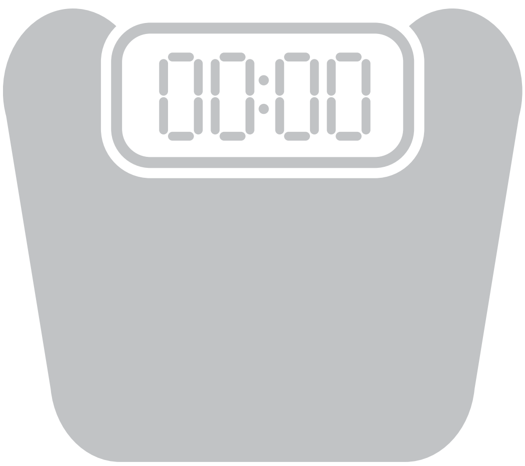
Chapter 2

Meta-analyses of workplace physical activity and dietary behavior interventions on weight outcomes



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Abstract

This meta-analytic review critically examines the effectiveness of workplace interventions targeting physical activity, dietary behavior, or both on weight outcomes. Data could be extracted from 22 studies published between 1980 and November 2009 for meta-analyses. The GRADE approach was used to determine the level of evidence for each pooled outcome measure. Results show moderate quality of evidence that workplace physical activity and dietary behavior interventions significantly reduce body weight (9 studies; Mean Difference -1.19 kg [95% Confidence Interval -1.64 to -0.74]), BMI (11 studies; MD -0.34 kg/m2 [95% CI -0.46 to -0.22]), and body fat percentage calculated from sum of skin-folds (3 studies; MD -1.12% [95% CI -1.86 to -0.38]). There is low quality of evidence that workplace physical activity interventions significantly reduce body weight and BMI. Effects on percentage body fat calculated from bioelectrical impedance or hydrostatic weighing, waist circumference, sum of skin-folds and waist-hip ratio could not be investigated properly due to a lack of studies. Subgroup analyses showed a greater reduction in body weight of physical activity and diet interventions containing an environmental component. As the clinical relevance of the pooled effects may be substantial on a population level, we recommend workplace physical activity and dietary behavior interventions, including an environment component, in order to prevent weight gain.

Introduction

The worldwide increasing prevalence of overweight and obesity is a cause for concern as the overweight-related morbidity, mortality and health care costs concurrently increase (1). According to US data, more than 37% of the workers is currently overweight (BMI≥25 kg m^{-2}) and at least 29% is obese (BMI≥30 kg m^{-2}) (2). The burden of disease attributable to overweight includes effects on chronic diseases such as cardiovascular diseases and type II diabetes, musculoskeletal disorders and a lower quality of life (1;3). Additionally, overweight and obesity are related to increased absenteeism rates and productivity-loss, and thus influence overweight-related costs (4-6).

Efforts to prevent weight gain by targeting physical activity, dietary behavior, or both via the workplace have been numerous over the last decades. Several systematic reviews have been conducted that found favorable effects on physical activity, dietary behavior or both (7-10) and on weight outcomes (7;8;10-12). However, a rigorous quantification of the effects is lacking. Summarising these effects in a meta-analyses has the advantage of a higher power to detect an effect, thus providing better estimates of an effect. Recently, a meta-analysis was published that found modest evidence for an effect of worksite physical activity and nutrition interventions in favor of the intervention group with a decrease of -1.3 kg (9 studies; [95% CI -2.1 to -0.45]) and -0.5 kg/m^2 (6 studies; [95% CI -0.8 to -0.2]) compared to controls at 6 or 12 months follow-up (13). Nevertheless, these results were limited to studies published up until 2005 and included studies aimed at weight loss only. In this rapidly growing research area, our meta-analytic review adds to the current body of evidence by providing an up-to-date meta-analyses excluding studies that focused on weight loss, and studies among only overweight or obese populations. Although the central aim of most included studies was not improving physical activity and dietary behavior or preventing weight gain, but for example reducing cardiovascular disease risk, a focus on primary and secondary prevention is important as population-based prevention of weight gain may prove to be more efficient in tackling the obesity epidemic than individual treatment of overweight subjects. The aim of this study is to critically examine the effectiveness of workplace interventions targeting physical activity, dietary behavior, or both on weight outcomes.

Methods

Inclusion criteria

Studies were eligible for inclusion if they were English-written randomized controlled trials (RCT), targeting physical activity and/or dietary behavior of employees, and reported any weight-related outcome measure (e.g. body weigh, body mass index, body fat percentage, waist circumference, waist-hip ratio and sum of skin-folds) (table 1). No limitations were set as to the subject and worksite characteristics (e.g. gender, age, occupation, number of employees), intervention content (e.g. exercise, counselling), follow-up measurements (e.g. short-term, long-term), or control group (e.g. health risk appraisal, waiting list, no intervention). As our focus is to assess possibilities for prevention, interventions aimed solely at overweight subjects (BMI≥25 kg m^{-2}) were excluded, as well as treatment and weight loss programs. Interventions targeting participants with an identified risk factors for chronic conditions (e.g. such as elevated blood lipids, cholesterol, or systolic blood pressure) were included. Studies targeting only participants with chronic conditions (e.g. diabetes, hypertension) were excluded.

Table 1. Search strategy.

Study design	Participants	Intervention	Outcome
Randomised controlled trial	Worker* Employee* Adult Occupational health Workplace*	Physical activity Exercise* Diet* Nutrition* Health promotion Health education Obesity prevention and control Weight gain prevention	Body weight Body fat Body mass index Waist circumference Sum of skinfolds Waist-hip ratio

This search strategy is from MEDLINE (MeSH) with search terms expanded. Keyword searches were further performed in EMBASE, PsycINFO, Cochrane Library, SportDiscus and Current Controlled Trials.
* terms expanded

Literature search

The search strategy was conducted following recommendations of Lipsey and Wilson for a comprehensive literature search (14). First, a computer search was performed in six electronic databases (MEDLINE, EMBASE, PsycINFO, Cochrane Library, SportDiscus and Current Controlled Trials) for studies published between 1980 and November 2009. Key articles were checked in MEDLINE to assess if relevant publications were missed. Second, references in relevant systematic reviews, narrative reviews and identified RCTs were screened. Third, personal databases were hand-searched for additional relevant publications. Identified studies were imported into the electronic bibliographic management package Reference Manager 11 (15).

Study selection

Two reviewers (LV and JC) independently applied the inclusion criteria to select potentially relevant studies from the titles, abstracts and keywords of the references retrieved from the literature search. The inclusion criteria were pilot tested by both reviewers on ten articles that were not included in this review, in order to resolve initial disagreement. Abstracts were scored as positive if all inclusion criteria were met, negative when one or more inclusion criteria was not met or unclear if there was insufficient information for a decision. Full text articles were retrieved for the studies that were scored as positive or unclear, as well as articles for which disagreement between the reviewers existed. All full text articles were read and subsequently checked to assess if inclusion was justified. Articles for which disagreement existed between the two reviewers were discussed with a third reviewer (KP).

Data extraction
Data were independently extracted by two authors (LV and JC) using a pre-designed data extraction form. Each study was summarized with regard to characteristics of participants, interventions, follow-up duration, outcome measures, and results. The data extraction form was pilot tested on three articles that were not included in this review. Disagreement between the reviewers about the data extraction was resolved by the third reviewer (KP). Missing data necessary for pooling was calculated according to the Cochrane Handbook for Systematic Reviews of Interventions (16-18). If articles did not contain sufficient information on the outcome measures, authors were contacted for the missing data.

Methodological quality assessment
The methodological quality of studies was independently assessed by two authors (LV and JC) following a predefined checklist based on recommendations of the Cochrane Handbook for Systematic Reviews of Interventions (table 2) (19). The checklist was pilot tested on three articles that were not included in this review. The checklist was slightly adapted for use in this review (20;21). A criterion regarding blinding of intervention providers was not used because this item is not applicable in lifestyle interventions. Regarding detection bias, items G, H, and I were added. This resulted in twelve criteria for internal validity that are related to selection bias (A, B), performance bias (C1, D1, D2), attrition bias (E, F) and detection bias (C2, G, H, I, J). Per article, criteria were scored as positive if the criterion was met, negative if the criterion was not met or unclear if insufficient information was provided for judgement. In case of disagreement, the third reviewer (KP) was consulted for a final decision. For articles that did not contain sufficient information, the authors were contacted. If authors could not be contacted or did not respond, the item was scored as unclear. Finally, each article received a quality judgement based on the number of positively scored criteria: excellent (10-12), good (7-9), fair (5-6) and poor (0-5).

Data synthesis and the GRADE approach
Data were analyzed of those studies that provided sufficient information for meta-analysis. For each continuous weight outcome measure, results were pooled per target behavior (physical activity, dietary behavior, or both) using the number of participants per group, mean differences (MD) and corresponding standard deviations (SD). Although included studies were all RCTs and none reported significant baseline differences for weight outcome measures, substantial differences between intervention and control groups were observed in several studies (22;23). To dissolve this bias, only change-from-baseline scores were included in our meta-analysis. Studies which provided final measurements and sufficient information to calculate change scores, were converted according to the Cochrane Handbook for Systematic Reviews of Interventions (16;17).
The measurement scales per outcome measure were comparable, allowing for the calculation of weighted mean differences using the random-effects model. A study was considered to have a positive effect in case of statistically significant results or a relevant effect size (i.e. >20% difference between study groups) (24). Heterogeneity was examined using the I^2 test,

with moderate heterogeneity assigned at 30–60% (17). To determine whether publication bias among included studies was present, the symmetry of the funnel plots was examined. Additional sensitivity analyses were conducted to explore subgroups. All meta-analyses were conducted using Review Manager 5.0 software (25).

Table 2. Methodological quality in included randomized controlled trials.

	Criterion	**Definition**
A	Randomisation Procedure	Positive if there was a clear description of the randomisation procedure *and* if randomisation was adequately performed: treatment allocation was concealed, i.e. by random aselect numbers or by a computer generated list (not by birthdate, entry order).
B	Similarity of study groups	Positive if the study groups were similar at the beginning of the study with regard to age and at least one of the relevant weight outcome measures ($p<0.05$). If differences existed between the groups, an adjusted analysis had to be performed.
C1	Blinding of participants	Positive if the participant was unaware of being assigned to the intervention group or the control group.
C2	Blinding of outcome assessor	Positive if the person performing the assessments was blinded as to the assignment of subjects to the groups. If questionnaires only were used, a negative score is given.
D1	Compliance	Positive if participants attended the intervention satisfactory according to the opinion of the reviewers. If compliance was not described, the author was contacted to provide the compliance data.
D2	Co-intervention	Positive if co-intervention was not present, such as following a program by a dietician or medication use.
E	Loss-to-follow-up	Positive if the percentage of dropouts during the study period did not exceed 20% for short term follow up (≤ 3 months) or 30% for long term follow up (>3 months).
F	Intention-to-treat	Positive if an intention-to-treat analysis was performed for at least one of the relevant weight outcome measures. Intention to treat was defined as analyzing participants in the group they were randomized to.
G	Timing of outcome assessments	Positive if the timing of the outcome measurement was identical for the intervention and control group
H	Data analyses	Positive if data analysis was adequate: if confounders were accounted for in at least one of the relevant outcome measures, if 95% CI were presented and analysis stratified where necessary.
I	Data collection methods	Positive if data collection methods were adequate: measurements done by trained personnel by means of standardized protocols. A negative score was given when data was self-reported.
J	Follow up	Positive if follow up was 6 months or longer, from the moment of randomization to the combined duration of intervention and (passive) follow up.

The overall quality of the evidence for each pooled weight outcome measure was assessed using GRADE, as recommended by the Cochrane Handbook for Systematic Reviews of Interventions (19). GRADE describes the confidence reviewers have in the estimated effect. The GRADE system provides information on 1) limitations of the included studies (methodological quality), 2) consistency of results, 3) directness (generalizability), 4) precision (sufficient data), and 5) publication bias. The overall quality of evidence was considered to be high if multiple RCTs with a low risk of bias provided consistent and generalizable findings, based on sufficient data with narrow SDs and no known or suspected publication bias. From this starting point, the quality of evidence was downgraded one level per factor that was not met. Thus, the GRADE approach results in four levels of evidence: high, moderate, low and very low. GRADEprofiler software (version 3.2.2) was used (26).

Results

Description of included studies

The literature search identified 1032 studies. After reading titles and abstracts, 43 randomized controlled trials were identified that met the inclusion criteria. Twenty-two of these studies provided sufficient information to be included in the meta-analyses (Figure 1). The description of the study characteristics is outlined in table 3. Twenty-six studies focused on improving physical activity and dietary behavior, 14 studies on physical activity only and 3 studies on dietary behavior only. The number of randomized participants ranged from 33 to 18,210. The age of the study populations ranged from 18 to 67 years. Seven studies included men only, four studies included women only, and the remaining 32 studies included both men and women. Based on the description of characteristics, 16 studies were performed among white collar workers, 9 among blue collar workers, and 18 studies did not describe this. Nine studies included participants with an elevated cardiovascular disease risk. Seventeen studies aimed at cardiovascular disease risk reduction, cholesterol reduction or chronic disease prevention. Sixteen studies aimed to improve physical fitness or physical activity, eight stated to focus on health promotion or healthy lifestyles, and two were aimed at obesity prevention or weight control. The interventions generally consisted of a health risk appraisal, an educational/informational component, a behavioural component, an exercise program or an environmental component. In 23 studies the control group received a health risk appraisal, 3 studies provided an educational/informational component, 3 provided a behavioral component, and 14 control groups received no intervention or were a wait list control group. The length of the intervention varied from 4 weeks to 3 years. Follow-up measurements were conducted at the short-term (< 6 months) in 11 studies, and long term (≥ 6 months) in 32 studies.

Table 3. Characteristics of trials (n=43) included in this review targeting physical activity and diet, physical activity only, or diet only.

1st Author year (ref) Country	Quality score	Study aim	Population	Intervention and control conditions	Compo-nents	Follow-up	Outcome measure	Result in mean difference
Target: PA and Diet								
Aldana 2005 (27) USA	8 (good)	Chronic disease prevention	145 Medical personnel and staff. I: 62 (T1); 61 (T2) C: 79 (T1); 76 (T2)	I: 4 weeks, 4x per week 2 hour group meetings by dieticians and medical professionals to improve understanding of importance of health risks and lifestyle changes + workbook and assignments + access to shopping tours and cooking demonstrations. C: Waiting list	I: b, c C: f	T1: 6 weeks T2 :6 months	1. Body weight (kg) 2. BMI (kg/m^2) 3. Body fat (%)	Significant decrease in I vs. C: 1. -2.9 vs. -0.4 **(T1); -4.4 vs. -1.0 **(T2) 2. -1.1 vs. -0.2 **(T1); -1.6 vs. -0.03 **(T2) 3. -1.1 vs. -0.3 *(T1); -2.4 vs. -0.4 **(T2)
Atlantis 2006 (30) Australia	7 (good)	Physical fitness	73 sedentary, healthy casino employees. I: 19 (T1) C: 23 (T1)	I: 24 weeks, 20 min 3x per week supervised aerobic exercise and 30 min 2-3x per week strength exercise + dietary/health education via 5 group seminars, one-on-one counselling, worksite manual +HRA C: Waiting list + HRA	I: a, b, c, d C: a	T1: 24 weeks	1. Body weight (kg) 2. BMI (kg/m^2) 3. WC (cm)	No significant difference in I vs. C: 1. +0.1 vs. +0.5 2. 0.0 vs. +0.1 Significant decrease in I vs. C: 3. -4.3 vs. -1.1**
Bruno 1983 (33) USA	0 (poor)	Cholesterol reduction	145 employees (selected on cholest, glusceos, age, weight, blood pressure, no heart disease) Ia + Ib: 47 (T1) C: 28 (T1)	Ia: 8 week cholesterol reduction program by health educator during lunch hours on food behavior change techniques: nutrition education, PA planning and self-management skills + HRA. Ib: Same as Ia, but different presentation in education materials C: HRA	Ia: a, b, c Ib: a, b, c C: a	T1: 3 months	1. Ideal body weight (%)	Significant decrease in Ia+Ib vs. C: 1. -2.4 vs. 1.1**
Cockcroft 1994 (34) England	5 (fair)	Health promotion	297 hospital staff I: 40 (T2) C: 43 (T2)	I: HRA + personal advice + leaflets + individual targets for change in 6 months C: HRA	I: a, b, c C: a	T1: 6 months	1. BMI (kg/m^2)	Significant decrease in I vs. C: 1. -0.54 vs. +0.01*
Connell 1995 (35) USA	3 (poor)	Health promotion	801 office workers, nurses and instructional staff, aged 19-67 years Ia: 142 Ib:248 Ic:253 C:158	1-year program with 4 arms. Ia: Health promotion + HRA booklet Ib: Health promotion Ic: HRA booklet C: HRA Health promotion: 1x per month optional individual counselling and feedback by health educator, optional classes and self-help materials. HRA booklet: personalized booklet based on HRA containing feedback, info, advice, space for an action plan and target dates.	Ia: a, b, c Ib: a, b, c Ic: a, b, c C: a	T1: 1 year	1. BMI (kg/m^2)	Significant decrease in Ia, Ib, Ic vs C: 1. ß: -0.05**, ß: -.0.05**, ß:-0.04* vs. ß:0

Edye 1989 (36) Australia	5 (fair)	CVD risk reduction	2489 white collar government workers, elevated cvd risk. I: 861 (T1) C: 1076 (T1)	I: HRA + 20 min counselling by physician on outcomes, attitude, and motivation. Tailored follow-up program during 3 months 3x 20 min counselling by nurse for reinforcement and measurements. C: HRA	I: a, b, c C: a	T1: 3 years	1. Body weight (kg)	No significant difference in I vs. C: 1. -1.00 vs. -1.25.
Elliot 2004 (37) USA	5 (fair)	Healthy lifestyle	33 fire fighters (3 fire stations) Ia: 12 (T1) Ib: 10 (T1) C: 11 (T1)	Ia: team-based curriculum with 10x 45 min peer taught sessions + workbooks, video, quiz, guide, goals + HRA Ib: 4x (+ 4.5 optional hours) individual counselling based on motivational interviewing + 1 physician visit + guide + HRA C: HRA	Ia: a, b, c Ib: a, b, c C: a	T1: 6 months	1. BMI (kg/m^2) 2. Body fat (%)	No significant difference in Ia, Ib vs. C: 1. -0.6; 0 vs. -0.3 2. -1.6, -0.9 vs. -0.4
Elliot 2007 (22) USA	3 (poor)	Healthy lifestyle	599 fire fighters (5 departments), aged 20-60. Ia: 186 Ib: 165 C: 129	Ia: team-based curriculum with 11x 45 min peer taught sessions + workbooks, video, quiz, guide, goals + HRA Ib: 4x (+ 5 optional hours) individual counselling based on motivational interviewing + guide + HRA C: HRA	Ia: a, b, c Ib: a, b, c C: a	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m^2)	Significant less increase in Ia, Ib vs. C: 1. +0.4, -0.5 vs. +1.5 * 2. +0.1, +0.2 vs. +0.5 *
Erfurt 1991 (38) USA	5 (fair)	Health promotion	4 plants (500-600 workers per site)	Ia: HRA + Health education Ib: HRA + Health education + follow-up counselling Ic: HRA + Health education + follow-up counselling + organisation C: HRA Health education: classes, use of media, guided self-help, individual counselling, mini-groups. Organisation: health network, peer support group, environmental interventions	Ia: a, b Ib: a, b, c Ic: a, b, c, e C: a	T1: 3 years	1. Body weight (kg)	Significant decrease in Ia, Ib, Ic vs. C: 1. +0.6, -1.2, -4.7 vs. +3.1*
Gemson 1995 (41) USA	4 (poor)	Health promotion	161 white collar workers, aged ≥ 30. I: 42 (T1) C: 48 (T1)	I: HRA + take-home report + 1x counselling by physician C: HRA	I: a, c C: a	T1: 6 months	1. Body weight (kg)	No significant difference in I vs. C: 1. -2.0 vs -0.7
Goetzel 2009 (44) USA	3 (poor)	Obesity prevention	10282 Dow Chemical employees Ia + Ib: 1583 (T1) C: 417 (T1)	Ia+Ib: health education materials (newsletters, intranet), PA and weight management programs. Ia: HRA + Moderate environmental changes using prompts and point-of-choice messages Ib: HRA + Ia+ Intensive environmental changes using adapted business goals and management commitment, and rewards for employees C:HRA	Ia: a, b, e Ib: a, b, e C: a	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m^2)	Significant difference in Ia+Ib vs. C: 1. -1.0 vs +1.4 ** 2. +0.1 vs +0.3**

Gomel 1993 (45) Australia	4 (poor)	CVD risk reduction	431 ambulance workers Used for analyses: I + C: 403 (T1), 369 (T2), 364 (T3)	Ia: C+ 20 min standard advice, educational manual and information video Ib: Ia + 10 weeks, 6x 50 min behaviour counselling + self-help manual Ic: Ic + goal setting + incentives C: HRA	Ia: a, b Ib: a, b, c Ic: a, b, c C: a	T1: 3 months T2: 6 months T3: 12 months	1. BMI (kg/m^2) 2. Body fat (%)	1. Significant difference between groups, change unknown. 2. No significant difference between groups, change unknown.
Hanlon 1995 (47) England	6 (fair)	CVD risk reduction	1632 employees at two worksites, aged 20-65. Ia: 247 (T1) Ib: 250 (T1) Ic: 241 (T1) Id: 219 (T1) Ie: 200 (T1) C: 246 (T1)	Ia: Health education without feedback Ib: Health education with feedback on cholesterol Ic: Health education with feedback on risk score Id: Health education with feedback on cholesterol and risk score Ie: No intervention (internal control group, intervention delayed) C: No intervention (external control group, intervention delayed)	Ia: b Ib: b, c Ic: b, c Id: b, c Ie: f C: f	T1: 5 months	1. BMI (kg/m^2)	No significant difference in I vs. C: 1.+0.11 vs. +0.02 (Id vs. Ie); +0.11 vs. +0.11 (Id vs. C)
Harrell 1996 (48) USA	2 (poor)	Physical fitness	1504 police trainees at 25 sites. I: unknown C: unknown	I: 4 hours lectures on health, nutrition and fitness + 12 hours fitness testing + 27 hours supervised aerobic and strength training by peers. C: Usual physical training.	I: b, c, d C: f	T1: 10 weeks	1. Body fat (%)	No significant difference in I vs C: 1. change unknown
Jeffery 1993 (49) USA	8 (good)	Weight control	Employees at 32 worksites participated in weight control program. I: 2041 C: unknown	I: during 2 years, 4x 11 bi-weekly health education classes (smoking cessation + weight loss) led by health educators + payroll-based incentives C: No treatment	I: b, c C: f	T1: 2 years	1. BMI (kg/m^2)	No significant difference in I vs. C: 1. -0.02 vs. +0.08
Kamioka 2009 (51) Japan	7 (good)	Healthy lifestyle	43 male white collar employees I: 22 (T1) C: 21 (T1)	I: during 24 weeks, every 2 weeks 2-hour health education by professionals and hot spa bathing and every week individualized program. C: general health guidance	I: b, c, d C: b	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m^2) 3. WC (cm) 4. Body fat (%)	No significant difference in I vs. C: 1. -0.5 vs. -0.6 2.-0.2 vs. -0.3 3. +0.1 vs. 0 4. -2.4 vs. -2.3
Makrides 2008 (54) Canada	4 (poor)	CVD risk reduction	566 employees, aged 19-66, ≥2 cvd risk factors. I: 282(T1), 178(T2) C: 284(T1), 219(T2)	I: 12 week health promotion program by professionals in exercise (individual + classes), education seminars, nutrition analysis, counselling + telephone follow up C: Waiting list	I: b, c, d C: f	T1: 3 months T2: 6 months	1. BMI (kg/m^2) 2. WH ratio	Significant difference in I vs C: 1. -0.57**(T2) No significant difference in I vs. C: 2. -0.007 (T2)
Muto 2001 (55) Japan	4 (poor)	CVD risk reduction	326 male workers at a building company, ≥1 abnormality in cvd risk factors. I: 152 (T2) C: 150 (T2)	I: 4 days education by professionals, counselling, group sessions + goals + during 1 year 4x self-evaluation with feedback from counsellor and family + HRA. C: Mailed advice after HRA	I: a, b, c, d, e C: a	T1: 6 months T2: 18 months	1. Body weight (kg) 2. BMI (kg/m^2)	Significant difference in I vs C: 1. -1.6 vs +0.1 ** (T1), -1.0 vs +0.5 ** (T2). 2. -0.5 vs 0.0** (T1), -0.3 vs +0.2**(T2).

Nilsson 2001 (56) Sweden	3 (poor)	CVD risk reduction	128 workers, elevated cvd risk. I: 44 (T1), 48 (T2) C: 43 (T1), 46 (T2)	I: HRA + during 1 year 16 group sessions with lectures, discussions, video, outdoor activities + individual counselling by a nurse C: HRA	I: a, b, c C: a	T1: 12 months T2: 18 months	1.BMI (kg/m²) 2. WH ratio	Significant difference in I vs C: 1. -0.7 vs +0.1 (T1), -0.5 vs 0.0* (T2) No significant difference in I vs. C: 2. +0.01 vs. 0 (T1); 0 vs. -0.01 (T2)
Nisbeth 2000 (57) Denmark	5 (fair)	CVD risk reduction	85 male white collar workers, aged 25-45 years. I: 34 (T1) C: 36 (T1)	I: 15 min counselling by exercise physiologist at baseline and 5 months on health information and education, and choice of goals (exercise, diet, smoking cessation, no change/ motivation) C: No intervention	I: b, c, d C: f	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m²)	Significant difference in I vs C: 1. -0.2 vs +1.4 * 2. -0.06 vs +0.42*
Okayama 2004 (59) Japan	7 (good)	CVD risk reduction	197 chemical company workers aged 30-64 with cholesterol ≥200 mg/dl. I: 96 (T1) C: 92 (T1)	I: HRA + blood tests every 2 months + education by health professional + personal action plan + feedback C: HRA + blood tests every 2 months	I: a, b, c C: a	T1: 6 months	1. Body weight (kg)	Significant difference in I vs C: 1. -0.8 vs -0.3*
Prochaska 2008 (61) USA	5 (fair)	Health promotion	1400 medical university workers. Ia: 464 Ib: 433 C: 503	Ia: C + 3 counselling sessions based on motivational interviewing during 6 months Ib: C+ Online tailored feedback program during 6 months C: HRA with feedback according to stage of change	Ia: a, c Ib: a, c C: a, c	T1: 6 months	1. BMI (kg/m2)	No significant difference in I vs. C: 1. change unknown
Proper 2003 (62) Netherlands	9 (good)	Physical fitness and health	299 white collar civil servants. I: 75 (T1) C: 117 (T1)	I: during 9 months, 7x 20 min counselling by professionals according to stages of change + standard information C: Standard information	I: b, c C: b	T1: 9 months	1. BMI (kg/m²) 2. Peripheral body fat (%)	No significant difference in I vs. C: 1. -0.08 vs. 0.13 Significant difference in I vs C: 2. -1.4 vs -0.6*
Racette 2009 (63) USA	8 (good)	CVD risk reduction	151 medical centre employees, 80% overweight I: 68 (T1) C: 55 (T1)	I: HRA + 1 year interventions by dietician/ exercise specialists; pedometers, weight watchers, group meetings, exercise program seminars, walking maps, team competitions, and rewards C: HRA	I: a, b, c, e C: a	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m²)	Significant difference in I vs C: 1. -0.8 vs. +0.6* 2. -0.4 vs. +0.1*
Rose 1980 (64) England	3 (poor)	CVD risk reduction	18210 male industry workers, aged 40-59. I: unknown C: unknown	I: C+ 4 extra OP visits + booklet + food records diary C: Letters + Poster + meeting + OP visit	I: a, b, c C: a, c	T1: 2 years T2: 4 years T3: 6 years	1. Body weight (kg)	No significant difference in I vs. C: 1. 0 between I and C (T3)
Veverka 2003 (66) USA	4 (poor)	Physical fitness	39 US air force men, aged 30-44. I: 20 (T1) C: 19 (T1)	I: during 6 months 1x per month tailored information via internet according to stage of change C: No intervention	I: b, c C: f	T1: 6 months	1. Body weight (kg) 2. BMI (kg/m²) 3. Body fat (%) 4. WH ratio	Significant difference in I vs C: 1. -2.2 vs -1.0**. 2. change unknown. 3. change unknown. 4. change unknown.

Target: PA								
Anshel 2009 (29) USA	7 (good)	*Physical fitness*	65 unfit, healthy university faculty and staff, aged 24-61. I: 29 (T1) C:36 (T1)	I: 8 week exercise, 3x per week aerobic and strength exercise, weekly coach visit, and weekly self monitoring exercise checklist C: 3x per week aerobic and strength exercise, weekly coach visit, but no checklist.	I: c, d C: c, d	T1: 8 weeks	1. Sum of skinfolds (mm)	No significant difference in I vs C: 1. -0.03 vs. -0.02
Fukahori 1999 (39) Japan	3 (poor)	*Physical fitness*	108 male blue and white collar workers, ≥2 cvd risk factors. I: 49 (T1) C: 52 (T1)	I: HRA + 6 months, 3x per week 20 min walking on treadmill at 70-75% heart rate + walk test 1x per month + notebook C: HRA	I: a, c, d C: a	T1: 3 months T2: 6 months	1. BMI (kg/m^2) 2. WH ratio	No significant difference in I vs C: 1. -0.3 vs. +0.2 (T2) 2. -0.06 vs. -0.01 (T2)
Garber 1992 (40) USA	1 (poor)	*Physical fitness*	60 university employees, aged 24-48. Ia: 14 (T1) Ib: 11 (T1) C: 10 (T1)	Ia: 8 weeks, 3x per week 50 min aerobic dance program. Ib: 8 weeks, 3x per week 50 min walk-jog program C: no intervention	Ia: d Ib: d C: f	T1: 8 weeks	1. Body weight (kg)	No significant difference Ia, Ib vs. C: 1. -1.0, -2.0 vs. +1.0
Gerdle 1995 (42) Sweden	6 (fair)	*Physical fitness*	97 female home care service workers I: 46 (T1) 32 (T2) C: 49 (T1) 45 (T2)	I: HRA + 1 year, 2x per week 1-hour aerobic exercise program by fitness instructor C: HRA	I: a, d C: a	T1: 1 year	1. Body weight (kg)	No significant difference in I vs. C: 1. -1.0 vs 0
Gilson 2007 (43) England	4 (poor)	*Physical activity*	70 academic and administrative university employees. Ia: 21 (T1) Ib: 21 (T1) C: 22 (T1)	Ia: Increasing steps per day by walking routes during 10 weeks15 min per day. Ib: Increasing steps per day during normal tasks during 10 weeks C: No intervention	Ia: b, c Ib: b, c C: f	T1: 10 weeks	1. Body fat (%) 2. WC (cm)	No significant difference in I vs. C: 1. +0.6 vs +0.9 2. +1.0 vs. +1.8
Grandjean 1996 (46) USA	1 (poor)	*CVD risk reduction*	37 female blue collar employees I: 20 (T1) C: 17 (T1)	I: 24 weeks, 3x per week 20-60 min aerobic training of increasing intensity + logbook. C: No intervention	I: c, d C: f	T1: 24 weeks	1. Body weight (kg) 2. Body fat (%)	Significant difference in I vs. C: 1. -2.0 vs +0.7 * No significant difference in I vs. C: 2. -4.1 vs. -2.1
Junea 1987 (50) USA	5 (fair)	*Physical fitness*	120 sedentary employees, aged 40-60. I: 60 (T1) 57 (T2) C: 60 (T1) 56 (T2)	I: HRA + 1x counselling + video + during 6 months, self-monitored home based exercise at moderate intensity C: HRA	I: a, b, c C: a	T1: 12 weeks T2: 24 weeks	1. Body weight (kg) 2. Body fat (%)	No significant difference in I vs. C: 1. -1.0 vs -0.2 (T2) 2. -1.5 vs. -1.7 (T2)
Keele-Smith 2003 (52) USA	3 (poor)	*Physical fitness*	149 faculty, students and staff. I: unknown C: unknown	I: during 5 weeks, education + monitoring by research assistant + brochure about exercise + individual written exercise prescription C: Monitoring only by telephone	I: b, c, d C: c	T1: 5 weeks	1. Body weight (kg) 2. Body fat (%)	No significant difference in I vs. C: 1. -0.6 vs. -0.3 2. -0.5 vs. +0.3

Lee 1997 (53) Australia	6 (fair)	*Physical fitness*	37 female university employees, aged 40-61. I: 16 (T1), 14 (T3) C: 16 (T1), 11 (T3)	I: during 12 weeks, weekly aerobic exercise class at 60% HR by fitness instructors + self-help exercise booklet C: Waiting list	I: c, d C: f	T1: 12 weeks T2: 24 weeks T3: 48 weeks	1.BMI (kg/m^2) 2. WC (cm) 3. Sum of skinfolds (mm)	No significant difference in I vs. C: 1. +0.8 vs. +1.1 (T3) 2. -1.7 vs. -0.2 (T3) 3. 18.3 vs. 18.9 (T3)
Murphy 2006 (23) England	6 (fair)	*CVD risk reduction*	37 civil service workers, aged ≤65. I: 21 (T1) C: 12 (T1)	I: 8 weeks, 2 days per week 45 min self-paced walking + diary. C: No intervention	I: c, d C: f	T1: 8 weeks	1. Body weight (kg) 2. Body fat (%) 3. WC (cm)	No significant difference in I vs. C: 1.+0.4 vs. +1.2 2. -0.1 vs. +1.8 3. -0.8 vs. +0.2
Oden 1989 (58) USA	2 (poor)	*Physical fitness*	45 sedentary workers, aged 18-49. I: unknown (T1) C: unknown (T1)	I: during 24 weeks individual exercise prescription (3x per week aerobic training at increasing heart rate) + weekly exercise logs, feedback and friendship. C: Normal daily routine.	I: c, d C: f	T1: 6 months	1. Body fat (%)	Significant difference in I vs. C: 1. change unknown.
Pedersen 2009 (60) Denmark	7 (good)	*Physical fitness*	549 public administration workers from 9 offices Ia: 106 (T1) Ib: 107 (T1) C: 106 (T1)	Ia: during 1 year 2-3x per week 20 min supervised resistance training + diary Ib: during 1 year all-round physical exercise using step counters, Cd, 1-4x per month instructor, information, contract, environmental campaign C: during 1 year self-supporting groups, presentations, no worksite changes.	Ia: c, d Ib: b, c, d, e C: c	T1: 1 year	1. Body weight (kg) 2. BMI (kg/m^2) 3. Body fat (%)	No significant difference in I vs. C: 1, 2, 3. change unknown
Spittaels 2007 (65) Belgium	10 (excellent)	*Physical activity*	526 healthy adults at 6 worksites, aged 25-55, no cvd history Ia: 14 (T1) Ib: 22 (T1) C: 21 (T1)	Ia: Online tailored PA advice + stage based reinforcement e-mails. Ib: Online tailored PA advice C: Online non-tailored PA advice	Ia: b, c Ib: b, c C: b	T1: 6 months	1. BMI (kg/m^2) 2. Body fat (%)	No significant difference in I vs. C: 1. Ia:-0.3, Ib:0.0 vs C:-0.3 Significant difference in Ia vs Ib,C: 2. Ia:-2.1* vs Ib:+0.1, C:-0.9
Von Thiele Schwarz 2008 (67) Sweden	9 (good)	*Physical activity and fitness*	195 women in dentistry at 6 worksites. Ia: 58 (T2) Ib: 43 (T2) C: 64 (T2)	Ia: on 2 days 1-2.5 hours medium-high intensity mandatory self chosen activity + diary. Ib: 1-2.5 hours reduction in working hours. C: No intervention.	Ia: c, d Ib: f C: f	T1: 6 months T2: 12 months	1. WH ratio	No significant difference in Ia vs C, significant increase in Ib vs C: 1. Ia:+0.03, +0.05** vs. C: -0.01 (T2)

Target: Diet								
Anderson 1999 (28) USA	3 (poor)	*CVD risk reduction*	502 blue collar workers at 8 worksites, aged 18-64, cholesterol ≥200 mg/dl. Ia: 50 (T1); 35 (T2) Ib: 41 (T1); 35 (T2) C: 276 (T1); 61 (T2)	Intervention participants could choose Ia or Ib. Ia: 4 group nutrition education classes for skill building on risk factors and food issues + HRA. Ib: 4 step individual nutrition education program (same content as Ia) for skill building + HRA. C: usual care: 20 min HRA counselling session with nurse + results + printed materials	Ia: a, c Ib: a, b C: a, b	T1: 6 months T2 :12 months	1. Body weight (kg) 2. BMI (kg/m^2)	No significant difference in Ia, Ib vs C: 1. +1.7, -2.4 vs. -0.1 (T2) 2. -0.1, -0.8 vs. +0.1 (T2)
Barratt 1994 (31) Australia	2 (poor)	*Cholesterol reduction*	683 workers at 6 hospitals, cholesterol ≥200 mg/dl. Used for analyses: 417 (T1); 430 (T2)	Ia: HRA + self-help package: educational workbook and behavior change aids (quizzes, shopping guidelines, recipes, 3-min video, monitoring sheet). Ib: HRA + nutrition course: 5x 1 hour group sessions by a dietician with opportunities to discuss fat, fiber, labelling, and barriers + taste sessions + workbook. C: HRA	Ia: a, b, c Ib: a, c C: a	T1: 3 months T2: 6 months	1. Body weight (kg)	Significant decrease in Ib vs. C: 1. - 0.35 vs. unknown* at (T2)
Braekman 1999 (32) Belgium	8 (good)	*Cholesterol reduction*	770 male blue-collar employees at 4 worksites, aged 35-59. I: 272 (T1) C: 366 (T1)	I: HRA with tailored feedback + 3 month education program to lower fat and cholesterol intake via 2-hour group sessions by a dietician on knowledge and skills, video and mass media activities (posters and leaflets). C: HRA	I: a, c, e C: a	T1: 3 months	1. BMI (kg/ m^2)2. WH ratio	Significant *increase* in I vs. C: 1. + 0.1 vs. -0.2** No significant difference in I vs. C: 2. -0.005 vs. -0.002

a. Health risk appraisal (HRA); b. Educational/ informational; c. Behavioral; d. Exercise; e. Environmental; f. Wait list/no intervention. BMI: body mass index; WC: waist circumference; WH ratio; waist-hip ratio. * p<0.05; ** p<0.01.

Quality of included studies

The methodological quality of the 43 included studies is outlined in table 3 (second column). The two reviewers disagreed on 74 of the 516 items (14%). Disagreement was mainly due to differences in interpretation of the methodological quality items and due to reading errors. Of the 21 authors that were contacted, 10 authors provided us with additional information on methodological quality.

Many studies failed to report information on methodological quality. Therefore, the majority of the studies was of fair (11/43) or poor quality (20/43). Eleven studies were of good quality and one of excellent quality. Recurrent methodological limitations were an inadequate or unclear description of the randomization procedure and treatment allocation concealment (31/43), inadequate or an unclear description of blinding of participants and outcome assessors (40/43), unclear whether co-intervention was present (39/43), and inadequate or an unclear description as to the performance of an intention-to-treat analysis (31/43).

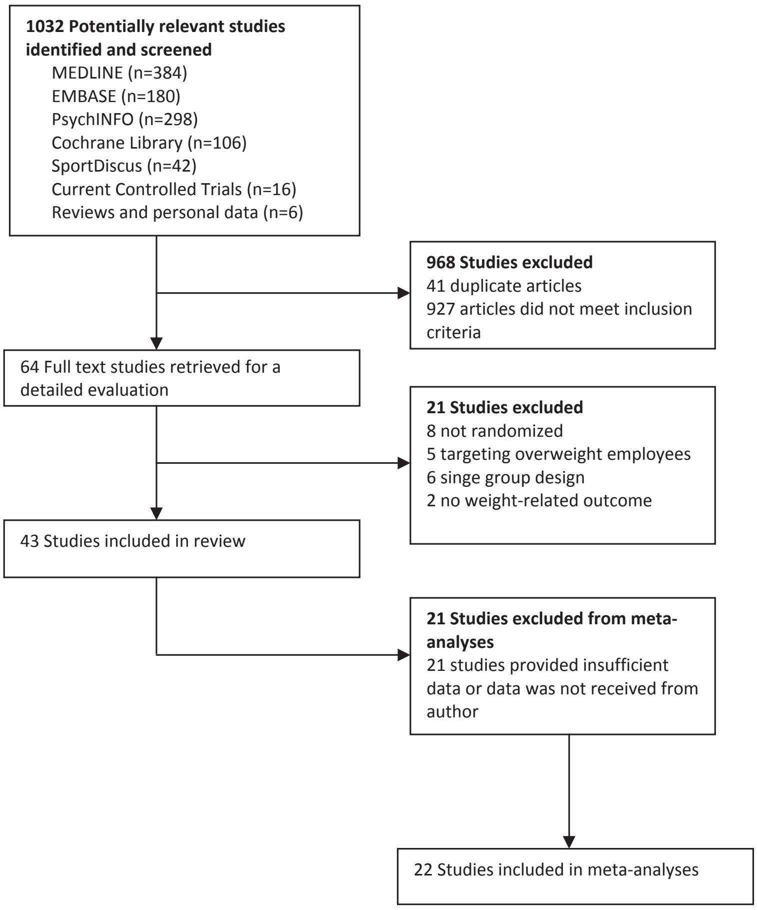

Figure 1. Flow chart for inclusion of studies.

Effectiveness of interventions

Twenty-two studies provided sufficient information to calculate mean differences and standard deviations for body weight (fourteen studies), body mass index (fourteen studies), percentage body fat (seven studies), waist circumference (four studies), waist-hip ratio (four studies), and sum of skin-folds (two studies) (figure 2-7). Eight authors were contacted for additional information on data, but none responded. All studies that provided weight data as final measurements could be converted into change scores. For all analyses, the random-effects model was used as mild heterogeneity was present. Sensitivity analyses using the fixed-effects model did not change the results. Funnel plots were examined for publication bias (data not shown). The distribution of point estimates were symmetrically distributed across the horizontal axis, indicating limited association between study precision and effect size.

	Intervention			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
1.1.1 PA and Diet								
Aldana 2005	-4.4	5.05	64	-1	5.05	79	3.9%	-3.40 [-5.06, -1.74]
Atlantis 2006	0.1	5.9	19	0.5	2.7	23	1.5%	-0.40 [-3.27, 2.47]
Elliot 2007	0.45	1.4	351	1.5	1.74	129	17.0%	-1.05 [-1.38, -0.72]
Goetzel 2009	-0.1	4.5	2486	1.4	4.5	633	16.2%	-1.50 [-1.89, -1.11]
Kamioka 2009	-0.5	2.8	22	-0.6	1.8	21	5.1%	0.10 [-1.30, 1.50]
Muto 2001	-1	3.2	152	0.5	2.2	150	12.7%	-1.50 [-2.12, -0.88]
Nisbeth 2000	-0.2	2.3	48	1.4	3.5	26	4.6%	-1.60 [-3.09, -0.11]
Okayama 2004	-0.8	1.2	96	-0.3	1.3	92	16.7%	-0.50 [-0.86, -0.14]
Racette 2009	-0.8	4.3	68	0.6	4.2	55	4.6%	-1.40 [-2.91, 0.11]
Subtotal (95% CI)			**3306**			**1208**	**82.3%**	**-1.19 [-1.64, -0.74]**
Heterogeneity: Tau² = 0.24; Chi² = 27.29, df = 8 (P = 0.0006); I² = 71%								
Test for overall effect: Z = 5.19 (P < 0.00001)								
1.1.2 PA								
Garber 1992	-0.66	5.15	24	0.45	8.25	9	0.4%	-1.11 [-6.88, 4.66]
Gerdle 1995	-1	2.6	32	0	2.3	45	7.0%	-1.00 [-2.12, 0.12]
Grandjean 1996	-2	4.14	20	0.7	3.9	17	1.8%	-2.70 [-5.29, -0.11]
Juneau 1987	-1	2.6	52	-0.1	2.7	51	7.8%	-0.90 [-1.92, 0.12]
Murphy 2006	0.4	6.67	21	1.2	6.12	12	0.7%	-0.80 [-5.29, 3.69]
Subtotal (95% CI)			**149**			**134**	**17.7%**	**-1.08 [-1.79, -0.36]**
Heterogeneity: Tau² = 0.00; Chi² = 1.65, df = 4 (P = 0.80); I² = 0%								
Test for overall effect: Z = 2.96 (P = 0.003)								
Total (95% CI)			**3455**			**1342**	**100.0%**	**-1.17 [-1.54, -0.80]**
Heterogeneity: Tau² = 0.18; Chi² = 28.94, df = 13 (P = 0.007); I² = 55%								
Test for overall effect: Z = 6.21 (P < 0.00001)								

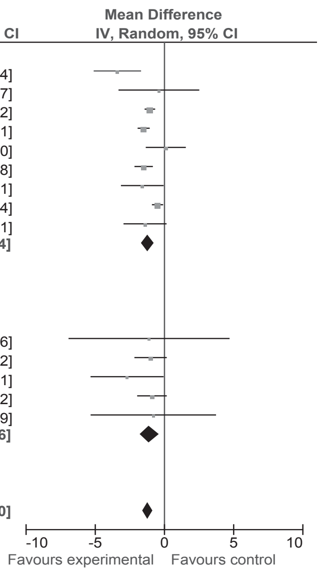

Figure 2. Comparison: Physical activity and dietary behavior interventions (1.1.1), physical activity interventions (1.1.2) versus control– Outcome: Body weight (kg).

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 PA and Diet								
Aldana 2005	-1.6	2.33	64	-0.03	2.33	79	2.9%	-1.57 [-2.34, -0.80]
Muto 2001	-0.3	1.1	152	0.2	0.8	150	10.5%	-0.50 [-0.72, -0.28]
Racette 2009	-0.4	1.67	68	0.1	1.44	55	4.7%	-0.50 [-1.05, 0.05]
Nilsson 2001	-0.5	1.25	43	0	1.02	46	5.7%	-0.50 [-0.98, -0.02]
Nisbeth 2000	-0.06	0.68	48	0.42	1	26	6.3%	-0.48 [-0.91, -0.05]
Elliot 2007	0.15	0.06	351	0.5	0.04	129	13.5%	-0.35 [-0.36, -0.34]
Proper 2003	-0.08	1.05	75	0.13	0.69	115	9.4%	-0.21 [-0.48, 0.06]
Goetzel 2009	0.1	1.32	2486	0.3	1.32	633	12.5%	-0.20 [-0.32, -0.08]
Atlantis 2006	0	1.9	19	0.1	1.3	23	1.9%	-0.10 [-1.11, 0.91]
Elliot 2004	-0.33	1.38	22	-0.3	1.52	11	1.7%	-0.03 [-1.10, 1.04]
Kamioka 2009	-0.2	0.8	22	-0.3	0.7	21	6.1%	0.10 [-0.35, 0.55]
Subtotal (95% CI)			**3350**			**1288**	**75.3%**	**-0.34 [-0.46, -0.22]**
Heterogeneity: Tau² = 0.01; Chi² = 24.53, df = 10 (P = 0.006); I² = 59%								
Test for overall effect: Z = 5.49 (P < 0.00001)								
1.2.2 PA								
Fukahori 1999	-0.3	0.44	49	0.2	0.34	52	11.8%	-0.50 [-0.65, -0.35]
Lee 1997	0.8	1.5	14	1.1	1.4	11	1.5%	-0.30 [-1.44, 0.84]
Subtotal (95% CI)			**63**			**63**	**13.3%**	**-0.50 [-0.65, -0.34]**
Heterogeneity: Tau² = 0.00; Chi² = 0.12, df = 1 (P = 0.73); I² = 0%								
Test for overall effect: Z = 6.38 (P < 0.00001)								
1.2.3 Diet								
Braekman 1999	0.1	1.13	272	-0.2	1.13	366	11.4%	0.30 [0.12, 0.48]
Subtotal (95% CI)			**272**			**366**	**11.4%**	**0.30 [0.12, 0.48]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.32 (P = 0.0009)								
Total (95% CI)			**3685**			**1717**	**100.0%**	**-0.30 [-0.45, -0.15]**
Heterogeneity: Tau² = 0.04; Chi² = 79.66, df = 13 (P < 0.00001); I² = 84%								
Test for overall effect: Z = 3.95 (P < 0.0001)								

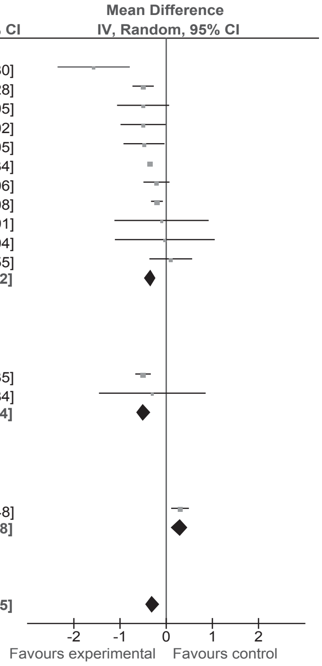

Figure 3. Comparison: Physical activity and dietary behavior interventions (1.2.1), physical activity interventions (1.2.2), dietary behavior interventions (1.2.3) versus control – Outcome: Body Mass Index.

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 PA and Diet (sum of skinfolds)								
Aldana 2005	-2.4	3.47	64	-0.4	3.47	79	13.6%	-2.00 [-3.14, -0.86]
Elliot 2004	-1.28	2.02	22	-0.4	1.36	11	13.4%	-0.88 [-2.05, 0.29]
Proper 2003	-1.39	2.46	75	-0.64	1.99	117	18.8%	-0.75 [-1.41, -0.09]
Subtotal (95% CI)			**161**			**207**	**45.9%**	**-1.12 [-1.86, -0.38]**
Heterogeneity: Tau² = 0.19; Chi² = 3.51, df = 2 (P = 0.17); I² = 43%								
Test for overall effect: Z = 2.98 (P = 0.003)								
1.3.2 PA and Diet (bioelectrical impedance)								
Kamioka 2009	-2.4	1.4	22	-2.3	1.1	21	17.8%	-0.10 [-0.85, 0.65]
Subtotal (95% CI)			**22**			**21**	**17.8%**	**-0.10 [-0.85, 0.65]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.26 (P = 0.79)								
1.3.3 PA (sum of skinfolds)								
Grandjean 1996	-4.1	1.89	20	-2.1	2.3	17	11.5%	-2.00 [-3.37, -0.63]
Subtotal (95% CI)			**20**			**17**	**11.5%**	**-2.00 [-3.37, -0.63]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 2.86 (P = 0.004)								
1.3.4 PA (bioelectrical impedance or hydrostatic weighing)								
Murphy 2006	-0.1	2.33	12	1.8	3.29	12	6.1%	-1.90 [-4.18, 0.38]
Juneau 1987	-1.5	1.6	52	-1.7	1.9	51	18.6%	0.20 [-0.48, 0.88]
Subtotal (95% CI)			**64**			**63**	**24.7%**	**-0.56 [-2.53, 1.42]**
Heterogeneity: Tau² = 1.47; Chi² = 2.99, df = 1 (P = 0.08); I² = 67%								
Test for overall effect: Z = 0.55 (P = 0.58)								
Total (95% CI)			**267**			**308**	**100.0%**	**-0.86 [-1.52, -0.20]**
Heterogeneity: Tau² = 0.48; Chi² = 18.46, df = 6 (P = 0.005); I² = 67%								
Test for overall effect: Z = 2.57 (P = 0.01)								

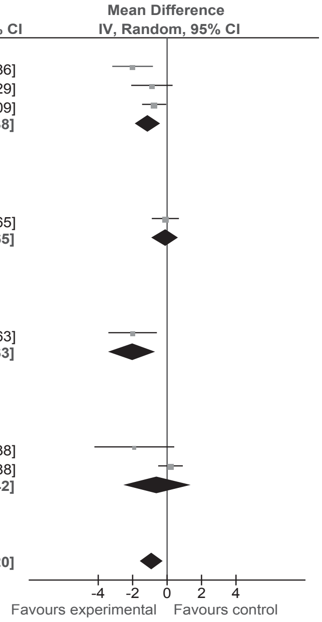

Figure 4. Comparison: Physical activity and dietary behavior interventions calculated from sum of skinfolds (1.3.1) or bioelectrical impedance (1.3.2), physical activity interventions calculated from sum of skinfolds (1.3.3) or bioelectrical impedance (1.3.4) versus control – Outcome: Body fat (%).

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.4.1 PA and Diet								
Atlantis 2006	-4.3	7.5	19	-1.1	3.4	23	11.5%	-3.20 [-6.85, 0.45]
Kamioka 2009	0.1	2.2	22	0	1.8	21	60.8%	0.10 [-1.10, 1.30]
Subtotal (95% CI)			**41**			**44**	**72.3%**	**-1.08 [-4.18, 2.02]**
Heterogeneity: Tau² = 3.53; Chi² = 2.84, df = 1 (P = 0.09); I² = 65%								
Test for overall effect: Z = 0.68 (P = 0.49)								
1.4.2 PA								
Lee 1997	-1.7	3.2	14	-0.2	4.1	11	16.8%	-1.50 [-4.45, 1.45]
Murphy 2006	-0.8	4.4	21	0.2	5.7	12	11.0%	-1.00 [-4.73, 2.73]
Subtotal (95% CI)			**35**			**23**	**27.7%**	**-1.31 [-3.62, 1.00]**
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.84); I² = 0%								
Test for overall effect: Z = 1.11 (P = 0.27)								
Total (95% CI)			**76**			**67**	**100.0%**	**-0.67 [-1.96, 0.63]**
Heterogeneity: Tau² = 0.34; Chi² = 3.56, df = 3 (P = 0.31); I² = 16%								
Test for overall effect: Z = 1.01 (P = 0.31)								

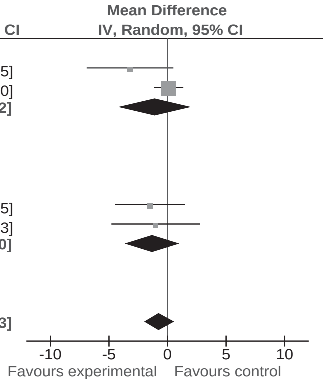

Figure 5. Comparison: Physical activity and dietary behavior interventions (1.4.1), physical activity interventions (1.4.2) versus control – Outcome: Waist circumference (cm).

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Lee 1997	18.3	7.4	14	18.9	7.9	11	0.0%	-0.60 [-6.67, 5.47]
Anshel 2009	-0.03	0.06	29	-0.02	0.06	36	100.0%	-0.01 [-0.04, 0.02]
Total (95% CI)			**43**			**47**	**100.0%**	**-0.01 [-0.04, 0.02]**
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.85); I² = 0%								
Test for overall effect: Z = 0.67 (P = 0.50)								

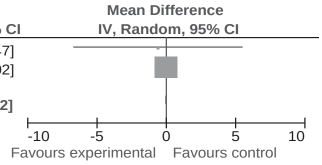

Figure 6. Comparison: Physical activity interventions versus control – Outcome: Sum of skinfolds (mm).

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.6.1 PA and Diet								
Nilsson 2001	0	0.02	43	-0.01	0.02	46	24.8%	0.01 [0.00, 0.02]
Subtotal (95% CI)			**43**			**46**	**24.8%**	**0.01 [0.00, 0.02]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 2.36 (P = 0.02)								
1.6.2 PA								
Fukahori 1999	-0.06	0.01	49	-0.01	0.01	52	25.1%	-0.05 [-0.05, -0.05]
Von Thiele 2008	0.03	0.02	58	-0.01	0.02	64	24.9%	0.04 [0.03, 0.05]
Subtotal (95% CI)			**107**			**116**	**50.0%**	**-0.01 [-0.09, 0.08]**
Heterogeneity: Tau² = 0.00; Chi² = 473.40, df = 1 (P < 0.00001); I² = 100%								
Test for overall effect: Z = 0.11 (P = 0.91)								
1.6.3 Diet								
Braekman 1999	0.005	0.0001	272	0.002	0.0001	366	25.2%	0.00 [0.00, 0.00]
Subtotal (95% CI)			**272**			**366**	**25.2%**	**0.00 [0.00, 0.00]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 374.75 (P < 0.00001)								
Total (95% CI)			**422**			**528**	**100.0%**	**0.00 [-0.03, 0.03]**
Heterogeneity: Tau² = 0.00; Chi² = 815.50, df = 3 (P < 0.00001); I² = 100%								
Test for overall effect: Z = 0.04 (P = 0.97)								

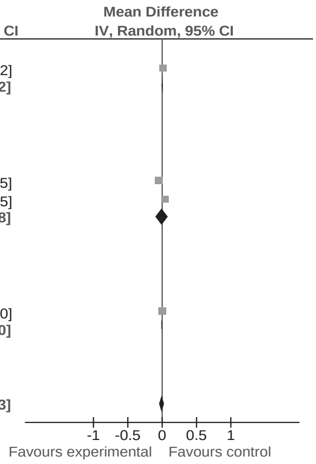

Figure 7. Comparison: Physical activity and dietary behavior interventions (1.6.1), physical activity interventions (1.6.2), dietary behavior interventions (1.6.3) versus control – Outcome: Waist-hip ratio.

Body weight

Nine studies that focused on improving physical activity and dietary behavior, and five studies that focused on improving physical activity, provided sufficient information to calculate mean differences for body weight. No studies were available for pooling that focused on improving diet only. Of the studies targeting physical activity and dietary behavior, five were of good quality, one of fair quality and three of poor quality. Two of the good quality studies found significant decreases in weight of -3.4 kg and -0.5 kg at 6 months respectively, by comparing a 4-week group sessions program provided by health professionals to wait list controls (27) and a 6-month education program by professionals, including an action plan and feedback to HRA controls (59). The other three good quality studies found non-significant differences by comparing an exercise program combined with education and counselling during 24-weeks (30), or combined with group meetings and team competitions during 1 year (63) to HRA controls, or counselling to general information during one year (51). The fair quality study found a significant effect of -1.6 kg by comparing counselling and goal setting to no intervention (57). The three poor quality studies found significant effects by comparing counselling sessions, group sessions, feedback and goals (-1.5 kg) (55), an informational and environmental intervention (-1.5 kg) (44), or team-based sessions and motivational interviewing (-1.1 kg) (22) to a HRA control group. Of the interventions targeting physical activity, three were of fair quality and two of low quality. The three fair quality interventions compared an 8-week self-paced walking program to no intervention (23), an aerobic exercise program during 1 year (42), or counselling sessions combined with 24-weeks of self-monitored home-based exercise (50) to HRA controls. The two poor quality, small studies compared a 24-week and 8-week exercise program to no intervention, but only the 24-week program found a significant effect of -2.7 kg (42;46).

According to the GRADE guidelines, the level of evidence for interventions targeting physical activity and dietary behavior was downgraded by one level due to statistical heterogeneity (-1 for item: inconsistency because I^2=71%) (Table 4). The level of evidence for interventions targeting physical activity was downgraded by two levels because less than 50% of the studies scored good on methodological quality (-1 for item: limitations) and the small number of participants (-1 for item: imprecision). **There is moderate quality of evidence from 9 studies (n=4514) that workplace interventions targeting <u>physical activity and dietary behavior</u> significantly reduce body weight (MD -1.19 kg [95% CI -1.64 to -0.74]). There is low quality of evidence from 5 studies (n=283) that workplace interventions targeting <u>physical activity</u> significantly reduce body weight (MD -1.08 kg [95% CI -1.79 to -0.36]). No studies were available targeting <u>dietary behavior</u>.**

Table 4. GRADE: overall judgement of quality of evidence.

Quality assessment							Summary of findings			
							No of patients		Effect	Quality
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention versus control (change from baseline)	control	Absolute*	
Body weight (kg) (PA and Diet; follow-up 6-18 months)										
9	randomized trials	no serious limitations	serious†	no serious indirectness	no serious imprecision	none	3306	1208	MD -1.19 (-1.64 to -0.74) ‡	MODERATE
Body weight (kg) (PA; follow-up 2-12 months)										
5	randomized trials	Serious§	no serious inconsistency	no serious indirectness	Serious¶	none	149	134	MD -1.08 (-1.79 to -0.36) ‡	LOW
BMI (kg/m^2) (PA and Diet; follow-up 6-18 months)										
11	randomized trials	Serious§	no serious inconsistency	no serious indirectness	no serious imprecision	none	3350	1288	MD -0.34 (-0.46 to -0.22) ‡	MODERATE
BMI (kg/m^2) (PA; follow-up 6-12 months)										
2	randomized trials	Serious§	no serious inconsistency	no serious indirectness	Serious¶	none	63	63	MD -0.50 (-0.65 to -0.34) ‡	LOW
BMI (kg/m^2) (Diet; follow-up 3 months)										
1	-	-	-	-	-	-	272	366	MD +0.3 (+0.12 to +0.48) ‡	VERY LOW**
Body fat (%) (PA and Diet; calculated from sum of skinfolds; follow-up 6-9 months)										
3	randomized trials	no serious limitations	no serious inconsistency	no serious indirectness	Serious¶	none	161	207	MD -1.12 (-1.86 to -0.38) ‡	MODERATE
Body fat (%) (PA and Diet; calculated from bioelectrical impedance; follow-up 1 year)										
1	-	-	-	-	-	-	22	21	MD -0.10 (-1.85 to -0.65) ‡	VERY LOW**
Body fat (%) (PA; calculated from sum of skinfolds follow-up 24 weeks)										
1	-	-	-	-	-	-	20	17	MD -2.00 (-3.37 to -0.63) ‡	VERY LOW**
Body fat (%) (PA; calculated from hydrostatic weighing or bioelectrical impedance; follow-up 8-24 weeks)										
2	randomized trials	Serious§	Serious††	no serious indirectness	Serious¶	none	64	63	MD -0.56 (-2.53 to +1.42)	VERY LOW

Waist circumference (cm) (PA and Diet; follow-up 24 weeks-1 year)										
2	randomized trials	no serious limitations	Serious‡‡	no serious indirectness	Serious¶	none	41	44	MD -1.08 (-4.18 to +2.02)	LOW
Waist circumference (cm) (PA; follow-up 8-48 weeks)										
2	randomized trials	Serious§	no serious inconsistency	no serious indirectness	Serious¶	none	35	23	MD -1.31 (-3.62 to +1.00)	LOW
Sum of skinfolds (mm) (PA; follow-up 8-48 weeks)										
2	randomized trials	no serious limitations	no serious inconsistency	Serious§§	Serious¶	none	43	47	MD -0.01 (-0.04 to +0.02)	LOW
Waist-Hip ratio (cm) (PA and Diet; follow-up 3-18 months)										
1	-	-	-	-	-	-	43	46	MD +0.01 (0 to +0.02)	VERY LOW**
Waist-Hip ratio (cm) (PA; follow-up 3-18 months)										
2	randomized trials	no serious limitations	Serious¶¶	no serious indirectness	Serious¶	none	107	116	MD 0 (-0.03 to +0.03)	LOW
Waist-Hip ratio (cm) (Diet; follow-up 3-18 months)										
1	-	-	-	-	-	-	272	366	MD 0 (-0.03 to +0.03)	VERY LOW**

The basis for the *assumed risk* (e.g. the median control group risk across studies) is provided in footnotes. The *corresponding risk* (and its 95% confidence interval) is based on the assumed risk in the comparison group and the *relative effect* of the intervention (and its 95% CI).
CI: Confidence interval; MD: Mean Difference; PA: Physical activity.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

*Better indicated by lower values.
† Statistical heterogeneity was present (I^2=71%).
‡ Significant at p<0.05.
§ less than 50% of the studies scored above 7 (good or excellent) on methodological quality.
¶ Small number of participants (<400) and wide 95% CI that could either support or refute the effectiveness of the workplace intervention.
** Only one study available.
†† Statistical heterogeneity was present (I^2=67%).
‡‡ Statistical heterogeneity was present (I^2=65%).
§§ Controls (29) are not comparable to those defined in inclusion criteria.
¶¶ Statistical heterogeneity was present (I^2=100%).

Body mass index

Eleven studies that focused on improving physical activity and dietary behavior, two studies that focused on improving physical activity and one study that focused on improving dietary behavior provided sufficient information on body mass index for pooling. Five of the studies that targeted physical activity and dietary behavior were of good quality, two were of fair quality and four were of poor quality. Of the good quality studies, only Aldana *et al* found a significant effect of -1.6 kg/m² at 6 months for the 4-week group sessions intervention program provided by health professionals compared to wait list controls (27). Racette *et al* compared exercise combined with group meetings and team competitions during 1 year compared to HRA controls (63). Two studies compared counselling to general information (51;62), and one study compared a short-term exercise program combined with education and counselling during 24-weeks to HRA controls (30). The two fair quality, small, long-term studies favored the intervention group. Elliot *et al* did not find a significant effect by comparing team-based sessions and motivational interviewing sessions to a HRA control group (37). Nisbeth *et al* found a significant difference (-0.5 kg/m²) by comparing counselling and goal setting during 5 months to no intervention (57). The four poor quality, long-term studies targeting physical activity and diet were all compared to a HRA control group, and found significant effects of -0.2 to -0.5 kg/m² in favor of the intervention group. The interventions varied from counselling sessions, group sessions, feedback and goals (22;55;56) to an informational and environmental intervention (44). Of the two studies that focused on improving physical activity, the fair quality study of Lee *et al* did not find a significant effect by comparing a self-help booklet during 12-weeks to a wait list control group (53). The poor quality study of Fukahori *et al* found a significant effect (-0.50 kg/m²) of an exercise intervention compared to a HRA control group (39). Remarkably, the high quality study that focused on improving dietary behavior significantly favored the intervention group (+0.30 kg/m²) via an education program and the environment during 3 months (32).

The evidence for studies targeting physical activity and dietary behavior, and physical activity only was downgraded by one level because less than 50% of the studies scored good on methodological quality (-1 for item: limitations). The evidence for studies targeting physical activity only was additionally downgraded due to the small number of participants (-1 for item: imprecision). The evidence for studies targeting diet was directly downgraded to very low because only one study was available. **There is moderate quality of evidence from 11 studies (n=4638) that workplace interventions targeting <u>physical activity and dietary behavior</u> significantly reduce body mass index (MD -0.34 kg/m² [95% CI -0.46 to -0.22]). There is low quality of evidence from 2 studies (n=126) that workplace interventions targeting <u>physical activity</u> significantly reduce body mass index (MD -0.50 kg/m² [95% CI -0.65 to -0.34]). No conclusion is provided for workplace interventions targeting <u>dietary behavior</u> because only one study was available.**

Body fat percentage

Four studies focused on improving physical activity and dietary behavior, and three studies focused on improving physical activity reported sufficient information on body fat percentage for pooling. However, because different measurement methods were used that do not correlate well (68), analysis were separated for studies that calculated percent body fat based on sum of skin-folds versus studies that used bioelectrical impedance or hydrostatic weighing. Three of the studies targeting physical activity and diet calculated body fat percentage from sum of skin-folds. Two were of high quality and found a significant decrease of -2.0% and -0.8% by comparing an intensive group session to a wait list control at 6 months, and individual counselling to standard information at 9 months respectively (27;62). The other study was of fair quality study and favored the intervention group by comparing team-based sessions and motivational interviewing to a HRA control group (37). One small, fair quality study focused on improving physical activity and diet, that calculated body fat percentage from bioelectrical impedance, found a non-significant effect after one year in favor of the intervention group receiving individual and group health education including hot spa bathing, compared to general health guidance (51). One small, low quality study focused on improving physical activity, that calculated body fat percentage from sum of skin-folds, found a 24-week aerobic training intervention significantly decreased body fat percentage with -2.0% at 24 weeks compared to no intervention (46). Finally, two studies focused on improving physical activity, that calculated body fat percentage from bioelectrical impedance or hydrostatic weighing, found non-significant effects on body fat percentage by comparing an 8-week self-paced walking program to no intervention (23) or one counselling session and self-monitored home-based exercise during 6 months to a HRA control group (50).

The evidence for studies targeting physical activity and dietary behavior, and physical activity only was downgraded by one level due to the small number of participants (-1 for item: imprecision). The evidence for studies targeting physical activity was additionally downgraded because less than 50% of the studies scored good on methodological quality (-1 for item: limitations) and due to statistical heterogeneity (-1 for item: inconsistency because I^2=67%). Because only one study was available, the evidence was directly downgraded to very low for the study that focused on improving physical activity and dietary behavior which calculated body fat percentage from sum of skin-folds, and the study that focused on improving physical activity which calculated body fat percentage from bioelectrical impedance or hydrostatic weighing.

There is moderate quality of evidence from 3 studies (n=368) that workplace interventions targeting <u>physical activity and dietary behavior</u> significantly reduce percent body fat calculated from sum of skin-folds (MD -1.12 % [95% CI -1.86 to -0.38]). No conclusion is provided for percent body fat calculated from bioelectrical impedance because only one study was available. There is very low quality of evidence from 2 studies (n=127) that workplace interventions targeting <u>physical activity</u> reduce percent body fat calculated from bioelectrical impedance or hydrostatic weighing (MD -0.56 % [95% CI -2.53 to 1.42]). No conclusion is provided for percent body fat calculated from sum of skin-folds because only one study was available. No studies were available targeting <u>dietary behavior</u>.

Waist circumference

Two small, good quality studies focusing on improving physical activity and dietary behavior (30;51) and two small, fair quality studies focusing on improving physical activity (23;53) provided sufficient information on waist circumference for pooling. Atlantis *et al* and Kamioka *et al* found non-significant effects from an exercise program combined with education and counselling during 24 weeks, or an individual and group health education including hot spa bathing after one year compared to general health guidance (30;51). Lee *et al* and Murphy *et al* found non-significant effects from a self-help booklet for 12-weeks, or a diary during 8-weeks, compared to no intervention (23;53).

The evidence was downgraded for both groups due to the small number of participants (-1 for item: imprecision). The evidence was additionally downgraded for interventions targeting physical activity and dietary behavior due to statistical heterogeneity (-1 for item: inconsistency because I^2=67%) and for interventions targeting physical activity because less than 50% of the studies scored good on methodological quality (-1 for item: limitations).

There is low quality of evidence from 2 studies (n=85) that workplace interventions targeting <u>physical activity and dietary behavior</u> reduce waist circumference (MD -1.08 cm [95% CI -4.18 to +2.02]). There is low quality of evidence from 2 studies (n=58) that workplace interventions targeting <u>physical activity</u> reduce waist circumference (MD -1.31 cm [95% CI -3.62 to +1.00]). No studies were available targeting <u>dietary behavior</u>.

Sum of skin-folds

Two small studies that focused on improving physical activity only provided sufficient data on sum of skin-folds for pooling. Lee *et al* found a non-significant effect in favor of a 12-week aerobic exercise class at 60% heart rate compared to wait list controls (53). Anshel *et al* found a non-significant effect in favor of an 8-week exercise intervention combined with weekly coach visits and a self-monitoring checklist, compared to the same program but without the self-monitoring checklist (29).

The evidence was downgraded to low quality because the controls of Anshel *et al* were not comparable to those in the inclusion criteria (-1 for item: indirectness), and due to the small number of participants (-1 for item: imprecision).

There is low quality of evidence from 2 studies (n=90) that workplace interventions targeting <u>physical activity</u> reduce sum of skin-folds (MD -0.01 mm [95% CI -0.04 to +0.02]). No studies were available targeting <u>physical activity and dietary behavior</u>, or <u>dietary behavior</u>.

Waist-hip ratio

Four studies that measured waist-hip ratio provided sufficient information for pooling. One study focused on improving physical activity and diet found a small difference in favor of the control group compared to individual counselling by a nurse combined with 16 groups sessions (56). Two studies focused on improving physical activity found small significant effects from a walking intervention versus a health risk appraisal control group (-0.05) (39) and a medium intensity mandatory self-chosen activity on 2 days per week during six months compared to no intervention (+0.04) (67). One study focused on improving diet via an education program and the environment during 3 months found no effects compared to a HRA control group (32).

The evidence of studies targeting physical activity was downgraded by two levels based on statistical heterogeneity (-1 for item: inconsistency because I^2=100%) and the small number of participants (-1 for item: imprecision). The evidence for studies targeting physical activity and diet, and diet only was directly downgraded to very low because only one study was available.

There is low quality of evidence from 2 studies (n=223) that workplace interventions targeting physical activity do not reduce waist-hip ratio (MD 0 [95% CI -0.03 to 0.03]). No conclusion is provided for studies targeting physical activity and dietary behavior, or dietary behavior because only one study was available.

Subgroup analyses

A sufficient number of participants for subgroup analyses was only available for workplace interventions targeting physical activity and dietary behavior for outcome measures body weight and body mass index. Subgroup analyses could be performed for follow-up duration (6 months or >6 months (none had <6 months follow-up)), intervention content (educational, behavioural, exercise or environmental), and methodological quality (good quality versus fair or poor quality). Analyses could not be performed for gender, age or blue versus white collar workers, because this could not be determined in the majority of the studies. Analyses could neither be performed for a health risk appraisal versus waiting list/ no intervention control group due to statistical heterogeneity.

Analysis by follow-up duration did not show a relevant change (>20%) in pooled body weight estimates. Analysis by intervention content showed that the pooled reduction on body weight of interventions targeting physical activity and dietary behavior, providing an environmental component was larger (3 studies; -1.50 kg [95% CI -1.82 to -1.17]) (44;55;63) than the pooled effect of interventions without an environmental component (6 studies; -1.01 kg [95% CI -1.63 to -0.38]). Analysis by methodological quality showed that the pooled reduction of weight for high quality interventions targeting physical activity and dietary behavior was smaller and non-significant (5 studies; -1.07 kg [95% CI -2.15 to 0.00]) (27;30;51;59;63) than the pooled effect of fair or poor quality interventions (4 studies; -1.30 kg [95% CI -1.58 to -1.03]). Analyses by follow-up duration, intervention content or methodological quality did not show a relevant change (>20%) in pooled body mass index estimates.

Discussion

This meta-analyses of twenty-two studies showed there is moderate quality of evidence that workplace physical activity and dietary behavior interventions significantly reduce body weight, body mass index, and body fat percentage calculated from sum of skin-folds. Additionally, there is low quality of evidence that workplace physical activity interventions significantly reduce body weight and body mass index. No evidence was found from workplace interventions focusing on dietary behavior only due to a lack of studies. Moreover, effects

on percentage body fat calculated from bioelectrical impedance or hydrostatic weighing, waist circumference, sum of skin-folds and waist-hip ratio could also not be investigated properly due to a lack of studies.
Our findings are consistent with a previous review, that demonstrated a similar modest weight loss of -1.3 kg (9 studies; [95% CI -2.1 to -0.45]) and -0.5 kg/m^2 (6 studies; [95% CI -0.8 to -0.2]) among studies up until 2005 (13). Six of the studies found by Anderson et al. that measured body weight, and five that measured BMI, were also included in this review. Thus, in our study we were able to include eight and nine additional studies with regard to body weight and body mass index, respectively. In total, eight studies were included that were published after 2005. Moreover, this review presents pooled results for body fat, waist circumference, waist-hip ratio and sum of skin-folds. These findings emphasize the ongoing interest for research in this area and the rationale for this review.
Subgroup analyses showed that studies targeting physical activity and dietary behavior, with an environmental component were more effective in reducing body weight than studies without an environmental component. The environmental component varied from walking maps and team competitions (63) to family involvement (55) and prompts, point-of-choice messages, walking routes, business goals and management commitment (44). This finding implicates that even though these environmental components differ, future studies should seriously consider environmental components besides personal components. Although this has been suggested previously (69), our study is the first to quantify the importance of environmental components. Subgroup analyses further showed that effects of good quality studies on body mass index (change>20%; also on body weight but change<20%) were smaller and non-significant, than for fair or poor quality studies. Thus, based on the current evidence the conclusion that there is moderate evidence ('future research may change the estimate') for effects of physical activity and dietary behavior interventions body mass index remains the best conclusion. Future research may find that the addition of one or more good quality studies may strengthen the effect, and change the quality of evidence judgement from 'moderate' to 'high'.
Moderate evidence was also assigned to the effect of studies targeting physical activity and dietary behavior on body weight. Although the evidence was downgraded based on the significant random-effect meta-analysis and I^2 larger than 50%, all studies were in the direction of benefit. It is therefore safe to conclude that the intervention is beneficial, even though the amount of benefit is uncertain (70). Finally, evidence was downgraded to moderate for effects of three physical activity and dietary behavior interventions on body fat percentage calculated from sum of skin-folds because of the limited number of participants. However, because effects of two other interventions that calculated body fat percentage more reliably from bioelectrical impedance or hydrostatic weighting, we feel this result is very unreliable.
A first strength of this meta-analytic review compared to other reviews is that we only included randomised controlled trials. This design most adequately reduces bias (71). Nevertheless, we acknowledge that other study designs may provide information that adds to the existing knowledge of lifestyle interventions (72). Because the study by Anderson et

al. included other study designs (ie, non-randomised studies, cohort designs, time series) and concluded that these results were similar, it seems results are consistent across research designs. Second, we excluded studies aimed at treatment or weight loss, and studies among overweight (BMI≥25 kg m-^{2}) populations, as obesity prevention may be a more important and cost-effective way for improving population health than individual treatment of overweight subjects (73). Third, as the decision to include or exclude a particular study is subjective, we chose not to exclude studies of poor quality. Although inclusion of methodologically sound studies only ('best evidence meta-analyses') may prevent that a good meta-analysis of badly designed studies will result in bad statistics, we found it more interesting to include these studies to allow the reader to make an own judgement of the conclusions. Moreover, our results did not indicate stronger evidence for good quality studies. Fourth, we chose to use the last available measurement for pooling, instead of standardising the effects at for example 6 months. Because most people who lose weight regain weight over time, using long-term data may better approach the true effect. Nevertheless, we found no effect of follow-up duration on body weight or body mass index in workplace physical activity and dietary behavior interventions, most likely because all follow-up durations were long-term (6-18 months). Finally, by applying the GRADE method, it was possible to provide a more transparent overview of our decisions in the confidence in the overall effects.
There are some limitations as well. First, the central study aim of the included study differed from our study aim. Because only recently there is a rise in studies that specifically aim to improve physical activity, dietary behavior, or both, we had to widen our inclusion criteria. Our results may therefore be underestimated. Second, we cannot exclude publication bias. The distribution of effect sizes were not skewed in the funnel plots and the results therefore do not suggest publication bias. Nevertheless, only half of the studies included in this review provided sufficient information for pooling. This possible publication bias should be considered when interpreting the outcomes of our meta-analyses. Finally, most studies did not provide information on methodological quality, especially with regard to the randomization procedure, blinding, co-intervention, and intention-to-treat analysis. This led to the downgrading of the level of evidence for the several outcome measures. Taking into account that this was the only item we downgraded on for the outcome body mass index, we urge future studies to report methodological quality for a better assessment of the overall quality.

Conclusion

Implications for practice

This meta-analytic review showed interventions focusing on improving physical activity *and* dietary behavior are moderately effective in reducing body weight of employees with -1.19 kg, and that adding an environmental component may reduce body weight with an additional -0.29 kg. Based on the fact that we did not have to downgrade for the item directness, these effects are generalizable to the worksite setting. However, we were not able to assess differences among subgroups of employees. Nevertheless, the prevention paradox must be considered. The effect of weight gain prevention interventions on population level may be substantial, but the influence and perceptible benefits on the health of most people is relatively small. For one person to benefit, many people have to change their behavior, even though they receive no benefit or even perceive harm from the change (74). The review by Shaw *et al* showed that exercise interventions (especially when combined with dietary interventions) were found to be effective for improving secondary outcomes (such as cardiovascular disease risk, blood pressure and blood glucose) even if weight loss did not occur (75). Moreover, a public health policy report in the Netherlands determined that a broad implementation of physical activity in combination with dietary interventions may realistically reduce the prevalence rate of overweight by 1-3 percentage points and the prevalence of inactivity by 1-2 percentage points over 5 years (76). If this succeeds, it was estimated 15,000 to 41,000 diabetes cases, 17,000 to 40,000 heart disease cases, and 43,000 to 100,000 musculoskeletal disorders can be prevented during the next 20 years. Additionally, by implementing environmental and individual interventions, a cost-effectiveness ratio per life year gained was estimated to be €6,000. Thus, these studies support the use of physical activity and dietary behavior interventions, including an environmental component, to prevent weight gain among employees.

Implications for researchers

The evidence for the effectiveness of interventions targeting physical activity and dietary behavior in achieving small reductions of body weight remains moderately convincing, but more convincing than in previous reviews. Future research should particularly focus on environmental opportunities in addition to behavioral strategies. Moreover, when more studies are available, we may find more components that contribute to reducing weight. More studies are also needed that report on waist circumference, waist-hip ratio, and sum of skin-folds before sound conclusions can be formulated for these outcome measures. Finally, studies should pay more attention to reporting randomization procedures, blinding, co-intervention, and intention-to-treat analysis (19), in order to gain insight in methodological quality.

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