when two outliers were included in the analysis.
[c] adjusted for baseline weight.

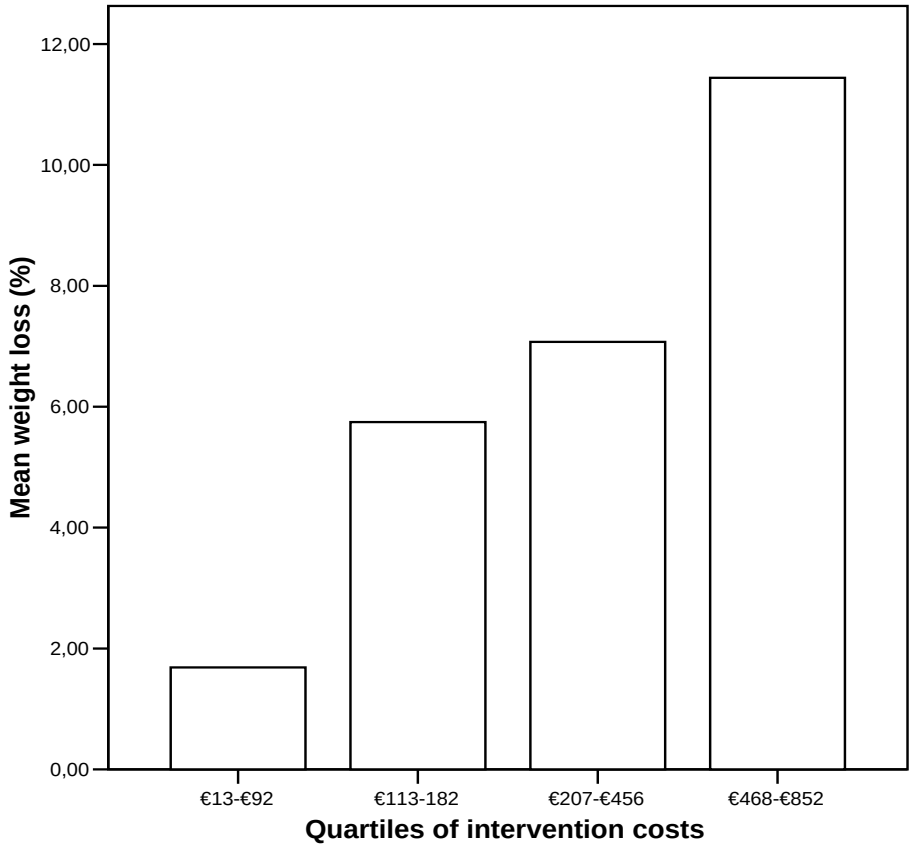


Figure 3. Percentage weight reduction at one year per quartile of intervention costs 1: €13 – €92 (n=15); 2: €113 – €182 (n=15); 3: €207 – €456 (n=15); 4: €468 – €852 (n=16)

Figure 3 shows the mean weight reduction for quartiles of intervention costs. The mean weight reduction was higher in higher quartiles of intervention costs. Interventions costing €113 – €182 (mean €142) showed a mean (SD) weight loss of 5.8 (4.3) %. After the most expensive interventions (mean €633) participants lost more than 10% of their weight. This general picture was similar when the mean weight loss was calculated for the same cost categories for RCTs and larger (>60 participants) studies only (Table 4). Differences in

weight loss between the second and third categories were small; programmes costing €207 – €456 also were associated with a weight loss around 5%.

Table 4. Mean costs and effects in different cost categories, for randomised controlled trials and studies with a large study size

		Cost category							
		€13 – €92		**€113 – €182**		**€207 – €456**		**€468 – €852**	
All studies	N	15		15		15		16	
	Mean (SD) costs	55	(25)	142	(21)	306	(76)	633	(139)
	Mean (SD) effect	1.7	(2.7)	5.8	(4.3)	7.1	(4.0)	11.4	(4.5)
RCTs	N	13		5		3		5	
	Mean (SD) costs	56	(22)	139	(30)	299	(31)	728	(130)
	Mean (SD) effect	1.9	(2.9)	3.8	(1.3)	3.8	(2.1)	10.2	(5.2)
Study size>60	N	9		5		5		2	
	Mean (SD) costs	65	(19)	135	(17)	294	(61)	635	(167)
	Mean (SD) effect	1.2	(2.6)	5.3	(4.5)	4.0	(3.0)	13.2	(11.0)

3.3 Influence of intervention characteristics

Appendix F presents several characteristics of the intervention programmes. In 18 of the 61 interventions (30%) a specific reduced-energy diet was prescribed, and in 10 interventions (16%) participants followed an exercise program under supervision. Thirty-seven (61%) interventions included some form of behavioural therapy in their programme. The intervention included only individual activities in 16 (26%) interventions, included only group sessions in 29 (48%) interventions and both individual and group sessions in 16 (26%) interventions.

Table 5. Percentage weight loss for interventions with or without certain components in the programme, per cost quartile

Intervention component		**Cost category**							
		€13 – €92		**€113 – €182**		**€207 – €456**		**€468 – €852**	
		N[a]	**%change**	**N[a]**	**%change**	**N[a]**	**%change**	**N[a]**	**%change**
Specific reduced-energy diet prescribed	no	15	1.7	10	4.2	12	6.3	6	10.6
	yes	0	n.a.	5	8.8	3	10.2	10	11.9
Exercise programme under supervision	no	15	1.7	15	5.7	11	7.3	10	11.2
	yes	0	n.a.	0	n.a.	4	6.4	6	11.8
Behavioural therapy	no	11	1.7	5	5.6	5	3.4*	3	8.7
	yes	4	1.7	10	5.8	10	8.9*	13	12.1

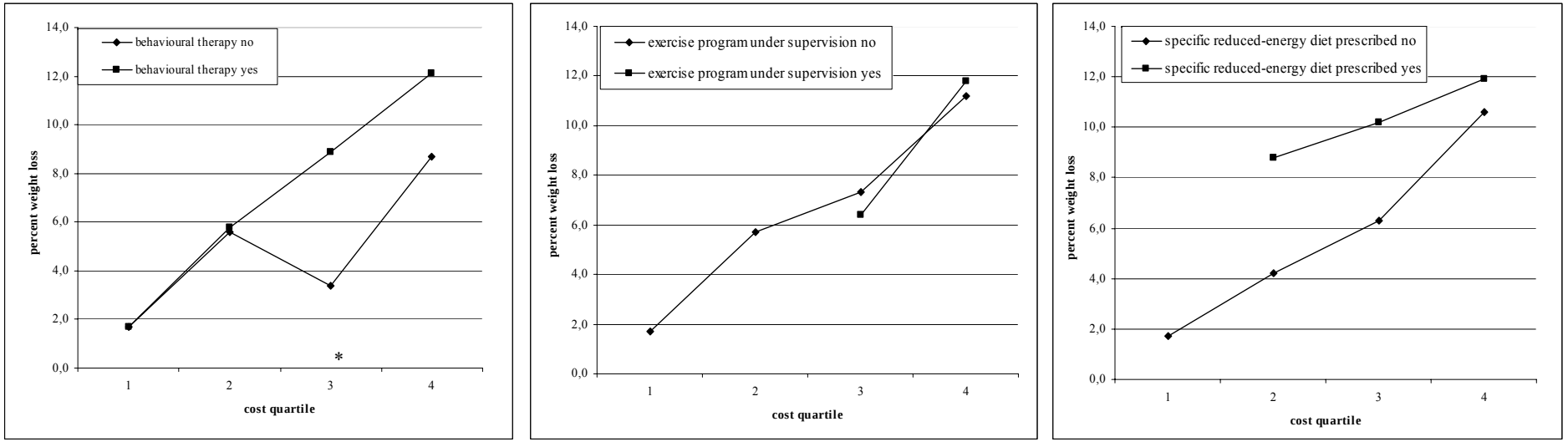
[a] number of interventions.
n.a.: not applicable.
*difference between yes and no significant at p<0.01.

Table 5 shows that in higher costs categories, a higher percentage of interventions included a specific diet, exercise training under supervision and behavioural therapy. Data from Table 5 were used to produce Figure 4, which shows that in general programmes in which a specific reduced-energy diet was prescribed or which contained behavioural therapy were associated with more weight loss independent of the intervention costs. Inclusion of a supervised exercise programme in an intervention did not seem to result in a higher percentage of weight loss (Figure 4 and Table 5). However, because of a low number of interventions for some comparisons, lack of statistical power might be a problem.

In Table 6 interventions were compared in which a diet was prescribed, with or without a supervised exercise programme. However, the number of interventions was too small to make a valid comparison.

Table 6. Percentage weight loss for interventions in which a specific diet was prescribed, with or without an exercise programme under supervision, per cost quartile.

Exercise programme under supervision	**Cost category**							
	€13 – €92		**€113 – €182**		**€207 – €456**		**€468 – €852**	
	N	**%change**	**N**	**%change**	**N**	**%change**	**N**	**%change**
No	-	-	5	8.8	2	11.6	5	11.1
Yes	-	-	0	-	1	7.5	5	12.8



A B C

Figure 4. Mean weight loss (%) per cost quartile and per intervention component
A: behavioural therapy; B: exercise under supervision; C: prescription of diet

Cost quartiles: 1: €13 – €92; 2: €113 – €182; 3: €207 – €456; 4: €468 – €852
* $p < 0.05$.

Table 7. Mean weight loss in individually and group-oriented interventions

	Cost category							
	€13 – €92		€113 – €182		€207 – €456		€468 – €852	
	N	%change	N	%change	N	%change	N	%change
Individual component	8	0.7	2	10.1	4	2.3	2	9.6
Group component	2	6.1	11	5.7	9	9.2	7	11.8
Individual and group component	5	1.5	2	1.7	2	7.2	7	11.6

The mean percentages of weight loss in interventions that were offered individually, in groups and in both ways are shown in Table 7. It appears that intervention programmes which were done in groups, e.g. which include classes, were the most effective. However, there were few interventions in some categories. Moreover, Table 8 shows that if an intervention contained one of the components which were shown to be effective above, this was almost always done in groups. Thus, it is hard to disentangle the mode of intervention from the intervention components.

Table 8. Number of interventions by mode of intervention (group or individual) and intervention components (diet, exercise, behavioural therapy)

Intervention component	Specific reduced-energy diet prescribed		Exercise programme under supervision		Behavioural therapy	
	yes	no	yes	No	yes	no
Individual component	0	16	1	15	3	13
Group component	15	14	8	21	26	3
Individual and group component	3	13	1	15	8	8

3.4 Costs and weight loss after two years

Figure 5 shows that there was large variation in intervention costs after two years. Like was done in the one-year analyses, the analyses were limited to interventions below €1000 (n=18, see Figure 6 and appendices G and H). The mean weight loss after 2 years of these 18 interventions was 6.4% (SD 4.1) and the mean costs €379 (SD 301). Figure 6 suggests an association between costs and weight loss after two years. Linear regression analysis showed that for each increase in costs of €100 the extra weight loss was 0.6% (95% CI -0.1 – 1.2), but this association was not statistically significant (p=0.087).

Intervention costs and weight losses for a 2-year period for each intervention are tabulated in Table 9. Interventions for which relatively high weight losses were observed after one year also showed relatively high losses after two years, although weight regain also was high for those interventions. With respect to spreading of the costs over the first two years, it can be seen that generally interventions became less intensive or ended after the first year. There were too few interventions to draw conclusions regarding the effects of spreading of the costs on weight loss after two years.

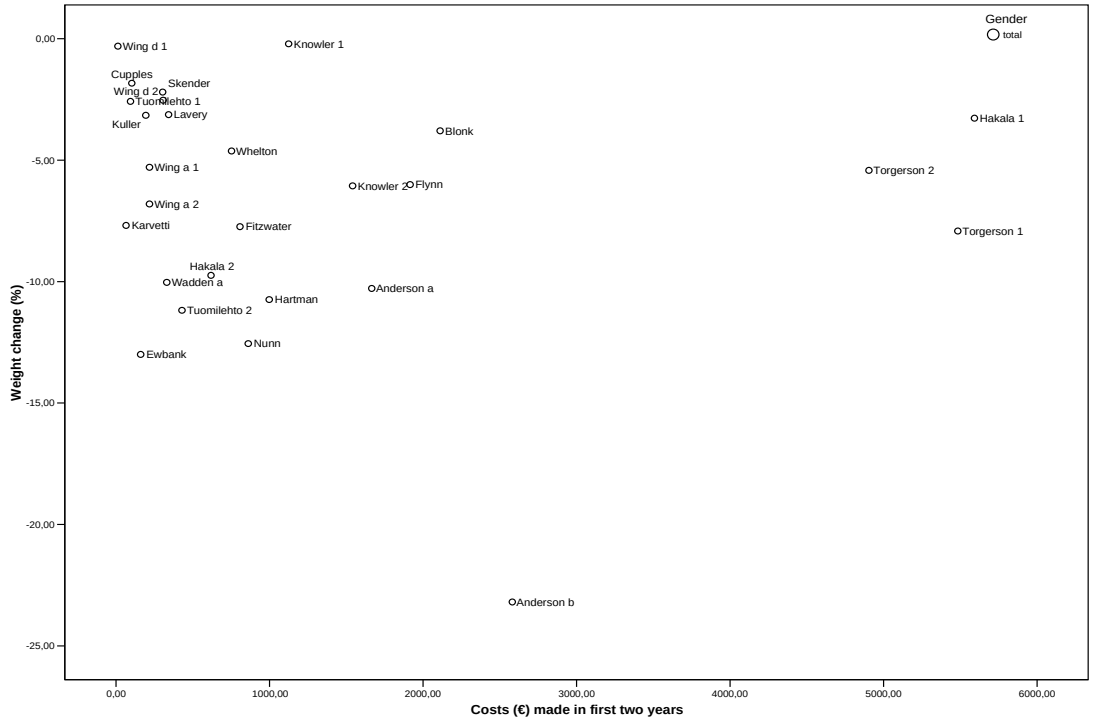


Figure 5. The relationship between costs of an intervention and percentage change in weight two years after the start of an intervention (n=27)

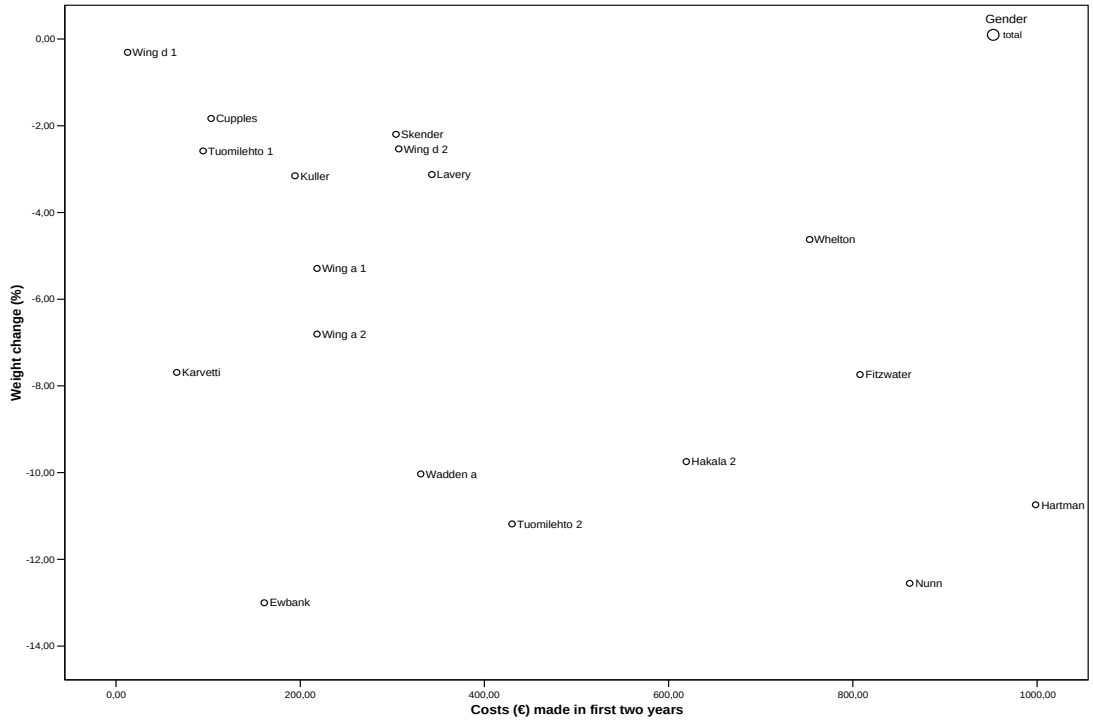


Figure 6. The relationship between costs of an intervention and percentage change in weight two years after the start of an intervention for interventions below €1000 (n=18)

Table 9. Intervention costs[a] and weight losses in year one and two

Intervention	Sex	Costs per participant year 1	Costs per participant year 2	Percentage of total costs spent in year 2	Weight loss year 1 (%)[b]	Weight loss year 2 (%)	Difference between year 1 and 2[c]
Wing d 1	total	13	0	0	-0.3	-0.3	0.0
Cupples	total	52	52	50	-1.8	-1.8	0.0
Tuomilehto 1	total	54	41	43	-0.9	-2.6	-1.7
Karvetti	total	66	0	0	-7.6	-7.7	-0.1
Kuller [d]	total	118	35	18	-5.8	-3.2	2.7
Ewbank	total	161	0	0	-28.0	-13.0	15.0
Wing a 1	total	218	0	0	-9. 6	-5.3	4.5
Wing a 2	total	218	0	0	-13.4	-6.8	6.6
Tuomilehto 2	total	278	152	35	-4.7	-11.2	-6.5
Wing d 2	total	293	14	5	-7.5	-2.5	5.0
Skender	total	304	0	0	-8.9	-2.2	6.7
Wadden a	total	331	0	0	-23.3	-10.0	13.2
Lavery	total	343	0	0	-5.0	-3.1	1.8
Hakala 2	total	497	123	20	-13.5	-9.8	3.8
Whelton	total	753	0	0	-5.4	-4.6	0.8
Nunn	total	767	94	11	-18.5	-12.6	5.9
Fitzwater	total	808	0	0	-7.1	-7.7	-0.7
Hartman	total	998	0	0	-25.9	-10.7	18.1

[a] interventions are ordered from low to high costs made in year 1.
[b] Follow-up time *within* first year but not necessarily after exactly one year.
[c] negative values indicate extra weight loss, positive values weight regain between year 1 and 2.
[d] between 1.5 and 2.5 years €41 spent.

3.5 Success rate

Table 10 shows the success rate of 16 interventions where this information was reported. The success rate is defined as the percentage of the study population with a weight reduction of 5 or 10%. Since there is variation in the years of follow-up, after which the success rates were determined, it is hard to draw conclusions. For interventions after which an average weight reduction between 3 to 7% was observed, the success rates for a 5% weight loss varied between 40% and 60%, while the follow-up period for most of these interventions was 2 years or more.

Table 10. Percentage of participants who lost at least 5% and 10% of their body weight

Intervention	Sex	Average weight loss (%)	Success rate 5%	Success rate 10%	Years from baseline	Cumulative costs (€)
Fogelholm 1	total	-8.8	38	20	3.0	851
Fogelholm 2	total	-5.0	38	20	3.0	851
Hakala 1	total	-3.3	43	14	2.0	5592
Hakala 1	total	-1.9	36	22	5.0	6696
Hakala 2	total	-9.8	75	46	2.0	619
Hakala 2	total	-5.3	40	24	5.0	619
Holden	total	-11.5	60	40	3.3	4170
Knowler 1	total	-0.2	15	5	4.0	1975
Knowler 2	total	-3.9	45	20	4.0	1975
Lindahl 1	total	-0.6	12	3	1.0	85
Lindahl 2	total	-6.3	61	20	1.0	2178
Steptoe	total	-0.8	18	4	1.0	63
Torgerson 1	men	-12.0	74	34	2.0	5484
Torgerson 1	women	-5.2	47	20	2.0	5484
Torgerson 2	men	-4.3	38	19	2.0	4905
Torgerson 2	women	-6.0	48	30	2.0	4905
Tuomilehto 1	total	-0.9	13	n.a.	1.0	54
Tuomilehto 2	total	-4.7	43	n.a.	1.0	278
Wadden a	men	-13.1	75	42	2.5	331
Wadden a	men	-10.8	75	42	3.5	331
Wadden a	men	-8.6	61	26	4.5	331
Wadden a	men	-7.7	58	28	5.5	331
Wadden a	women	-9.2	58	43	2.5	331
Wadden a	women	-7.6	55	35	3.5	331
Wadden a	women	-6.2	49	32	4.5	331
Wadden a	women	-5.2	48	31	5.5	331
Wing c 4	total	-15.4	16	3	1.0	136

4. Discussion and conclusions

4.1 Summary of main results

The objective of the present study was to investigate the association between the costs (which reflect intensity) and effects of interventions aimed at reducing body weight and performed within a health care setting or in an overweight population and/or carried out by health care professionals. For 15 interventions costing on average €150 per person, the mean weight loss was around 5%, which is considered clinically significant. The relationship between costs and effects was linear until approximately €1000 per person. In the linear range, each increase in costs of €100 per person was associated with a weight reduction of 1.0% after one year. It appeared that interventions in which a specific diet (e.g. a (very)-low-calorie diet) was prescribed and which included behavioural therapy in their programme were associated with greater weight loss than interventions without these components. Weight reductions after 2 years also appeared to be related to intervention costs.

4.2 Discussion of methods

The results of the present study must be interpreted with some considerations in mind. First, the weight changes that were used in the analyses were the changes *within* each intervention or control group. This was done because many studies did not include a control group. If any, there were considerable variations in the type of control group. Some control groups were 'real' control groups, whereas other control groups received usual care or a less intensive intervention. We therefore decided to include control groups only if they fulfilled the same inclusion criteria as the intervention group in a study. The implication of using within-group changes is that several factors which influence weight (change) could not be controlled for. These sources include the natural course of weight over time and changes in diet and physical activity that would also have occurred without the intervention. Nevertheless, it is plausible that the observed weight changes result from the interventions, because the majority of the included interventions showed reductions in weight as opposed to the normally observed increases over time when no intervention is administered.

Second, it is important to notice that when only large studies and RCTs were included in the analyses, the weight loss in the second (mean costs approximately €150) and third (mean costs approximately €300, range €207 – €456) quartiles of intervention costs was similar. This implies that it is possible to achieve a weight loss of 5% with interventions costing €150 per person, but that it may also be necessary to use more expensive (i.e. more intensive) interventions to reach the same amount of weight loss. In addition to analysing all interventions, the analyses were performed for large studies and RCTs only because the quality of these studies is considered as high. However, the quality of the smaller studies and non-RCTs included in the present report was also good and all studies had all passed the criteria for inclusion in one or more of the six literature reviews that were used as a starting point for the selection of studies for the present report.

Third, if possible we extracted information for only the participants who did not drop out during the study, because the large majority of articles reported weight loss for participants who completed measurements. Since persons who drop out of a study may be less motivated

to participate, weight loss is likely to be higher among participants who remain in a study. A related issue is the participation in the intervention activities like classes and exercise trainings. As the fixed costs of an intervention and costs of the staff remain the same regardless of the number of participants, low participation increases the *real* costs of an intervention per participant. However, if it is true that more motivated persons (who are likely to lose more weight) participate to a higher extent in a programme, this would decrease the *real* costs per person for each percent of weight loss. Since the effect of participation thus is unclear, we calculated the costs per percent weight loss per participant who started an intervention. This is equivalent to the *planned* intervention costs per person.

Fourth, because the description of the interventions was not always complete, some costs may not have been included in the cost calculations. Only the resource use as mentioned in the literature or as given by the authors was included in the calculations. In addition, the unit prices are estimates and may differ from the actual costs. Therefore the calculations described in this report are an indication of the real costs per participant in the several interventions. The calculated costs may be an underestimate of the real costs because fixed costs were excluded. On the other hand, an overestimation is also possible because we assumed a surcharge of 45% overhead costs, which may be too high for extramural interventions. However, for all interventions a standardised method was used to calculate costs, so that small underestimates or overestimates are not likely to have led to biased results with respect to the association between intervention costs and weight loss.

Fifth, we observed a linear relationship between intervention costs and weight loss for interventions costing less than €1000. Therefore more expensive interventions were excluded from the analyses. After approximately €1000 the relationship became weaker. When more expensive interventions were included, i.e. the cut-off points for inclusion in the regression analyses were chosen at €1500, €2000 and €4000, each increase in costs of €100 per person was associated with a weight reduction of 5%, 4% and 3%, respectively.

Finally, regain of weight after ending a weight loss programme may occur. However, there was little information on weight loss one year or more after an intervention had ended. Therefore we could not examine if the association between intervention costs and effects would hold after an intervention has ended for some time. This implies that each year additional investments in weight loss maintenance programmes may be necessary to ensure that (a part of) the weight loss will sustain on the longer term. Nevertheless, since all interventions were directed towards changing lifestyle, we expect that as positive changes in diet and exercise behaviour are made, at least a certain percentage of weight loss will be maintained. In addition, the results after two years show that despite weight regain, for most interventions a net weight loss is still observed, and that if a relatively high weight loss was observed after one year this was also the case after two years.

4.3 Policy implications

The present study indicates that interventions are likely to be more effective if the intervention costs are higher, i.e. if an intervention is more intensive. However, it seems that after a certain amount of money, which lies around €1000, extra weight loss cannot be warranted; the interventions which cost more did not seem to result in more weight loss.

A clinically relevant weight loss of 5% of body weight during the first year of treatment can already be achieved by interventions costing around €150 per person. However, after exclusion of certain types of studies, the range in costs necessary for this weight loss was higher, and thus the costs may amount to €300-€400. Interventions costing €650 were associated with a mean weight loss of 10%. Compared to around €75 per person per month of treatment with orlistat or sibutramine (see http://www.cvzkompassen.nl/fk/), lifestyle interventions are relatively cheap. Moreover, lifestyle interventions are more likely to lead to other positive effects on health, like a reduction in blood pressure and improved blood lipid profiles (13).

Because of the variety in intervention programmes, the policy maker has to know which interventions work best in order to effectively allocate financial resources. All the included interventions were aimed at changing diet and exercise behaviour. Our results indicate that, irrespective of costs, a diet programme is more effective if participants are prescribed a certain reduced-energy diet (for an example see text box on page 17), than when they are simply encouraged to reduce their energy intake. Programmes which include behavioural therapy seem to be more effective than programmes without this form of therapy.
Interventions in which participants engage in physical activity under supervision of a trainer did not appear to be more effective than programmes in which participants are merely advised to be more physically active. However, the number of interventions that included a supervised exercise programme was relatively low and statistical power may have been insufficient on this specific point. From literature there are indications that exercise may be important in the *maintenance* of weight loss (14, 15). Furthermore, it must be reminded that *all* interventions were directed at physical activity, but that some only encouraged participants to exercise more. Moreover, being physically active is related to various other favourable health outcomes (16, 17).
With respect to weight loss after group or individually-oriented interventions our data were not suitable to draw conclusions.

4.4 Conclusions

In the light of several methodological considerations, it is concluded that the costs of an intervention, which reflect the intensity, are predictive of its outcome. More intensive (expensive) interventions thus are likely to be more effective in reducing body weight in the secondary prevention of obesity. However, lifestyle interventions do not need to be expensive, because a clinically significant weight loss of 5% was observed among the interventions costing around €150.
Intervention programmes which include prescribed energy-reduced diets and behavioural therapy seem to be more effective than interventions without these components. Although our analysis did not indicate that supervised physical activity programmes are associated with more weight loss, it is known from literature that physical exercise may be important in the maintenance of weight loss.

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Appendix A: Characteristics of the six literature reviews

McTigue et al. (8):
- Screening and interventions for obesity in adults
- RCT (of fair or good quality)
- Reviews and literature search 1994-2003 (articles from literature search were considered for the present report)
- Adults
- Outcome: weight loss or BMI reduction; glucose tolerance, blood pressure, lipid disorders
- Duration: ≥ 6 months
- Sample generalisable to typical US primary care population

Anderson et al. (4):
- Long-term weight loss maintenance
- VLED (very-low-energy diets) and HBD (hypoenergetic balanced diets), some combined with exercise
- Medline literature search 1970-1999 and reference tracking in single studies and reviews
- Studies conducted in the United States
- Inclusion of participants in a structured weight-loss program (instead of self-help activities)
- Follow-up data with variance estimates for ≥2 y.
- Primary outcome variables were weight-loss maintenance in kilograms, weight-loss maintenance as a percentage of initial weight loss, and weight loss as a percentage of initial body weight (reduced weight).
- sample typical of general population

Avenell et al. (9):
- Systematic review of obesity treatment in adults
- RCT
- Literature search 1966-may 2001
- Mean or median age 18 y or over
- Mean or median BMI 28 or over
- Mean or median duration 52 weeks or over (intervention + follow-up)
- Diets, exercise, behaviour therapy, drugs, surgery, complementary therapies
- Weight loss or prevention of weight gain explicitly stated as a main study outcome
- Studies were scored for methodological quality

Wilcox et al. (5):
- Trials in health care settings that investigated the effects of physical activity or dietary advice on cardiovascular disease risk factors
- Literature search 1980-2000 in electronic databases and reference tracking of original and review articles
- English language
- cardiovascular disease risk factor as outcome variable
- Primary study rather than review or practice guideline
- Women ages 18 or over
- Inclusion of control group or minimal intervention group
- No pharmacotherapy

Eakin et al. (10):
- Primary care-based interventions for increasing physical activity
- Literature search 1980-1998 in electronic databases and reference tracking of original and review articles; expert consultancy
- English language
- RCT or quasi experimental study using a comparison group
- Intervention delivered or initiated in a primary care setting
- Reported results on at least 1 measure of physical activity
- No studies that focused solely on cardiovascular disease patients

Ashenden et al. (11):
- Trials which investigated the effectiveness of lifestyle advice provided in a general practice setting
- Literature search in electronic databases from year of their inception up to May 1995 and reference tracking of original and review articles
- Subjects randomly allocated to experimental groups
- Comparison between either no intervention or usual care, or between advice of differing intensities
- Advice provided organised around the structure of a general practice or equivalent primary care setting
- No restrictions with respect to follow-up period

Appendix B: Overview of included studies from the six literature reviews

Name	Reference	Anderson (4)	Ashenden (11)	Avenell (9)	Eakin (10)	McTigue (8)	Wilcox (5)
Anderson a	(18)	1					
Anderson b	(19)	1					
Ashley	(20)					1	
Blonk	(21)			1			
Cousins	(22)			1			
Cupples	(23)		1				1
Ewbank	(24)	1					
Family Heart Study Group (FHSG)	(25)		1				1
Fitzwater	(26)	1					
Flynn	(27)	1					
Fogelholm	(14)					1	
Frey-Hewitt	(28)			1			
Grodstein	(29)	1					
Hakala	(30)			1			
Hartman	(31)	1					
Jakicic	(32)					1	
Jalkanen	(33)			1			
Jeffery a	(34)					1	
Jeffery b	(35)			1			
Karvetti	(36)			1			
Knowler	(37)					1	
Kuller	(38)					1	
Lavery	(39)	1					
Lindahl	(40)			1			
Narayan	(41)			1			
Nunn	(42)	1					
Pritchard a	(43)			1			
Pritchard b	(44)			1			
Reseland	(45)			1			
Rosamond	(46)						1
Sbrocco	(47)					1	
Shah	(48)			1			
Skender	(49)			1			
Stenius-Aarniala	(50)			1			
Steptoe	(51)						1
Stevens a	(52)			1		1	
Stevens b	(53)			1			
Torgerson	(54)			1			
Tuomilehto	(55)			1		1	
Vanninen	(56)			1			
Viegener	(57)			1			
Wadden a	(58)	1					

Name	Reference	Anderson	Ashenden	Avenell	Eakin	McTigue	Wilcox
Wadden b	(59)			1			
Wadden c	(15)			1			
Whelton	(60)			1			
Wing a	(61)			1			
Wing c	(62)					1	
Wing d	(63)			1			
Wood	(64)			1			

Appendix C: Assumptions made for each intervention

Intervention*	Assumptions
Anderson a	- group size group classes is 15 persons - weekly review by programme staff is 15 minutes - time weekly group sessions during maintenance is 60 minutes - time monthly seminars is 120 minutes - group size monthly seminars is 50 persons - periodic restaurant meals every half year 120 minutes with 15 persons - grocery shopping tours every half year 60 minutes with 15 persons - intervenor for all components of the intervention is a behavioural health educator (=counsellor)
Anderson b	- group size group classes is 15 persons - weekly review by programme staff is 15 minutes - time weekly group sessions during maintenance is 60 minutes - time monthly seminars is 120 minutes - group size monthly seminars is 50 persons - periodic restaurant meals every half year 120 minutes with 15 persons - grocery shopping tours every half year 60 minutes with 15 persons - intervenor for all components of the intervention is a behavioural health educator (=counsellor)
Blonk	- dietician time is 60 minutes per visit - physician time is 10 minutes per visit - psychologist time is 60 minutes
Cousins 1	- price of one cookbook is equal to one manual
Cousins 2	- dietician time is 60 minutes per visit - group size is 15 persons
Cousins 3	- dietician time is 60 minutes per visit - group size is 15 persons
Cupples	- for the low energy diet Slimfast products were used
Fogelholm 1	- week 1per day: 1 Slimfast shake and two bars - week 2-9 per day: 1 Slimfast shake and one bar - wk 10-12 per day: 1 Slimfast shake and further meals as normal
Fogelholm 2	- week 1per day: 1 Slimfast shake and two bars - week 2-9 per day: 1 Slimfast shake and one bar - wk 10-12 per day: 1 Slimfast shake and further meals as normal
Frey-Hewitt 1	- classes supervised by fitness instructor - group size is 30 persons
Frey-Hewitt 2	- time sessions is 60 minutes - group size is 15 persons - half of the sessions is individual and half of the sessions are group sessions
Hakala 1	- individual session is 60 minutes
Jakicic 1	- group size is 15 persons - time session is 60 minutes
Jakicic 2	- group size is 15 persons - time session is 60 minutes
Jakicic 3	- group size is 15 persons - time session is 60 minutes
Jeffery a 1	- group size is 15 persons - time session is 120 minutes - price of newsletter is equal to one brochure per month with letter (flyer) and delivery costs
Jeffery a 2	- group size is 15 persons - time session is 120 minutes - price of newsletter is equal to one brochure per month with letter (flyer) and delivery costs
Jeffery b	- time session is 60 minutes - sessions facilitated by dietician (50%) and psychologist (50%) - food record equivalent in costs to a manual
Karvetti	- time lectures is 120 minutes
Knowler 1	- information is a brochure
Knowler 2	- staff member and case manager are nutritionists
Lindahl 1	- sessions are individual - price of written information equal to brochure - time health check is 20 minutes

Intervention*	Assumptions
Lindahl 2	- mean costs of full board per person in Dutch wellness centres - group size is 15 persons - group exercise activities are supervised by a fitness instructor
Narayan 1	- price of written information is equal to brochure - equal to newsletters are equal to brochures - interviews were done by counsellors
Narayan 2	- training sessions and reviews supervised by fitness instructor - group size is 15 persons - time to review the diary is 15 minutes - time sessions by dieticians is 60 minutes - price of diary is equal to a manual
Nunn	- physician is a general practitioner (GP) - lab test during visit GP - classes performed by dieticians - amount of workshops is 3 (one topic each) and they last for 120 minutes - group size is 15 persons
Pritchard a 1	- sessions supervised by dieticians - group size is 15 persons - session is 60 minutes
Pritchard a 2	- sessions supervised by dieticians - group size is 15 persons - session is 60 minutes
Pritchard a 3	- price of diary is equal to manual - price of calendar is equal to 12 times (months) a flyer
Pritchard b 1	- coordination by dietician is 15 minutes - price of diary is equal to manual
Pritchard b 2	- price of diary is equal to manual
Reseland	- individual sessions supervised by dieitician - duration individual session is 60 minutes - group sessions supervised by fitness instructor - group size is 15 persons
Sbrocco 1	- student is not paid - duration of orientation session is 90 minutes (60 minutes PC instruction)
Sbrocco 2	- student is not paid - duration of orientation session is 90 minutes (60 minutes PC instruction)
Shah 1	- half of the group sessions performed by dietician and half by counsellor - group size is 15 persons - duration of session is 60 minutes - information during the session is flyer or brochure - price of diary is equal to manual
Shah 2	- half of the group sessions performed by dietician and half by counsellor - group size is 15 persons - duration of session is 60 minutes - information during the session is flyer or brochure - price of diary is equal to manual
Skender	- group sessions supervised by dieticians - group size is 15 persons
Stenius-Aarniala	- price of VLCD of Nutrilett products is equivalent to 5 Slimfast shakes (200-250 kJ) and 2 bars (200-250 kJ) per day - group size is 15 persons
Steptoe	- duration telephone calls is 10 minutes
Stevens b	- duration baseline session is 60 minutes - baseline session is performed by an dietician - duration monthly sessions is 90 minutes
Torgerson 1	- duration session is 60 minutes - all sessions are individual - VLCD consists of 2 shakes and 1 bar per day
Torgerson 2	- duration session is 60 minutes - all sessions are individual - VLCD consists of 2 shakes and 1 bar per day
Vanninen 1	- sessions are individual - sessions are supervised by dieticians - duration sessions is 60 minutes

Intervention*	Assumptions
Vanninen 2	- sessions are individual - duration physician visit is 10 minutes - duration dietician session is 60 minutes - duration nurse session is 60 minutes
Wadden b 1	- group size is 15 persons - duration of group sessions is 60 minutes - exercise group size is 30 persons - exercise is supervised by fitness instructor - duration dietician sessions is 60 minutes - diary is manual
Wadden b 2	- group size is 15 persons - duration of group sessions is 60 minutes - exercise group size is 30 persons - exercise is supervised by fitness instructor - duration dietician sessions is 60 minutes - price of diary is equal to manual - physician is general practitioner - duration physician visit is 10 minutes
Wadden c 1	- group size is 15 persons - sessions supervised by dieticians (therapy) and fitness instructor (exercise)
Wadden c 2	- group size is 15 persons - sessions supervised by dieticians (therapy) and fitness instructor (exercise)
Wadden c 3	- group size is 15 persons - sessions supervised by dieticians (therapy) and fitness instructor (exercise)
Whelton	- half of the session supervised by nutritionist and half of the sessions by fitness instructor - group size is 15 persons - duration sessions is 60 minutes
Wing c 1	- group size 20 persons - duration session is 60 minutes
Wing c 2	- group size 20 persons - duration session is 60 minutes
Wing c 3	- group size 20 persons - duration session is 60 minutes
Wing c 4	- group size 20 persons - duration session is 60 minutes
FHSG	- duration telephone call is 5 minutes
Wood	- group size is 15 persons - duration session is 60 minutes

* the interventions for which no assumptions were made are excluded from this table

Appendix D: Cost estimates per unit

Personnel costs were calculated by using the method as described in the Dutch guidelines for cost calculations within pharmacoeconomic research (Oostenbrink et al., 2004). Firstly, the monthly mean gross salary per professional category had to be determined by using the middle number plus 1 within the specific salary scale. A surcharge of 35% was calculated for holiday allowance, social security, pensions etc. Thereafter, a surcharge of 35% was calculated for institutional overhead costs. That is for example personnel costs of general and administrative staff members, general costs, depreciation costs of the inventory and immaterial fixed capital and interest. A further surcharge of 10% was calculated for housing costs. Summarizing, the surcharge of overhead and accommodation together was determined as an additional percentage of 45% on top of the gross personnel costs. Finally the amount of working hours in one year was calculated, 1540 for a 36-hour working week and 1632 for a 38-hour working week. The unit cost per hour were calculated assuming a productivity of 70%.

Example:

The mean gross salary of a nurse practitioner is €2482 per month if working 38-hours a week. The unit costs of a nurse practitioner can be estimated as:

$$\frac{(2482 * 12 \text{ months}) * 135\% \text{ (holiday allowance etc)} * 145\% \text{ (overhead+ housing)}}{1632 \text{ working hours} * 70\% \text{ productivity}} = 51 \text{ euro / hour}$$

The unit costs for a consult of a general practitioner and physiotherapist were taken from the Dutch guidelines for cost calculations within pharmacoeconomic studies (Oostenbrink et al., 2004). Unit prices that were not mentioned in these guidelines, such as the salary of a fitness instructor or a psychologist were searched for on the internet.

	Unit	Costs (€)
Personnel costs		
GP assistant	Minute	0,61
Fitness instructor	Minute	0,70
Research assistant	Minute	0,75
Nurse practitioner	Minute	0,86
Dietician	Minute	0,84
Physiotherapist	Minute	0,86
Counsellor	Minute	1,07
Junior researcher	Minute	1,02
Senior researcher	Minute	1,45
Psychologist	Minute	1,10
General practitioner	Minute	2,04
Student assistant	Minute	0,63

	Unit	Costs (€)
Fitness products		
Stepping meter	Piece	16,50
Heart rate monitor	Piece	39,46
Treadmill	Piece	199
Meal replacements		
Slimfast shake	Piece	1,69
Slimfast bar	Piece	1,69
Information material		
Manual	Piece	12,65
Video tape	Piece	11,13
Software	Piece	8,09
Brochure	Piece	3,04
Flyer	Piece	1,01
Others		
Telephone calls		0,0429 + 0,0289 * amount of minutes
Care in revalidation centre	Day	339,97

Reference

Oostenbrink JB. Standaard kostprijzen en rekenwaarden, bijlage bij "Handleiding voor Kostenonderzoek; methoden en standaard kostprijzen voor economische evaluaties in de gezondheidszorg" (in Dutch), 2004, College voor Zorgverzekeringen, Amstelveen

Appendix E: General characteristics of studies reporting weight after one year

Intervention	*	De-sign	Population	Sex	Recruitment of population	N base-line	% asse ssed	Years follow-up (incl. inter-vention)
Anderson a	0	NT	13-78 y obese men and women, many with obesity-related disorders	t	not reported	100	93	3.5
Anderson b	0	NT	mean 42 y morbidly obese men and women	t	not reported	80	88	2
Ashley 1	1	RT	overweight premenopausal women	t	newspaper advertisements	23	62	1
Ashley 2	0	RT	overweight premenopausal women	t	newspaper advertisements	26	68	1
Ashley 3	0	RT	overweight premenopausal women	t	newspaper advertisements	25	67	1
Blonk	0	NT	mean 59 y obese NIDDM patients	t	via general practices and outpatient diabetes clinic	27	.	2
Cousins 1	1	RCT	18-45 y obese Mexican American women	w	via media promotion and personal contacts in the local community, primarily churches and health agencies	27	51	1
Cousins 2	1	RCT	18-45 y obese Mexican American women	w	via media promotion and personal contacts in the local community, primarily churches and health agencies	32	51	1
Cousins 3	1	RCT	18-45 y obese Mexican American women	w	via media promotion and personal contacts in the local community, primarily churches and health agencies	27	51	1
Cupples	1	RCT	angina patients	t	letters via general practices	342	93	2
FHSG	1	RCT	GP patients	t	general practices invited, men and their families approached by research nurses	3440	87	1
Fogelholm 1	1	RCT	obese premenopausal women	t	newspaper advertisements	26	92	3
Fogelholm 2	1	RCT	obese premenopausal women	t	newspaper advertisements	27	85	3
Frey-Hewitt 1	1	RCT	30-59 y overweight sedentary non-smoking men	m	not reported	52	85	1
Frey-Hewitt 2	1	RCT	30-59 y overweight sedentary non-smoking men	m	not reported	51	71	1
Grodstein	1	NT	participants in Sandoz Nutrition program	t	questionnaire sent to former participants in commercial weight-loss programme	192	82	3
Hakala 1	0	RT	severely obese adults	t	newspaper advertisements	30	100	5
Hakala 2	1	RT	severely obese adults	t	newspaper advertisements	28	100	5
Jakicic 1	1	RT	25-45 y sedentary overweight women	t	newspaper advertisements	49	88	1,5
Jakicic 2	1	RT	25-45 y sedentary overweight women	t	newspaper advertisements	51	86	1,5
Jakicic 3	1	RT	25-45 y sedentary overweight women	t	newspaper advertisements	48	94	1,5
Jalkanen	1	RCT	35-59 y overweight hypertensive subjects	t	through nurses in hypertension clinics	25	96	1
Jeffery a 1	1	RCT	20-45 y healthy men and women	t	direct phone solicitation, newspaper advertisement, mailings to employees of University of Minnesota	294	87	1
Jeffery a 2	1	RCT	20-45 y healthy men and women	t	direct phone solicitation, newspaper advertisement, mailings to employees of University of Minnesota	299	84	1

Intervention	*	De-sign	Population	Sex	Recruitment of population	N base-line	% asse ssed	Years follow-up (incl. inter-vention)
Jeffery b	1	RCT	mean 38 y 14-32 kg overweight men and women	t	newspaper advertisements, radio announcement, mailed invitations	40	87	1.5
Karvetti	1	RCT	17-65 y overweight men and women	t	through GPs	126	74	7
Knowler 1	1	RCT	nondiabetics with elevated fasting and post-load plasma glucose	t	various methods; see http://www.bsc.gwu.edu/dpp	1082	93	2,8
Knowler 2	0	RCT	nondiabetics with elevated fasting and post-load plasma glucose	t	various methods; see http://www.bsc.gwu.edu/dpp	1079	93	2,8
Lindahl 1	1	RCT	mean 56 y subjects with IGT	t	mailed invitations to subjects who had participated in a health survey	94	100	1
Lindahl 2	0	RCT	mean 55 y subjects with IGT	t	mailed invitations to subjects who had participated in a health survey	100	96	1
Narayan 1	1	RT	25-54 y obese normoglycaemic Pima men and women	t	invitations for screening and extensive local advertising	47	98	1
Narayan 2	0	RT	25-54 y obese normoglycaemic Pima men and women	t	invitations for screening and extensive local advertising	48	98	1
Nunn	1	NT	18-70 y overweight men and women	t	self-referred former participants of weight-loss programme contacted	60	83	2
Pritchard a 1	1	RCT	mean 43 y overweight men	m	via worksite	21	90	1
Pritchard a 2	1	RCT	mean 43 y overweight men	m	via worksite	23	78	1
Pritchard a 3	1	RCT	mean 43 y overweight men	m	via worksite	22	95	1
Pritchard b 1	1	RT	25-65 y overweight men and women	t	via general practice	92	71	1
Pritchard b 2	1	RT	25-65 y overweight men and women	t	via general practice	88	55	1
Reseland	1	RCT	mean 45 y overweight men	m	not reported	57	100	1
Rosamond 1	1	NT	low-income women	t	local health departments recruited	966	77	1
Rosamond 2	1	NT	low-income women	t	local health departments recruited	998	72	1
Sbrocco 1	1	RT	18-55 y overweight women	t	newspaper advertisements	12	92	1
Sbrocco 2	1	RT	18-55 y overweight women	t	newspaper advertisements	12	83	1
Shah 1	1	RT	25-45 y overweight nonsmoking healthy women	w	newspaper advertisements	61	61	1
Shah 2	1	RT	25-45 y overweight nonsmoking healthy women	w	newspaper advertisements	61	61	1
Skender	1	RT		t		42	64	2
Stenius-Aarniala	1	RT	18-60 y obese and asthmatic persons	t	newspaper advertisements	19	100	1
Steptoe	1	RCT	men and women with one or more modifiable risk factors	t	via general practices	316	54	1
Stevens a	1	RCT	30-54 y overweight individuals with DBP 83-89 and SBP<140 mmHG	t	TOHP 2: see Ann Epidemiol 1995, 5, 140-8	595	100	3
Stevens b	1	RCT	30-54 y overweight men and women with high-normal DBP	t	TOHP 1: see Ann Epidemiol 1992, 2, 295-310	308	93	1,5
Torgerson 1	0	RCT	37-58 y obese men and women	t	newspaper advertisements	58	.	2
Torgerson 2	0	RCT	37-58 y obese men and women	t	newspaper advertisements	55	.	2
Tuomilehto 1	1	RCT	40-65 y overweight men and women with IGT	t	through screening of members of high-risk groups	257	100	2
Tuomilehto 2	1	RCT	40-65 y overweight men and women with IGT	t	through screening of members of high-risk groups	265	100	2
Vanninen 1	1	RT	40-64 y obese newly diagnosed NIDDM patients	t	referral by physicians	40	88	1,25

Intervention	*	De-sign	Population	Sex	Recruitment of population	N base-line	% asse ssed	Years follow-up (incl. inter-vention)
Vanninen 2	1	RT	40-64 y obese newly diagnosed NIDDM patients	t	referral by physicians	38	88	1,25
Viegener 1	1	RT	21-59 y obese women	t	newspaper advertisements	43	70	1
Viegener 2	1	RT	21-59 y obese women	t	newspaper advertisements	42	71	1
Wadden b 1	1	RT	mean 39 y obese women	w	newspaper advertisements	21	100	1,5
Wadden b 2	0	RT	mean 39 y obese women	w	newspaper advertisements	28	100	1,5
Wadden c 1	1	RT	mean 42 y obese women	w	patients who had completed a weight-loss programme contacted	21	78	1
Wadden c 2	1	RT	mean 42 y obese women	w	patients who had completed a weight-loss programme contacted	18	78	1
Wadden c 3	1	RT	mean 42 y obese women	w	patients who had completed a weight-loss programme contacted	17	78	1
Whelton	1	RCT	60-80 y hypertensive men and women	t	TONE: see Ann Epidemiol 1995, 5, 119-29	294	89	2.5
Wing a 1	1	RT	overweight NIDDM diabetics	t	newspaper advertisements	48	85	2
Wing a 2	1	RT	overweight NIDDM diabetics	t	newspaper advertisements	45	84	2
Wing c 1	1	RT	30-70 y overweight NIDDM patients	t	newspaper advertisements	8	100	1
Wing c 2	1	RT	30-70 y overweight NIDDM patients	t	newspaper advertisements	8	100	1
Wing c 3	1	RT	30-70 y overweight NIDDM patients	t	newspaper advertisements	38	79	1
Wing c 4	1	RT	30-70 y overweight NIDDM patients	t	newspaper advertisements	37	79	1
Wing d 1	1	NT	40-55 y overweight subjects with 1 or 2 NIDDM parents	t	newspaper advertisements	40	73	2
Wing d 2	1	NT	40-55 y overweight subjects with 1 or 2 NIDDM parents	t	newspaper advertisements	40	75	2
Wood	1	RT	25-49 y overweight men and women	t	media announcements	90	90	1
73	73	73	73	73	73	73	73	73

*1=intervention costs < €1000 and included in one-year analyses; 0=not included in one-year analyses
RCT: randomised controlled trial; RT: randomised trial; NT: non-randomised or non-controlled trial

Appendix F: Intervention characteristics of studies reporting weight after one year

Intervention	*	Sex	Years of intervention	Intervention at group or individual level	Diet prescribed	Super-vised exercise program	Behaviou-ral therapy	Costs in first year (€)	Weight change (%)
Anderson a	0	t	1.79	individual and group	1	0	1	1454	-12.3
Anderson b	0	t	2.00	individual and group	1	0	1	2316	-32.7
Ashley 1	1	t	1.00	group	1	0	0	175	-4.1
Ashley 2	0	t	1.00	group	1	0	0	1410	-9.2
Ashley 3	0	t	1.00	individual	1	0	0	1800	-4.2
Blonk	0	t	2.00	individual and group	1	1	1	1378	-3.1
Cousins 1	1	w	0.00	individual	0	0	1	25	-0.9
Cousins 2	1	w	1.00	group	0	0	1	114	-2.7
Cousins 3	1	w	1.00	group	0	0	1	114	-5.1
Cupples	1	t	2.00	individual	0	0	0	52	-1.8
FHSG	1	t	1.00	individual	0	0	0	335	-1.4
Fogelholm 1	1	t	1.00	group	1	1	1	851	-16.0
Fogelholm 2	1	t	0.92	group	1	1	1	851	-15.7
Frey-Hewitt 1	1	m	0.92	individual and group	0	0	0	161	-4.4
Frey-Hewitt 2	1	m	0.93	individual and group	1	0	1	597	-7.1
Grodstein	1	t	2.00	individual and group	0	0	1	517	-21.0
Hakala 1	0	t	2.00	individual and group	0	1	1	5535	-11.6
Hakala 2	1	t	1.50	individual	0	0	0	497	-13.5
Jakicic 1	1	t	1.50	individual and group	0	0	1	412	-8.3
Jakicic 2	1	t	1.50	individual and group	0	0	1	412	-6.1
Jakicic 3	1	t	1.00	individual and group	0	0	1	611	-11.3
Jalkanen	1	t	1.00	group	0	0	1	181	-4.7
Jeffery a 1	1	t	1.00	individual and group	0	0	0	67	0.8
Jeffery a 2	1	t	1.00	individual and group	0	0	0	67	0.8
Jeffery b	1	t	1.50	group	0	0	1	92	-4.7
Karvetti	1	t	2.80	group	0	0	0	66	-7.6
Knowler 1	1	t	2.80	individual	0	0	0	28	-0.2
Knowler 2	0	t	.	individual and group	0	1	0	1108	-7.4
Lindahl 1	1	t	0.08	individual	0	0	0	85	-0.6
Lindahl 2	0	t	1.00	individual and group	1	1	1	2178	-6.3
Narayan 1	1	t	1.00	individual and group	0	0	0	158	0.9
Narayan 2	0	t	1.50	individual and group	0	0	1	684	2.6
Nunn	1	t	1.00	individual and group	1	0	1	767	-18.5
Pritchard a 1	1	m	1.00	individual and group	0	0	0	40	1.0
Pritchard a 2	1	m	1.00	individual and group	0	0	0	53	-7.2
Pritchard a 3	1	m	1.00	individual and group	0	0	0	25	-3.0
Pritchard b 1	1	t	1.00	individual	0	0	0	160	-9.8
Pritchard b 2	1	t	1.00	individual	0	0	0	114	-10.4
Reseland	1	m	0.50	individual and group	0	1	0	589	-6.9
Rosamond 1	1	t	0.50	individual	0	0	0	87	-0.1

Intervention	*	Sex	Years of intervention	Intervention at group or individual level	Diet prescribed	Super-vised exercise program	Behaviou-ral therapy	Costs in first year (€)	Weight change (%)
Rosamond 2	1	t	1.00	individual	0	0	0	208	-0.7
Sbrocco 1	1	t	1.00	group	0	0	1	277	-4.8
Sbrocco 2	1	t	0.50	group	0	0	1	277	-11.2
Shah 1	1	w	0.50	group	0	0	1	139	-3.1
Shah 2	1	w	1.00	group	0	0	1	139	-1.0
Skender	1	t	1.00	group	0	0	1	304	-8.9
Stenius-Aarniala	1	t	0.27	individual and group	1	0	1	704	-11.3
Steptoe	1	t	3.00	individual	0	0	1	78	-0.7
Stevens a	1	t	1.50	group	0	0	1	126	-2.1
Stevens b	1	t	2.00	group	0	1	1	284	-5.3
Torgerson 1	0	t	2.00	individual	1	0	1	2929	-11.2
Torgerson 2	0	t	2.00	individual	0	0	1	2350	-6.0
Tuomilehto 1	1	t	2.00	individual	0	0	0	54	-0.9
Tuomilehto 2	1	t	1.25	individual	0	1	0	278	-4.7
Vanninen 1	1	t	1.25	individual	0	0	0	455	-2.4
Vanninen 2	1	t	1.00	individual	0	0	0	837	-5.7
Viegener 1	1	t	1.00	group	1	0	1	468	-9.1
Viegener 2	1	t	1.50	group	1	0	1	468	-9.5
Wadden b 1	1	w	1.50	group	0	0	1	252	-13.7
Wadden b 2	0	w	0.92	group	1	0	0	1446	-16.1
Wadden c 1	1	w	0.92	group	1	1	1	540	-10.4
Wadden c 2	1	w	0.92	group	1	1	1	540	-10.1
Wadden c 3	1	w	2.42	group	1	1	1	540	-11.7
Whelton	1	t	1.00	individual and group	0	0	1	753	-5.4
Wing a 1	1	t	1.00	group	1	0	1	218	-9.7
Wing a 2	1	t	1.00	group	1	0	1	218	-13.4
Wing c 1	1	t	1.00	group	1	0	1	136	-6.4
Wing c 2	1	t	1.00	group	1	0	1	136	-7.0
Wing c 3	1	t	1.00	group	1	0	1	136	-10.9
Wing c 4	1	t	2.00	group	1	0	1	136	-15.4
Wing d 1	1	t	2.00	individual	0	0	1	13	-0.3
Wing d 2	1	t	1.00	group	1	1	1	293	-7.5
Wood	1	t	1.00	group	0	1	0	367	-7.9
73	73	73	72	73	73	73	73	73	73

*1=intervention costs < €1000 and thus included in one-year analyses; 0=not included in one-year analyses (intervention costs more than €1000 or outlier in the regression analysis).

Appendix G: General characteristics of studies reporting weight after two years

Intervention	De-sign	Population	Sex	Recruitment of population	N baseline	% assessed	Years follow-up (incl. intervention)
Anderson a	NT	13-78 y obese men and women, many with obesity-related disorders	t	not reported	100	86	3.5
Anderson b	NT	mean 42 y morbidly obese men and women	t	not reported	80	79	2
Blonk	NT	mean 59 y obese NIDDM patients	t	via general practices and outpatient diabetes clinic	27	88	2
Cupples	RCT	angina patients	t	letters via general practices	342	93	2
Ewbank	NT	obese men and women	t	former patients of programme approached	45	78	2
Fitzwater	NT	obese adults	t	participants who completed weight and eating disorders program earlier contacted	213	69	2.08
Flynn	NT	participants in Sandoz Nutrition program	t	letter to patients who were in a commercial weight-loss programme	255	37	2.5
Hakala 1	RT	severely obese adults	t	newspaper advertisements	30	100	5
Hakala 2	RT	severely obese adults	t	newspaper advertisements	28	100	5
Hartman	NT	22-54 y men and women from obesity clinic	t	patients referred to programme by physician or self-referred	102	74	2.5
Karvetti	RCT	17-65 y overweight men and women	t	through GPs	126	83	7
Knowler 1	RCT	nondiabetics with elevated fasting and post-load plasma glucose	t	various methods; see http://www.bsc.gwu.edu/dpp	1082	93	2.8
Knowler 2	RCT	nondiabetics with elevated fasting and post-load plasma glucose	t	various methods; see http://www.bsc.gwu.edu/dpp	1079	93	2.8
Kuller	RCT	44-50 y premenopausal women	t	recruitment of participants from ongoing trial	260	93	4.5
Lavery	NT	mean 45 y men and women who attended at least one class in weight control program	t	self-referred former participants of weight-loss programme	1460	35	2
Nunn	NT	18-70 y overweight men and women	t	self-referred former participants of weight-loss programme contacted	60	95	2
Skender	RT		t		42	50	2
Torgerson 1	RCT	37-58 y obese men and women	t	newspaper advertisements	58	78	2
Torgerson 2	RCT	37-58 y obese men and women	t	newspaper advertisements	55	82	2
Tuomilehto 1	RCT	40-65 y overweight men and women with IGT	t	through screening of members of high-risk groups	257	100	2
Tuomilehto 2	RCT	40-65 y overweight men and women with IGT	t	through screening of members of high-risk groups	265	100	2
Wadden a	NT	participants in Sandoz Nutrition program	t	patients who were in a weight-loss programme phoned	621	99	5
Whelton	RCT	60-80 y hypertensive men and women	t	TONE: see Ann Epidemiol 1995, 5, 119-29	294	86	2.5
Wing a 1	RT	overweight NIDDM diabetics	t	newspaper advertisements	48	77	2
Wing a 2	RT	overweight NIDDM diabetics	t	newspaper advertisements	45	80	2
Wing d 1	NT	40-55 y overweight subjects with 1 or 2 NIDDM parents	t	newspaper advertisements	40	78	2

Intervention	De-sign	Population	Sex	Recruitment of population	N baseline	% assessed	Years follow-up (incl. intervention)
Wing d 2	NT	40-55 y overweight subjects with 1 or 2 NIDDM parents	t	newspaper advertisements	40	80	2
27	27	27	27	27	27	27	27

RCT: randomised controlled trial; RT: randomised trial; NT: non-randomised or non-controlled trial

Appendix H: Intervention characteristics of studies reporting weight after two years

Intervention	Sex	Years of intervention	Intervention at group or individual level	Diet prescribed	Supervised exercise program	Behavioural therapy	Costs in first two years (€)	Weight change (%)
Anderson a	t	1.79	individual and group	1	0	1	1666	-10.3
Anderson b	t	2.00	individual and group	1	0	1	2582	-23.2
Blonk	t	2.00	individual and group	1	1	1	2112	-3.8
Cupples	t	2.00	individual	0	0	0	103	-1.8
Ewbank	t	0.75	group	1	1	1	161	-13.0
Fitzwater	t	0.58	individual and group	1	0	1	808	-7.7
Flynn	t	0.50	individual and group	1	0	1	1916	-6.0
Hakala 1	t	2.00	individual and group	0	1	1	5592	-3.3
Hakala 2	t	2.00	individual	0	0	0	619	-9.8
Hartman	t	0.43	individual and group	1	0	1	998	-10.7
Karvetti	t	1.00	group	0	0	0	66	-7.7
Knowler 1	t	2.80	individual	0	0	0	1125	-0.2
Knowler 2	t	2.80	individual and group	0	1	0	1542	-6.1
Kuller	t	4.50	individual and group	0	0	1	194	-3.2
Lavery	t	0.15	group	0	0	1	343	-3.1
Nunn	t	1.50	individual and group	1	0	1	862	-12.6
Skender	t	1.00	group	0	0	1	304	-2.2
Torgerson 1	t	2.00	individual	1	0	1	5484	-7.9
Torgerson 2	t	2.00	individual	0	0	1	4905	-5.4
Tuomilehto 1	t	2.00	individual	0	0	0	95	-2.6
Tuomilehto 2	t	2.00	individual	0	1	0	430	-11.2
Wadden a	t	0.50	individual and group	1	0	1	331	-10.0
Whelton	t	2.42	individual and group	0	0	1	753	-4.6
Wing a 1	t	1.00	group	1	0	1	218	-5.3
Wing a 2	t	1.00	group	1	0	1	218	-6.8
Wing d 1	t	2.00	individual	0	0	1	13	-0.3
Wing d 2	t	2.00	group	1	1	1	307	-2.5
27	27	27	27	27	27	27	27	27

Appendix I: Procedure used to assess potential confounding by study characteristics on the relationship between intervention costs and weight changes

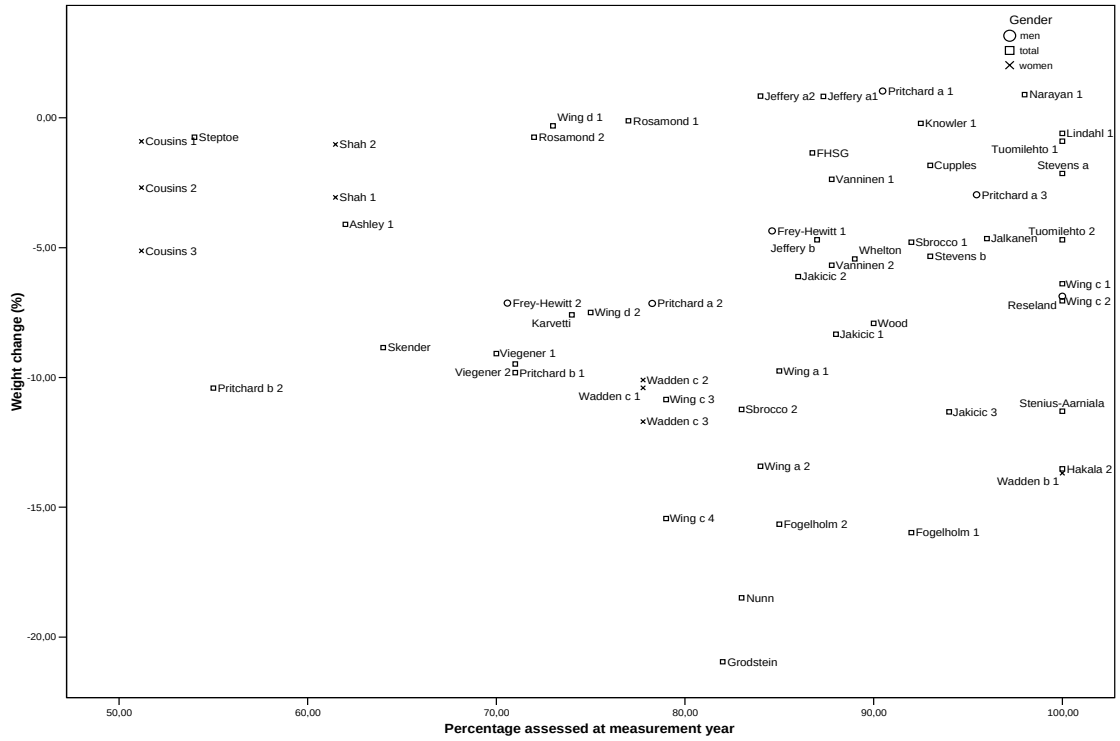
I-1. Regression models used to assess the influence of study characteristics on weight changes in addition to intervention costs (n=61).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
	(Constant)	-2.736	.852		-3.213	.002	-4.441	-1.032		
	Costs made in first year	-.013	.002	-.604	-5.815	.000	-.018	-.009	1.000	1.000
	(Constant)	-1.860	1.035		-1.796	.078	-3.932	.213		
	Costs made in first year	-.013	.002	-.612	-5.945	.000	-.018	-.009	.997	1.003
	Media recruitment	-1.565	1.072	-.150	-1.460	.150	-3.710	.580	.997	1.003
	(Constant)	-3.396	.917		-3.704	.000	-5.231	-1.561		
	Costs made in first year	-.013	.002	-.577	-5.598	.000	-.017	-.008	.979	1.022
	Health care recruitment	2.306	1.308	.182	1.763	.083	-.313	4.924	.979	1.022
	(Constant)	-3.391	.860		-3.942	.000	-5.113	-1.669		
	Costs made in first year	-.013	.002	-.580	-5.795	.000	-.017	-.008	.991	1.009
	Study size	.003	.001	.245	2.451	.017	.000	.005	.991	1.009
	(Constant)	-4.557	3.260		-1.398	.168	-11.083	1.969		
	Costs made in first year	-.013	.002	-.615	-5.786	.000	-.018	-.009	.963	1.038
	Percentage assessed at measurement year	.023	.040	.062	.579	.565	-.057	.102	.963	1.038
	(Constant)	-4.457	.994		-4.483	.000	-6.448	-2.467		
	Costs made in first year	-.012	.002	-.539	-5.384	.000	-.016	-.007	.952	1.050
	Study design (1=RCT)	3.081	1.052	.293	2.927	.005	.974	5.187	.952	1.050

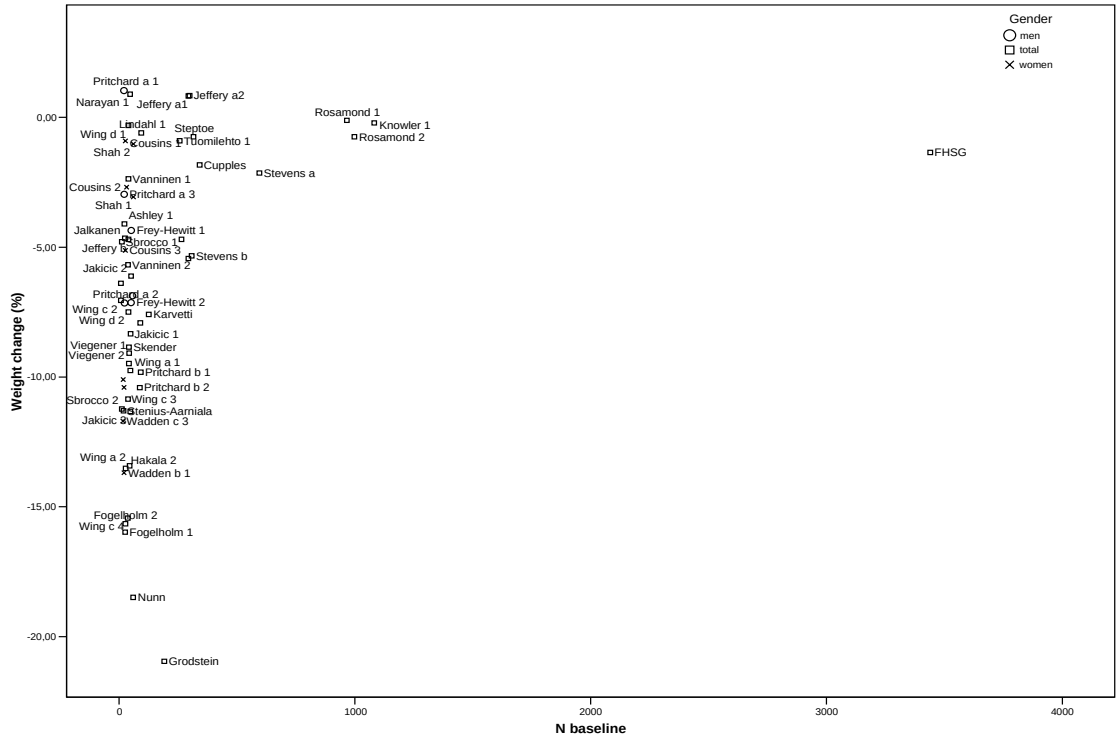
I-2. Multivariate regression models after a stepwise selection procedure used to assess the influence of study characteristics on weight changes in addition to intervention costs (n=61).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
A[a]										
1	(Constant)	-2.736	.852		-3.213	.002	-4.441	-1.032		
	Costs made in first year	-.013	.002	-.604	-5.815	.000	-.018	-.009	1.000	1.000
2	(Constant)	-4.457	.994		-4.483	.000	-6.448	-2.467		
	Costs made in first year	-.012	.002	-.539	-5.384	.000	-.016	-.007	.952	1.050
	Study design (1=RCT)	3.081	1.052	.293	2.927	.005	.974	5.187	.952	1.050
B[a]										
1	(Constant)	22.164	4.396		5.042	.000	13.367	30.961		
	Mean weight at baseline	-.316	.048	-.651	-6.581	.000	-.412	-.220	1.000	1.000
2	(Constant)	18.867	3.745		5.038	.000	11.371	26.362		
	Mean weight at baseline	-.249	.042	-.512	-5.867	.000	-.333	-.164	.903	1.108
	Costs made in first year	-.010	.002	-.444	-5.084	.000	-.014	-.006	.903	1.108
3	(Constant)	15.340	4.035		3.801	.000	7.259	23.421		
	Mean weight at baseline	-.266	.042	-.549	-6.317	.000	-.351	-.182	.864	1.158
	Costs made in first year	-.010	.002	-.465	-5.431	.000	-.014	-.006	.889	1.125
	Percentage assessed at measurement year	.064	.031	.172	2.040	.046	.001	.127	.922	1.085

[a] Model A considered study characteristics and intervention costs; model B as model A + baseline weight.



I-3. Relationship between percentage of population that was measured at one year and weight changes.



I-4. Relationship between study size and weight changes at one year.