Worksite health promotion in the construction industry

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Chapter 7

Cost-effectiveness and return-on-investment of a worksite intervention aimed at improving physical activity and nutrition among construction workers

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Abstract

Objectives: To conduct a cost-effectiveness and return-on-investment (ROI) analysis of a worksite physical activity and nutrition program for construction workers in comparison with usual practice.

Methods: The intervention consisted of generic as well as tailored health information and personal health counseling. A total of 314 participants were randomized to the intervention (n=162) or control group (n=152). Data on body weight, waist circumference, musculoskeletal disorders (MSD), work-related vitality, and job satisfaction were collected at baseline, 6, and 12 months. Sickness absence data were collected from company records. Other cost data were collected with 3-monthly questionnaires. Missing data were imputed using multiple imputation. Cost-effectiveness analyses were conducted from both the societal and employer's perspective. A ROI analysis was performed from the employer's perspective. Bootstrapping techniques were used to assess the uncertainty of the results.

Results: Intervention costs per participant were €178 from the societal perspective (bottom-up micro-costed) and €287 from that of the employer (market prices). At 12-month follow-up, no statistically significant cost and effect differences were found. The probabilities of cost-effectiveness for body weight, waist circumference, and MSD gradually increased with an increasing ceiling ratio to 0.84 (willingness-to-pay = €21,000/kg), 0.77 (willingness-to-pay = €18,000/cm), and 0.84 (willingness-to-pay = €42,000/person prevented from having a MSD), respectively. The probabilities of cost-effectiveness for work-related vitality and job satisfaction were low at all ceiling ratios (≤0.54). Financial return estimates were positive, but their confidence intervals were rather wide and none of them was statistically significant.

Conclusion: The intervention's cost-effectiveness in improving weight-related outcomes and MSD depends on the societal and employer's willingness-to-pay for these effects and the probability of cost-effectiveness that they consider acceptable. From the employer´s perspective, the intervention was not cost-effective in improving work-related vitality and job satisfaction. Also, due to a high level of uncertainty, it cannot be concluded that the intervention was cost-beneficial to the employer.

Introduction

Excessive body weight and musculoskeletal disorders (MSD) have a serious impact on public health in many developed countries (1-5). In the Netherlands, the combined prevalence of overweight (Body Mass Index [BMI] 25 - 30 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) is 48% among adults (6), and that of MSD is estimated to be 39% in adult men and 45% in adult women (7). Among construction workers, these prevalences are even higher (8;9). Both conditions not only reduce a person's well-being, but also impose a large economic burden on companies and society as a whole due to increased absenteeism, presenteeism (i.e. reduced productivity while at work), and healthcare consumption (10-12).

The workplace presents a useful setting to combat the high prevalence of excessive body weight and MSD, as it provides social and organizational support structures that can help improve risk behaviours and many companies have the infrastructure available to offer behaviour change interventions at relatively low costs (13). In addition, worksite physical activity and nutrition programs in particular, cannot only reduce body weight (14) and MSD prevalence (15), but may also generate cost savings to a company through reduced absenteeism (16) and presenteeism (17). Therefore, in the VIP in Construction study, a worksite physical activity and nutrition program was developed aimed at preventing and reducing overweight and MSD among construction workers (i.e. VIP in Construction intervention) (18). An evaluation of the intervention's effectiveness has been reported elsewhere (19;20).

7

Decisions about investments in worksite health promotion programs typically lie by the company management. In doing so, they are not just interested in the effectiveness of such interventions, but also in their impact on the company's bottom-line (21;22). To provide this information, return-on-investment (ROI) analyses can be performed in which the costs of an intervention are compared to the company's resulting financial savings (23;24). However, as health outcomes are not directly considered in a ROI analysis and other stakeholders may reap a large part of the benefits (e.g. health insurance companies), cost-effectiveness analyses (CEAs) and analyses from the broader societal perspective are of importance as well.

The present study aimed to conduct CEAs and a ROI analysis, in which the VIP in Construction intervention was compared to usual practice. CEAs were performed from both the societal and employer's perspective, and the ROI analysis from that of the employer.

Methods

Study design

Analyses were conducted alongside a 12-month randomized controlled trial (RCT), which took place from 2010 to 2012. The study protocol was approved by the Medical Ethics Committee of the VU University Medical Center (18), and the trial has been registered in the Netherlands Trial Register (NTR2095).

Participants

All blue collar workers of a Dutch construction company who were invited for a voluntary periodical health screening at the occupational health service between February 2010 and October 2011 were recruited for the study. Workers who were on long-term sick leave (≥4 weeks) were excluded. At baseline, all workers who decided to participate in the study provided informed consent. After baseline measurements, participants were randomized to the intervention or control group. Randomization took place at the individual level and was performed by a research assistant using a computer-generated randomization sequence in SPSS (v15, Chicago, IL). The research assistant had no information on the participants to ensure allocation concealment (18).

Intervention and control condition

All participants received practice as usual. Additionally, intervention group participants received the VIP in Construction intervention. A detailed description of the intervention has been given elsewhere (18). In brief, the intervention consisted of generic as well as tailored health information (i.e. VIP in Construction toolbox) and personal health counseling (PHC). Participants with a healthy weight status (i.e. BMI<25 and waist circumference<94) and a healthy physical activity level (i.e. meeting physical activity recommendations (25;26)) only received the VIP in Construction toolbox; all others also received PHC.

The VIP in Construction toolbox consisted of health information brochures tailored to the participants' physical activity level and weight status, a calorie guide, a pedometer, a BMI card, a waist circumference measuring tape, a cookbook including healthy recipes and a knowledge test, "personal energy plan" forms, an overview of the health promotion facilities of the company, and an exercise card.

PHC intensity (i.e. number and duration of contacts) was tailored to the participants' stage-of-change for improving physical activity and nutrition (Table 1) (18;27). Face-to-face and telephone coaching contacts were provided during work hours and were given by physiotherapists specialized in lifestyle coaching (i.e. health coaches). Face-to-face coaching contacts took place at the worksite. A web-based system was used to register the participants' coaching contacts (i.e. date, time), as well as their content (i.e. goals, action plans).

Table 1. Personal health coaching (PHC) contact schedule

Stage-of-change(27)	PHC-group	2 weeks	1 month	2 months	3 months	4 months
Pre-contemplation stage *The participant does not intend to change his risk behavior(s)*	A	Intake (60 min face-to-face)	Follow-up 1: (30 min; telephone)	Follow-up 2: (15 min; telephone)		Follow-up 3: (15 min; telephone)
Contemplation/Preparation stage *The participant wants to change his risk behavior(s), but does not know how*	B	Intake (60 min face-to-face)		Follow-up 1: (30 min; telephone)	Follow-up 2 (15 min; telephone)	
Action stage *The participant already started changing his risk behavior(s)*	C	Intake (30 min face-to-face)			Follow-up 1 (10 min telephone)	

Abbreviations: min: minutes

Effect measures

Primary and secondary outcomes were assessed at baseline, six, and 12 months.

Primary outcomes

Primary outcomes were body weight and waist circumference. Body weight was measured using a calibrated scale with participants wearing light clothes and no shoes. Waist circumference was measured midway between the lower rib margin and the iliac crest, and was rounded to the nearest 0.1cm. Measurements were performed in a standing position, over bare skin, and at the end of expiration (28). At baseline, these measurements were performed by occupational physicians or their assistants. At 6 and 12 months, they were performed by the research team.

Secondary outcomes

Secondary outcomes were MSD, work-related vitality, and job satisfaction. The prevalence of MSD was assessed using the "Dutch Musculoskeletal Questionnaire" (DMQ) (29). Participants were asked to rate the occurrence of pain or discomfort in the neck, shoulders, upper and lower back, elbows, wrists/hands, knees, and ankles/feet during the previous three months on a 4-point scale (never, sometimes, frequent, and prolonged). Participants who answered "frequent" or "prolonged" on one or more of the questions were classified as having MSD; all others as not having MSD. Work-related vitality was assessed using a subscale of the "Utrecht Work Engagement Scale" (i.e. UWES Vitality Scale). This scale included six items, scored on a 7-point scale ranging from "never"(0) to "always"(6). The UWES Vitality Score ranged from 0-6 (higher scores indicate a better work-related vitality) (30). Job satisfaction was assessed using a 1-item question of the

"Netherlands Working Conditions Survey" (31). Participants were asked to rate their overall job satisfaction on a 5-point scale ranging from "very dissatisfied"(1) to "very satisfied"(5).

Resource use and valuation

Intervention costs

For the societal perspective, bottom-up micro-costing was used to quantify intervention costs (32). Intervention costs included those related to the development, implementation, and operation of the intervention. Frequency, duration, preparation time, and locations of coaching contacts were recorded by the coaches. Labor costs were valued by multiplying the intervention staff's time investments (hours) by their gross hourly salaries including overhead costs. Capital costs were valued using cost data collected from finance department staff. Material costs were estimated using invoices. Coaches' travelling costs were valued according to the Dutch manual of costing (33). As PHC contacts took place during work hours, the participants' lost productivity costs for the duration of the contacts were included as well, and were valued using the average salary (including overhead costs) of Dutch construction workers (Economic Institute of the Dutch construction industry, personal communication).

For the employer's perspective, intervention costs were valued using charges paid. Lost productivity due to PHC was valued using the average salary (including overhead costs) of blue collar workers of the participating company.

Healthcare costs

Healthcare utilization was assessed using 3-monthly retrospective questionnaires and included costs of primary healthcare (i.e. general practitioner, allied health professionals, complementary medicine), secondary healthcare (i.e. medical specialist, hospitalization), and both prescribed and over-the-counter medications. Dutch standard costs were used to value primary and secondary healthcare utilization (33). If unavailable, prices according to professional organizations were used. Medication use was valued using unit prices of the Royal Dutch Society of Pharmacy (34).

Occupational health costs

Occupational health costs consisted of gym membership subsidies, as provided by the employer. The duration of the memberships was assessed using 3-monthly retrospective questionnaires. The associated costs were calculated by multiplying the duration of the memberships (in months) by the height of the subsidy (i.e. €10/month).

Sports costs

Sports costs were assessed using 3-monthly retrospective questionnaires asking participants to report their sports membership fees and expenses on sports equipment during the previous three months.

Absenteeism costs

Baseline (i.e. one year prior to baseline) and follow-up sickness absence data were collected from company records. For the societal perspective, costs per sickness absence day were calculated by dividing the average annual salary of Dutch construction workers (including overhead costs) by the associated number of workable days (i.e. 214) (33). Absenteeism costs were estimated using the "Friction Cost Approach"(FCA) (35). A friction period of 23 weeks (i.e. period needed to replace a sick worker) and an elasticity of 0.8 (i.e. a 100% reduction in work time corresponds with an 80% reduction in productivity) were assumed (33;35). For the employer's perspective, costs per sickness absence day were calculated using the average annual salary of blue collar workers of the participating company (including overhead costs). Subsequently, absenteeism costs were estimated using the "Human Capital Approach"(HCA), in which absenteeism costs are neither truncated as in the FCA, nor is elasticity considered (33).

Presenteeism costs

Presenteeism was assessed on a 3-monthly basis using an item of "The World Health Organization Health and Work Performance Questionnaire"(WHO-HPQ) (36;37). In the WHO-HPQ, presenteeism is conceptualized as a measure of actual work performance in relation to "best performance", irrespective of the presence or absence of health complaints (37). Participants were asked to rate their overall work performance during the previous three months on an 11-point scale ranging from "worst performance"(0) to "best performance"(10). Their average work performance during follow-up (*Wown*) was estimated and the participants' level of presenteeism (P_{HPQ}) was calculated using the following formula:

$$P_{HPQ} = (10 - Wown)/10$$

Presenteeism days were calculated by multiplying the participants' P_{HPQ} by their number of days worked during follow-up; i.e. working days minus sickness absence days. Presenteeism days were valued using the average salary of Dutch construction workers (societal perspective) and that of blue collar workers of the participating company (employer's perspective).

Using consumer price indices, all costs were converted to 2011 Euros (38). Discounting of costs and effects was not necessary, because the follow-up of the trial was one year (39). Price weights used for valuing resource use are given in Appendix 1.

Data analysis

Analyses were performed according to the intention-to-treat method. Descriptive statistics were used to compare baseline characteristics between intervention and control group participants, and participants with complete and incomplete data. Missing data were imputed in IBM SPSS

7

(v20, Chicago, IL) using Fully Conditional Specification and Predictive Mean Matching. An imputation model was constructed that included variables related to the "missingness" of data and those that predicted the outcome variables. The model included age, smoking status, baseline sickness absence, baseline effect measure values, and available midpoint and follow-up cost and effect measure values (6- and 12 months). Fifteen different data sets were created (Loss of Efficiency≤5%) (40). Each data set was analyzed separately as specified below. Pooled estimates were subsequently calculated using Rubin's rules (41). Data were imputed at the cost level. Therefore, a descriptive analysis of resource use was performed using the complete-cases only. T-tests were used for continuous variables and Chi-square tests for dichotomous variables. For skewed data, uncertainty was assessed using the bias-corrected accelerated (BCA) bootstrap method (5000 replications). Unless otherwise stated, data were analyzed in STATA (V12, Stata Corp, College Station, TX), with a level of significance of $p<0.05$.

Cost-effectiveness analysis

CEAs in terms of body weight and waist circumference were conducted from the societal perspective (i.e. all costs were taken into consideration regardless of who pays or benefits). CEAs in terms of work-related vitality, job satisfaction, and MSD were conducted from the employer's perspective (i.e. only the costs borne by employers were considered). Linear regression analyses were used to compare outcomes between the intervention and control group. Follow-up outcomes were adjusted for their baseline values. To compare costs between both groups, 95% confidence intervals (95%CIs) around the unadjusted mean differences in total and disaggregated costs were calculated using BCA bootstrapping (5000 replications). Seemingly unrelated regression (SUR) analyses were performed, in which effect differences were corrected for their baseline values and cost differences for baseline sickness absence and presenteeism scores (42). Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the corrected cost differences by those in effects. Uncertainty was graphically illustrated by plotting bootstrapped incremental cost-effect pairs (CE-pairs) on cost-effectiveness planes (CE-planes) (43). A summary measure of the joint uncertainty of costs and effects was provided using cost-effectiveness acceptability curves (CEACs), which provide an indication of the intervention's probability of cost-effectiveness at different ceiling ratios (i.e. the maximum amount of money decision-makers are willing to pay per unit of effect) (44).

Return-on-investment analysis

The ROI analysis was performed from the employer's perspective, in which only employer costs and benefits were considered. Costs were defined as intervention costs. Benefits were defined as the difference in total monetized outcome measures (i.e. absenteeism, presenteeism, and occupational health costs) between the intervention and control group during follow-up, with positive benefits indicating reduced spending. The ROI analysis (costs and benefits) was conducted using SUR analyses, in which benefits were adjusted for baseline sickness absence and presenteeism scores. Three ROI metrics were calculated; 1) Net Benefits (NB), 2) Benefit Cost Ratio (BCR), and 3) Return On Investment (ROI) (23;24;45).

NB = Benefits – Costs
BCR = Benefits / Costs
*ROI = ((Benefits – Costs)/Costs)*100*

To quantify precision, 95% bootstrapped confidence intervals (5000 replications) were estimated around the benefits and ROI metrics using the percentile method. Financial returns are positive if the following criteria are met: NB>0, BCR>1, and ROI>0% (23;24;45).

Sensitivity analyses
Five sensitivity analyses were conducted to test the robustness of the results. First, analyses were performed using the complete-cases only (SA1). Second, analyses were performed in which intervention costs were estimated under the assumption that the intervention took place outside work hours (SA2). Thus, the costs of lost productivity due to PHC were excluded. Third, analyses were performed in which absenteeism costs were valued using the HCA for the societal perspective and the FCA for the employer's perspective (SA3). Fourth, analyses were performed in which presenteeism costs were estimated using a slightly modified version of the "PROductivity and DISease Questionnaire" (PRODISQ) (46;47). In this version of the PRODISQ, presenteeism was conceptualized as reduced work performance due to health complaints and was valued by considering both the quantity and quality of labor input (SA4). Fifth, as overall consensus about whether or not to include presenteeism costs in economic evaluations does currently not exist, analyses were performed in which presenteeism costs were excluded (SA5).

Results

Participants

After randomization, 162 participants were allocated to the intervention group and 152 to the control group. At baseline, intervention group participants had approximately four more sickness absence days than their control group counterparts. Also, the prevalence of MSD was higher in the intervention group (55.6%) than in the control group (49.3%) (Table 2). After 12 months, 32 intervention group (19.7%) and 22 control group participants (14.5%) were lost to follow-up, among others, because they lost their job or lost interest in the study (Figure 1). Complete data were obtained from 62.4% of participants on the effect measures (n=196; 101 intervention group participants and 95 control group participants) and 40.5% on the cost measures (n=127;

62 intervention group participants and 65 control group participants). Some differences were observed between participants with complete and incomplete data in both the intervention and control group (Table 2).

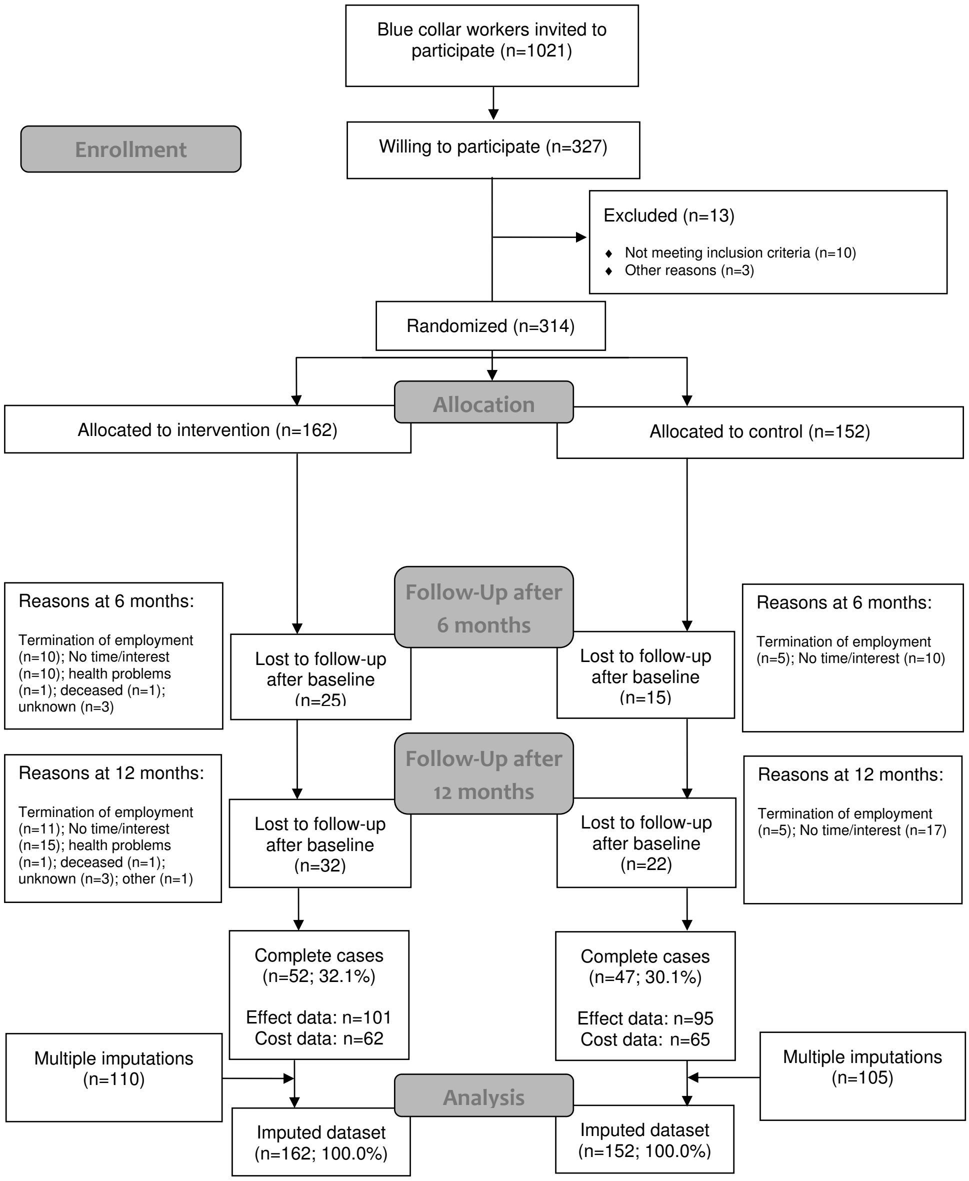

Figure 1. Flow chart of participants to the VIP in Construction study

Table 2. Baseline characteristics of the study population

Baseline characteristics	Intervention group All (n=162)	Intervention group Complete (n=52)	Intervention group Incomplete (n=110)	Control group All (n=152)	Control group Complete (n=47)	Control group Incomplete (n=105)
Male [n (%)]	162 (100); n=162	52 (100); n=52	110 (100); n=110	152 (100); n=152	47 (100); n=47	105 (100); n=105
Age (years) [mean (SD)]	46.3 (9.9); n=162	48.2 (9.2); n=52	45.3 (10.1); n=110	47.0 (9.5); n=151	47.5 (8.7); n=47	46.8 (9.9); n=104
Smokers [n (%)]	45 (27.8); n=155	12 (23.5); n=51	33 (31.7); n=104	44 (29.7); n=148	14 (31.1); n=45	30 (29.1); n=103
Body weight (kilograms) [mean (SD)]	88.7 (12.9); n=161	87.4 (11.8); n=52	89.3 (13.4); n=110	88.9 (14.4); n=152	89.9 (16.3); n=47	88.5 (13.5); n=105
Body Mass Index (kg/m^{-2}) [mean (SD)]	27.3 (3.5); n=161	27.2 (3.3); n=52	27.4 (3.6); n=109	27.4 (3.9); n=152	27.9 (4.4); n=47	27.2 (3.7); n=105
Waist circumference (centimetres) [mean (SD)]	99.0 (10.2); n=152	99.4 (10.1); n=52	98.9 (10.3); n=100	100.0 (11.8); n=133	100.3 (12.9); n=47	99.8 (11.2); n=86
Musculoskeletal disorders [n (%)]						
Yes	90 (55.6); n=162	30 (57.7); n=52	60 (54.5); n=110	75 (49.3); n=152	21 (44.7); n=47	54 (51.4); n=105
No	72 (44.4); n=162	11 (42.3); n=52	50 (45.5); n=110	77 (50.7); n=152	26 (55.3); n=47	51 (48.6); n=105
Work-related vitality (range: 0-6) [mean (SD)]	4.9 (1.0); n=157	5.0 (1.00); n=52	4.8 (1.1); n=105	5.0 (1.0); n=142	5.0 (1.0); n=47	5.0 (1.0); n=95
Job satisfaction (range: 1-5) [mean (SD)]	4.0 (0.7); n=157	4.0 (0.8); n=52	4.0 (0.7); n=105	3.9 (0.9); n=146	4.0 (0.9); n=47	3.9 (0.9); n=99
Sickness absence: number of sickness absence days during the year prior to baseline [mean (SD)]	14.0 (26.9); n=162	11.9 (24.7); n=52	15.0 (27.9); n=110	9.8 (20.6); n=152	11.1 (25.8); n=47	9.3 (17.8); n=105
Work performance: WHO-HPQ work performance score during a 4-week period prior to baseline [mean (SD)]	7.6 (1.1); n=154	7.7 (0.9); n=52	7.5 (1.2); n=102	7.9 (1.0); n=143	7.9 (1.0); n=47	7.9 (1.0); n=96

Abbreviations: n: number, SD: standard deviation, WHO-HPQ: World Health Organization Work Performance Questionnaire

Effectiveness

After 12 months, no statistically significant differences were found between the intervention and control group for body weight (-0.7; 95%CI: -2.2 to 0.7), waist circumference (-0.7; 95%CI: -2.5 to 1.1), MSD (-0.07; 95%CI -0.22 to 0.08), work-related vitality (-0.03; 95%CI: -0.39 to 0.33), and job satisfaction (-0.01; 95%CI: -0.34 to 0.32).

Resource use

Forty participants were allocated to PHC group A, 61 to PHC group B, 48 to PHC group C, and 13 only received the VIP in Construction toolbox (Table 1). During the intervention period, 126 face-to-face and 173 telephone counseling contacts were provided. Based on the complete-cases, intervention and control group participants did not significantly differ in terms of their average number of visits to a care provider (-2.4; 95%CI: -5.7 to 0.7), average number of days of hospitalization (-0.1; 95%CI: -0.4 to 0.2), average number of months of gym membership subsidies (0.5; 95%CI: -0.3 to 1.3), average number of sickness absence days (-2.7; 95%CI: -9.7 to 3.0), and average number of presenteeism days (-2.6; 95%CI: -9.6 to 4.1). However, significantly more intervention group participants (n=36) had sports costs than their control group counterparts (n=23; X^2: 5.3, p=0.02) (Appendix 1).

Costs

Average intervention costs per participant were €178 (SD=77) from the societal perspective and €287 (SD=22) from the employer's perspective (Appendix 2). No statistically significant differences were found on all cost measures (Table 3).

Table 3. Mean costs per participant in the intervention and control group, and unadjusted mean cost differences between both groups during the 12-month follow-up period

Cost category	Intervention group n=162; mean (SEM)	Control group n=152; mean (SEM)	Mean cost difference (95%CI)
Societal perspective			
Intervention costs	178 (6)	0 (0)	178 (166 to 190)
Medical costs	1499 (356)	1033 (174)	457 (-129 to 1434)
Occupational health costs	26 (4)	20 (3)	5 (-3 to 15)
Sports costs	461 (98)	265 (46)	156 (32 to 497)
Absenteeism costs	2214 (338)	2055 (345)	150 (-802 to 1094)
Presenteeism costs	9382 (550)	9663 (975)	-533 (-2449 to 1597)
Total	**13760 (725)**	**13037 (1025)**	**412 (-1572 to 3093)**
Employer's perspective			
Intervention costs	287 (2)	0 (0)	287 (283 to 290)
Occupational health costs	26 (4)	20 (3)	5 (-3 to 15)
Absenteeism costs	2543 (447)	2217 (374)	306 (-742 to 1551)
Presenteeism costs	10088 (591)	10390 (1048)	-573 (-2634 to 1717)
Total	**12943 (616)**	**12626 (1111)**	**25 (-2005 to 2485)**

Abbreviations: n: number; SEM: Standard Error of the Mean, CI: Confidence Interval, NA: Not Applicable, SD: Standard Deviation
Note: Costs are expressed in 2011 Euros

Societal perspective: cost-effectiveness

The ICER for body weight was -371, indicating that society has to pay €371 for an additional kilogram body weight loss. An ICER in the similar direction was found for waist circumference (ICER:-392). In both cases, the majority of CE-pairs were located in the north-east quadrant (Table 4; Figure 2 (1a-b)). These results imply that the intervention was more costly and more effective than usual practice, but the wide distribution of CE-pairs around the quadrants of the CE-planes indicates that the uncertainty surrounding these estimates was large (Table 4; Figure 2 (1a-b)). The CEAC in Figure 2 (2a) indicates that if society is not willing to pay anything for a kilogram body weight loss, the probability of cost-effectiveness is 0.41. This probability increased with an increasing willingness-to-pay to 0.84 at a ceiling ratio of €21,000/kg. The CEAC for waist circumference showed a similar picture, with a 0.41 probability at a ceiling ratio of €0/cm and a maximum of 0.77 at a ceiling ratio of €18,000/cm (Figure 2(2b)).

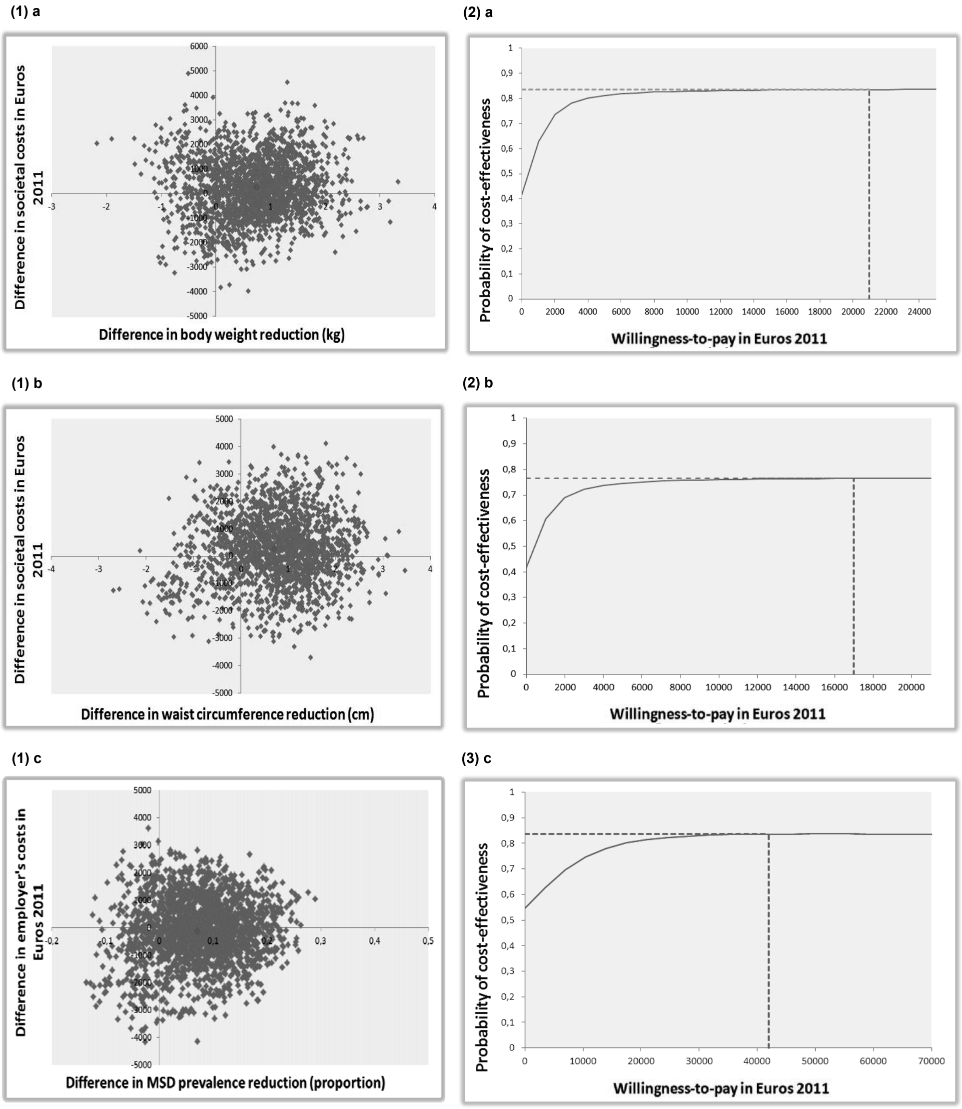

Figure 2. Cost-effectiveness planes indicating the uncertainty around the incremental cost-effectiveness ratios (1) and cost-effectiveness acceptability curves indicating the probability of the intervention being cost-effectiveness at different values (€) of willingness to pay per unit of effect gained (2) for weight loss (a), waist circumference (b), and MSD (c) (based on the imputed dataset).

Note: Effects are expressed in terms of kilogram body weight loss and waist circumference, and MSD prevalence reduction

Employer's perspective: cost-effectiveness

For MSD, an ICER of 2000 was found, indicating that employers save €2,000 per additional person prevented from having a MSD. Most CE-pairs were contained in the north-east quadrant (Table 4; Figure 2(1c)). This implies that the intervention was less costly and more effective than usual practice, but the level of uncertainty was large. The CEAC in Figure 2 (2c) indicates that the probability of cost-effectiveness was 0.55 at a ceiling ratio of €0/person, increasing to 0.84 at a ceiling ratio of €42,000/person.

The ICERs for work-related vitality and job satisfaction were 3322 and 16328, respectively (Table 4). In both cases, the intervention was less costly and less effective than usual practice. CEACs showed that the associated maximum probabilities of cost-effectiveness were 0.54 for both outcomes, irrespective of the willingness-to-pay (Figures not shown).

Employer's perspective: financial return

Total benefits in terms of absenteeism, presenteeism, and occupational health costs were on average €424 (95%CI: -1789 to 2923) (Table 5). The NB was on average 138 (95%CI: -2073 to 2641), suggesting that the intervention resulted in a net saving to the employer of €138 per participant. The BCR (i.e. amount of money returned per Euro invested) and ROI (i.e. percentage of profit per Euro invested) were 1.48 (95%CI: -6.23 to 10.21) and 48% (95%CI: -723 to 921), respectively. However, their confidence intervals were rather wide and none of them was statistically significant.

Sensitivity analyses

The results of SA2 and SA3 were similar to those of the main analysis, whereas the outcomes of SA1 (complete-case analysis), SA4 (PRODISQ), and SA5 (Excluding presenteeism) differed in some aspects from those of the main analysis (Table 4; Table 5).

Table 4. Differences in pooled mean costs and effects (95% Confidence intervals), incremental cost-effectiveness ratios, and the distribution of incremental cost-effect pairs around the quadrants of the cost-effectiveness planes

Analysis		Sample size		Outcome	ΔC (95% CI)	ΔE (95% CI)	ICER	Distribution CE-plane (%)			
				Societal perspective							
		Intervention	Control		€	Points	€/point	NE[1]	SE[2]	SW[3]	NW[4]
Main analysis	- Imputed dataset	162	152	Body weight	271 (-2155 to 2679)	-0.7 (-2.2 to 0.7)	-371	50.0	34.4	6.5	9.1
		162	152	Waist circumference	272 (-2140 to 2692)	-0.7 (-2.5 to 1.1)	-392	48.3	31.2	9.8	10.7
SA1	- Complete-cases	52	47	Body weight	-1228 (-3514 to 576)	-0.5 (-1.8 to 0.8)	2418	10.7	67.9	17.4	4.0
		52	47	Waist circumference	-1196 (-3400 to 602)	-1.1 (-3.0 to 0.8)	1068	13.7	74.4	10.5	1.4
SA2	- Outside work hours	162	152	Body weight	245 (-2181 to 2653)	-0.7 (-2.2 to 0.7)	-334	49.2	35.3	6.6	8.9
		162	152	Waist circumference	246 (-2168 to 2665)	-0.7 (-2.5 to 1.1)	-354	47.6	31.9	10.0	10.5
SA3	- HCA	162	152	Body weight	386 (-2011 to 2794)	-0.7 (-2.2 to 0.7)	-527	53.6	30.9	6.1	9.4
		162	152	Waist circumference	386 (-2001 to 2800)	-0.7 (-2.5 to 1.1)	-556	51.7	27.8	9.2	11.3
SA4	- PRODISQ	162	152	Body weight	-89 (-1586 to 1559)	-0.7 (-2.2 to 0.7)	122	39.2	45.3	9.5	6.1
		162	152	Waist circumference	-89 (-1586 to 1564)	-0.7 (-2.5 to 1.1)	128	36.0	43.5	11.2	9.3
SA5	- Excluding presenteeism costs	162	152	Body weight	799 (-430 to 2317)	-0.7 (-2.2 to 0.7)	-1093	74.5	9.9	2.1	13.5
		162	152	Waist circumference	796 (-433 to 2327)	-0.7 (-2.5 to 1.1)	-1147	69.6	9.9	2.2	18.4
				Employer's perspective							
		Intervention	Control		€	Points/ proportions	€/point	NE[1]	SE[2]	SW[3]	NW[4]
Main analysis	- Imputed dataset	162	152	MSD	-142 (-2674 to 2056)	-0.07 (-0.22 to 0.08)	2000	38.9	44.1	10.0	7.0
		162	152	Work-related vitality (range: 0-6)	-113 (-2583 to 2083)	-0.03 (-0.39 to 0.33)	3322	15.6	28.1	25.0	31.3
		162	152	Job satisfaction (range: 1-5)	-129 (-2610 to 2070)	-0.01 (-0.34 to 0.32)	16328	20.2	27.7	26.1	26.0
SA1	- Complete-cases	52	47	MSD	-1161 (-3027 to 706)	0.01(-0.19 – 0.18)	248800	5.6	45.8	40.4	8.2
		52	47	Work-related vitality (range: 0-6)	-1180 (-3300 to 496)	-0.05 (-0.36 to 0.25)	22121	3.1	33.1	53.5	10.3
		52	47	Job satisfaction (range: 1-5)	-1126 (-3266 to 550)	0.02 (-0.22 to 0.26)	-54230	4.4	52.5	34.4	8.6
SA2	- Outside work hours	162	152	MSD	-171 (-2702 to 2028)	-0.07 (-0.22 to 0.08)	2400	38.1	45.0	10.1	6.8
		162	152	Work-related vitality (range: 0-6)	-142 (-2611 to 2055)	-0.03 (-0.39 to 0.32)	4167	15.2	28.5	25.7	30.7
		162	152	Job satisfaction (range: 1-5)	-158 (-2638 to 2041)	-0.01 (-0.34 to 0.32)	19960	19.6	28.2	26.6	25.6
SA3	- FCA	162	152	MSD	-260 (-2824 to 1914)	-0.07 (-0.22 to 0.08)	3700	35.3	47.7	10.6	6.4
		162	152	Work-related vitality (range: 0-6)	-236 (-2742 to 1954)	-0.03 (-0.39 to 0.32)	9677	13.8	30.0	27.8	28.4
		162	152	Job satisfaction (range: 1-5)	-294 (-2761 to 1946)	-0.01 (-0.34 to 0.32)	30671	18.1	29.7	28.6	23.7

SA4	- PRODISQ	162	152	MSD	-556 (-1811 to 727)	-0.07 (-0.22 to 0.08)	7800	15.6	67.8	12.6	4.0
		162	152	Work-related vitality (range: 0-6)	-535 (-1798 to 760)	-0.03 (-0.39 to 0.32)	16464	8.5	35.5	43.9	12.2
		162	152	Job satisfaction (range: 1-5)	-544 (-1807 to 744)	-0.01 (0.34 to 0.32)	57512	8.4	39.2	40.5	11.8
SA5	- Excluding presenteeism	162	152	MSD	408 (-567 to 1487)	-0.07 (-0.22 to 0.08)	-5700	64.4	19.0	3.0	13.6
		162	152	Work-related vitality (range: 0-6)	422 (-559 to 1517)	-0.03 (-0.39 to 0.32)	-13155	34.9	9.1	12.2	43.7
		162	152	Job satisfaction (range: 1-5)	416 (-563 to 1504)	-0.01 (-0.34 to 0.32)	-43750	36.2	11.4	10.2	42.1

Abbreviations: CI: Confidence Interval, C: Costs, E: Effects, ICER: Incremental Cost-Effectiveness Ratio, CE-plane: Cost-Effectiveness plane, SA: Sensitivity Analysis, HCA: Human Capital Approach, FCA: Friction Cost Approach, MSD: Musculoskeletal Disorders

Note: Costs are expressed in 2011 Euros

[1] Refers to the northeast quadrant of the CE plane, indicating that the VIP in Construction intervention is more effective and more costly than usual practice

[2] Refers to the southeast quadrant of the CE plane, indicating that the VIP in Construction intervention is more effective and less costly than usual practice

[3] Refers to the northwest quadrant of the CE plane, indicating that the VIP in Construction intervention is less effective and more costly than usual practice

[4] Refers to the southwest quadrant of the CE plane, indicating that the VIP in Construction intervention is less effective and less costly than usual practice

Table 5. Intervention costs, benefits, Net Benefits (NB), Benefit Cost Ratio (BCR), and Return-On-Investment (ROI) per participant

Analysis		Sample size		Costs	Benefits		Financial return	
		I	C	€	Total (95% CI)	NB[1] (95% CI)	BCR[2] (95% CI)	ROI (%)[3] (95% CI)
Main analysis	- Imputed dataset	162	152	287 (283 to 290)	424 (-1789 to 2923)	138 (-2073 to 2641)	1.48 (-6.23 to 10.21)	48 (-723 to 921)
SA1	- Complete dataset	52	47	289 (283 to 295)	1447 (-265 to 3530)	1158 (-757 to 2948)	5.00 (-1.64 to 11.20)	400 (-264 to 1020)
SA2	- Outside work hours	162	152	258 (258 to 258)	430 (-1783 to 2928)	172 (-2039 to 2677)	1.67 (-6.90 to 11.38)	67 (-790 to 1038)
SA3	- HCA	162	152	287 (283 to 290)	543 (-1697 to 3034)	257 (-1967 to 2769)	1.90 (-5.87 to 10.67)	90 (-687 to 967)
SA4	- PRODISQ	162	152	287 (283 to 290)	840 (-442 to 2099)	553 (-728 to 1814)	2.93 (-1.54 to 7.33)	193 (-254 to 633)
SA5	- Excluding presenteeism	162	152	287 (283 to 290)	-123 (-1142 to 910)	-410 (-1458 to 595)	-0.43 (-4.08 to 3.08)	-143 (-508 to 208)

Abbreviations: CI: Confidence Interval, NB: Net Benefit, BCR: Benefit Cost Ratio, ROI: Return-On-Investment, I: Intervention, C: Control, SA: Sensitivity Analysis, HCA: Human Capital Approach

Note 1: Costs are expressed in 2011 Euros

Note 2: Financial returns are positive if the following criteria are met: NB>0, BCR>1, and ROI>0

[1] Indicates the amount of money returned after intervention costs are recovered

[2] Indicates the amount of money returned per Euro invested in the intervention

[3] Indicates the percentage of profit per Euro invested in the intervention

In SA1, total societal and employer's costs were lower in the intervention group than in the control group. All cost and effect differences were not statistically significant. CEACs differed from those of the main analysis (Figures not shown). Most notably, a 0.88 probability of cost-effectiveness was found for body weight at a ceiling ratio of €0/kg, increasing to 0.94 at €1,000/kg. In accordance with the main analysis, financial return estimates were positive, but their confidence intervals were rather wide and not statistically significant.

When using the PRODISQ (SA4), total societal and employer's costs were lower in the intervention group than in the control group. All cost and effect differences were not statistically significant. CEACs differed from those of the main analysis (Figure not shown). Most notably, a 0.54 probability of cost-effectiveness was found for body weight at a ceiling ratio of €0/kg, increasing to 0.84 at €4,000/kg. In accordance with the main analysis, financial return estimates were positive, but their confidence intervals were rather wide and not statistically significant.

When excluding presenteeism costs (SA5), total societal and employer's costs were higher in the intervention group than in the control group. All cost and effect differences were not statistically significant. CEACs differed from those of the main analysis (Figures not shown). Most notably, a 0.22 probability of cost-effectiveness was found for MSD at a ceiling ratio of €0/person, increasing to 0.82 at €100,000/person. In contrast to the main analysis, financial return estimates were negative, but statistically non-significant as well.

Discussion

This study evaluated the cost-effectiveness and financial return of a worksite physical activity and nutrition program for construction workers. In comparison with usual practice, the intervention had no significant effect on all cost and effect measures. The probabilities of cost-effectiveness for body weight, waist circumference, and MSD increased with an increasing ceiling ratio to 0.84 (willingness-to-pay = €21,000/kg), 0.77 (willingness-to-pay = €18,000/cm), and 0.84 (willingness-to-pay = €42,000/person prevented from having MSD), respectively. The probabilities of cost-effectiveness for work-related vitality and job satisfaction were low at all ceiling ratios (≤0.54). Also, per Euro invested in the program, €1.48 was returned to the employer, but the uncertainty surrounding this estimate was large.

Effects and costs

Various reasons may explain the lack of significant effects at 12-month follow-up. First, as the intervention focused on both the prevention and treatment of excessive body weight and MSD, participation in the intervention was not restricted to high-risk individuals (e.g. employees were not pre-selected on high body weight). As a consequence, many participants were relatively healthy at baseline, leaving less room for improvement. Second, a lower than expected number of participants fully participated in the program; e.g. 39% of participants eligible for counselling did not complete the PHC program and most of the VIP in Construction toolbox materials were used by fewer than 50% of participants (48). Third, it is possible that the intensity of the intervention was too low to improve the participants' lifestyle behaviours in such a way that it translates in long-term health improvements. To illustrate, the intervention was previously found effective in reducing body weight at 6-month follow-up (19), but this effect was not sustained at the long-term. To sustain this effect, more counselling contacts and/or booster sessions after the termination of the intervention may be needed. As for the lack of significant cost differences, it is known that cost data are right skewed and therefore require relatively large sample sizes to detect relevant differences. Nonetheless, as in most trial-based economic evaluations, the sample size was based on one of the primary outcomes (i.e. body weight) (18), which likely underpowered it to detect relevant cost differences.

It is noteworthy that the present findings with respect to body weight-related outcomes (i.e. the primary outcomes) contrast those of previous studies. Two systematic reviews found worksite physical activity and nutrition programs to significantly reduce body weight by -1.3kg and -1.2kg (14;49). In addition, Groeneveld et al. (2010) showed in an RCT that a similar intervention for construction workers resulted in a statistically significant body weight loss of -1.8kg at 12-month follow-up (50). The difference in effect between both studies is likely explained by the fact that their intervention was more intensive than ours; i.e. three face-to-face and four telephone contacts versus a maximum of one face-to-face and three telephone contacts. Furthermore, their intervention was aimed at construction workers with an elevated risk of cardiovascular disease, whereas the present intervention was aimed at construction workers in general. This supports our reasoning that a more intensive program, aimed at high-risk individuals, may have been needed to produce better effects.

Societal perspective: Cost-effectiveness

The intervention's cost-effectiveness in improving weight-related outcomes depends on the societal willingness-to-pay for these effects and the probability of cost-effectiveness that society considers acceptable. Since both are unknown, however, strong conclusions cannot be made. Nonetheless, decision-makers themselves can use the present results to consider whether they perceive that the intervention provides "good value for money" at an acceptable probability of cost-effectiveness.

The aforementioned study of Groeneveld et al. (2011) also evaluated the societal cost-effectiveness of the worksite physical activity and nutrition program. They found an ICER of €145/kg body weight loss, a 0.60 probability of cost-effectiveness at a ceiling ratio of €250/kg, which increased to 0.95 at €2,000/kg (51). In contrast to the present study, however, presenteeism and occupational health costs were not included. If we would exclude both cost categories as well, an ICER of €1088/kg body weight loss would be found. Van Wier et al. (2013) evaluated the societal cost-effectiveness of an occupational health guideline aimed at preventing weight gain among Dutch employees. As the probabilities of cost-effectiveness were low for body weight and waist circumference (≤0.52), the intervention was not considered cost-effective (52). Most other studies that evaluated the cost-effectiveness of similar interventions in improving weight-related outcomes solely included intervention costs (53).

Employer's perspective: Cost-effectiveness

The intervention was not cost-effective in improving work-related vitality and job satisfaction (≤0.54 probabilities of cost-effectiveness). If employers are not willing to pay anything for preventing one person from having a MSD, there is a 0.55 probability of the intervention being cost-effective. This probability increased with an increasing willingness-to-pay to 0.84 at a ceiling ratio of €42,000/person. Again, however, strong conclusions about the intervention's cost-effectiveness in terms of this outcome cannot be made, and employers themselves should consider whether the intervention provides "good value for money" at an acceptable probability of cost-effectiveness.

To our knowledge, studies evaluating the employer's cost-effectiveness of similar interventions in improving work-related vitality and MSD are lacking. One study, however, evaluated the employer's cost-effectiveness in improving job satisfaction of a mindfulness-based worksite intervention aimed at improving work engagement and energy balance-related behaviours (54). Irrespective of the maximum willingness-to-pay, the intervention had a low probability of cost-effectiveness (≤0.25) and was therefore not considered cost-effective in improving job satisfaction either.

Employer's perspective: Financial return

On average, €1.48 was returned to the employer per Euro invested in the program. However, as the uncertainty surrounding the financial return estimates was large and none of them was statistically significant, it cannot be concluded that the intervention was cost-beneficial to the employer.

A systematic review found worksite physical activity and/or nutrition programs to result in positive financial returns in terms of absenteeism benefits according to non-randomized studies (BCR: 4.25), but negative financial returns according to RCTs (BCR: 0.51). If we would solely include absenteeism benefits, our results would be in line with those of the review (BCR: 0.41). The review also indicated that the current evidence on the financial return of such interventions is limited by the fact that few studies incorporate presenteeism benefits and none of them report on the uncertainty surrounding their results. The present findings underscore the importance of addressing these limitations. Namely, as financial return estimates were positive, but statistically non-significant, wrong conclusions would have been drawn if the level of uncertainty was not taken into account. Furthermore, the direction of the financial return estimates proved to be highly influenced by the in- or exclusion of presenteeism benefits; i.e. positive when included, but negative when excluded.

Robustness of the study results

In accordance with the main analysis, cost and effect differences as well as financial return estimates were not statistically significant in all sensitivity analyses. Also, the overall conclusions would not change when using the results of any of the sensitivity analyses. Nonetheless, it is important to mention that the results of the complete-case analysis (SA1) were much more favorable than those of the main analysis. Amongst others, relatively high probabilities of cost-effectiveness were found at ceiling ratios of €0; e.g. a 0.88 probability at a ceiling ratio of €0/kg body weight loss. However, as a post-hoc analysis indicated that participants with complete data had fewer sickness absence days during follow-up than those with incomplete data (i.e. 6.7 versus 13.3 in the intervention group and 9.5 versus 10.9 in the control group), self-selection of participants seems to have biased these results, and the results of the main analysis were considered more valid.

Strengths and limitations

An important strength of the present study is its pragmatic RCT design. The pragmatic aspect of the trial enabled us to evaluate the intervention's resource implications under "real world" circumstances. This facilitates the generalizability of the results (i.e. external validity), whereas the internal validity is guaranteed by the randomization of participants (55;56). Another strength concerns the use of state-of-the-art statistical methods that are not or infrequently used in occupational health research. Amongst others, multiple imputation was used to deal with missing data, SUR analyses were performed to account for the possible correlation between costs and effects/benefits, and bootstrapping was used to estimate the uncertainty surrounding cost differences as well as cost-effectiveness and financial return estimates. Furthermore, both absenteeism and presenteeism costs were included, whereas most previous studies solely included absenteeism costs (45;53). This is of importance because efforts to improve health seem to have a more immediate effect on presenteeism than on absenteeism (57).

Several limitations deserve attention as well. First, complete cost and effect data were only obtained from 40.5% and 62.4% of participants, respectively. To deal with this issue, missing values were imputed using multiple imputation. While having complete data is always preferred, multiple imputation is increasingly being acknowledged as a more valid and precise way to deal with missing data than a complete-case analysis (56;58).Complete-case analyses reduce the power of a study and ignore available information of participants who only have missing data on a few measurement points. Also, complete-case analyses only produce reliable estimates when there are no systematic differences between the missing and observed values, which, according to a post-hoc analysis, was probably not the case (40;58). Second, many cost and effect data were gathered using self-report of participants, which may have causes "social desirability bias" and/or "recall bias". Amongst others, we had to rely on self-reported values of healthcare utilization as health insurance claim data of participants are practically inaccessible in

Dutch economic evaluations. Also, the period over which participants had to report their resource use was relatively long (i.e. 3 months). This might be a particular concern for presenteeism, as relatively short recall periods seem to be needed for this outcome (59). In future studies, mobile apps might provide a solution for this issue, as they can be used to collect data in a way that is relatively non-burdensome to participants. Third, the presence of MSD was assessed in terms of *"self-reported pain or discomfort in one or more body regions".* As discomfort can be regarded as an early manifestation of MSD, participants classified as having MSD may not necessarily have serious functional limitations and/or low levels of health-related welfare. This should be kept in mind while interpreting the results. It is also important to bear in mind that economic evaluation results are not directly transferable between countries or jurisdictions due to differences in healthcare and/or social security systems (60;61). In the Netherlands, for example, healthcare costs are generally borne by the government and/or health insurance companies, whereas in countries with employer-provided healthcare (e.g. The United States) they accrue to the employer. Furthermore, for the employer's perspective, the HCA was used for estimating absenteeism costs. This was done because Dutch employers are obliged to pay at least 70% of the salary of sick employees for a period of two years, and most of them top up the wage payments from 70% to 100% during the first year of sickness absence (62). Thus, although the initial productivity level of a Dutch company may be restored after the friction period, employers still bear the salary costs of a sick worker. Readers should keep in mind that alternative valuation methods may be more appropriate in other countries or jurisdictions (61).

Conclusion

The intervention's cost-effectiveness in improving weight-related outcomes and MSD depends on the societal and employer's willingness to pay for these effects and the probability of cost-effectiveness that they consider acceptable. From the employer's perspective, the intervention was not cost-effective in improving work-related vitality and job satisfaction. Also, due to a large degree of uncertainty, it cannot be concluded that the intervention is cost saving to the employer

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References

1. Overweight, obesity, and health risk. National Task Force on the Prevention and Treatment of Obesity. *Arch Intern Med* 2000;160(7):898-904.
2. Anandacoomarasamy A, Fransen M, March L. Obesity and the musculoskeletal system. *Curr Opin Rheumatol* 2009;21:71-77.
3. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between obesity and low back pain: a meta-analysis. *Am J Epidemiol* 2010;171:135-154.
4. Woolff AD, Phleger B. Burden of major musculoskeletal conditions. *Bull World Health Org* 2003;81(9):646-56.
5. World Health Organization. Overweight and Obesity Fact sheet. http://www.who.int/mediacentre/factsheets/fs311/en/
6. Statistics Netherlands. http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=81565NED&D1=a&D2=a&D3= a&D4=0&D5=30&HDR=T&STB=G1,G2,G3,G4&VW=T
7. Wijnhoven HAH, de Vet HCW, Picavet HS. Prevalence of Musculoskeletal Disorders Is Systematically Higher in Women Than in Men. *Clin J Pain* 2006;22(8):717-724.
8. Arbouw. Bedrijfstaksatlas 2012. http://www.arbouw.nl/pdf/tools/bedrijfstak-atlas-2012.pdf
9. Boschman J, van der Molen H, Sluiter J, Frings-Dresen M. Musculoskeletal disorders among construction workers: a one-year follow-up study. *BMC Musculoskeletal Disorders* 2012;13(1):196.
10. Council for Public Health and Health Care (Raad voor de Volksgezondheid en Zorg). Gezondheid en gedrag 2002.
11. Polder JJ, Takkern J, Meerding WJ, Kommer GJ, Stokx LJ. Cost of illness in the Netherlands Bilthoven: RIVM; 2002. Report No.: 270751005.
12. Lambeek LC, van Tulder MW, Swinkels ICS, Koppes LLJ, Anema JR, van Mechelen W. The trend in total cost of back pain in the Netherlands in the pseriod 2002 to 2007. *Spine (Phila Pa 1976)* 2011;36(13):1050-1058.
13. Goetzel RZ, Ozminkowski RJ. The health and cost benefits of work site health-promotion programs. *Annu Rev Public Health* 2008;29:303-323.
14. Verweij LM, Coffeng J, Van Mechelen W, Proper KI. Meta-analyses of workplace physical activity and dietary behaviour interventions on weight outcomes. Obes Rev 2011;12(6):406-429.
15. Proper KI, Koning M, van der Beek AJ, Hildebrandt VH, Bosscher RJ, van Mechelen W. The effectiveness of worksite physical activity programs on physical activity, physical fitness, and health. *Clin J Sport Med* 2003;13(2):106-17.
16. Neovius K, Johansson K, Kark M, Neovius M. Obesity status and sick leave: a systematic review. *Obes Rev* 2009;10(1):17-27.
17. Cancelliere C, Cassidy JD, Ammendolia C, Cote P. Are workplace health promotion programs effective at improving presenteeism in workers? a systematic review and best evidence synthesis of the literature. *BMC Public Health* 2011;11(1):395.
18. Viester L, Verhagen EA, Proper KI, van Dongen JM, Bongers PM, van der Beek AJ. VIP in construction: systematic development and evaluation of a multifaceted health programme aiming to improve physical activity levels and dietary patterns among construction workers. *BMC Public Health* 2012;12(1):89.
19. Viester L, Verhagen EALM, Bongers PM, van der Beek AJ. Improvement of dietary and physical activity behaviour through a worksite intervention in construction workers: results of a randomised controlled trial. Submitted
20. Viester L, Verhagen EALM, Bongers PM, van der Beek AJ. The effect of a health promotion intervention for construction workers on work-related outcomes: a randomised controlled trial. Submitted
21. Miller P, Rossiter P, Nuttall D. Demonstrating the economic value of occupational health services. Occup Med 2002;52(8):477-483.

22. van Dongen JM, Tompa E, Clune LA, Sarnocinska-Hart A, Bongers PM, van Tulder MW, et al. Bridging the gap between the economic evaluation literature and daily practice in health and safety: a study into the information needs of decision makers in the healthcare sector. *Implement Sci* 2013;8:57
23. Cavallo D. Using return on investment analysis to evaluate health promotion programs: challenges and opportunities. *Health Promotion Economics Issue Briefs* 2006;1(3):1-4. RTI-UNC Center of Excellence. Available at: http://www.rti.org/pubs/IssueBrief_3.pdf.
24. Stone PW. Return-on-investment models. *Appl Nurs Res* 2005;18(3):186-189.
25. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc* 1998;30(6):975-991.
26. Kemper HGC, Ooijendijk WTM, Stiggelbout M. Consensus over de Nederlandse Norm voor Gezond Bewegen. *Tijdschr Soc Gezondheidsz* 2000;78:180-183.
27. Ajzen I. The theory of planned behavior. *Orga Behav Hum Decis Process* 1991;50:179-211.
28. Lean ME, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. *BMJ* 1995;311:158-161.
29. Hildebrandt VH, Bongers PM, van Dijk FJ, Kemper HC, Dul J. Dutch Musculoskeletal Questionnaire: description and basic qualities. *Ergonomics* 2001;44:1038-1055.
30. Schaufeli WB, Bakker AB. Bevlogenheid: een begrip gemeten. *Gedrag en Organisatie* 2004;17:90-112.
31. Koppes LLJ, de Vroome EMM, Mol MEM, Janssen BJM, van den Bossche SNJ. *Nationale enquete arbeidsomstandigheden 2010: Methodologie en globale resultaten. 2010.* http://www.tno.nl/downloads/rapport_nea_20111.pdf
32. FD. Microcosting Quantity Data Collection Methods. *Med Care* 2009;47(7 Suppl 1):S76-S81.
33. Hakkaart-van Roijen L, Tan SS, Bouwmans CAM. Handleiding Voor Kostenonderzoek. Methoden en Standaardkostprijzen *Voor Economische Evaluaties in de Gezondheidszorg*. Diemen, the Netherlands: College Voor Zorgverzekeringen; 2010.
34. Z-index. G-Standard. The Hague, The Netherlands: Z-Index BV; 2009.
35. Koopmanschap MA, Rutten FFH, van Ineveld BM, van Roijen L. The friction cost method for measuring indirect costs of disease. *J Health Econ* 1995;14(2):171-189.
36. Kessler R, Ames M, Hymel P, Loeppke R, McKenas D, Richling D. Using the World Health Organization Health and Work Performance Questionnaire (HPQ) to evaluate the indirect workplace costs of illness. *J Occup Environ Med* 2004;46:S23-S37.
37. Kessler RC, Barber C, Beck A, Berglund P, Cleary PD, McKenas D. The world health organization health and work performance questionnaire (HPQ). *J Occup Environ Med* 2003;45:156-174.
38. Statistics Netherlands. 2011. http://www.cbs.nl
39. Drummond MF, Sculpher MJ, Torrance G.W., O'Brien B.J., Stoddart G.L. *Methods for the Economic Evaluation of Health Care Programmes. 3rd ed*. Oxford University Press: New York, 2005.
40. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Statist Med* 2011;30(4):377-399.
41. Rubin DB. *Multiple imputation for nonresponse in surveys.* John Wiley & Sons: New York, 1987.
42. Willan AR, Briggs AH, Hoch JS. Regression methods for covariate adjustment and subgroup analysis for non-censored cost-effectiveness data. *Health Econ* 2004;13(5):461-475.
43. Black WC. The CE plane: a graphic representation of cost-effectiveness. *Med Decis Making* 1990;10(3):212-214.
44. Fenwick E, O'Brien BJ, Briggs A. Cost-effectiveness acceptability curves - facts, fallacies and frequently asked questions. *Health Econ* 2004;13(5):405-415.
45. van Dongen JM, Proper KI, van Wier MF, van der Beek AJ, Bongers PM, Van Mechelen W, et al. Systematic review on the financial return of worksite health promotion programmes aimed at improving nutrition and/or increasing physical activity. *Obes Rev* 2011;12(12):1031-1049.

46. Koopmanschap MA. PRODISQ: a modular questionnaire on productivity and disease for economic evaluation studies. *Expert Rev Pharmacoecon Outcomes Res* 2005;5:23-28.

47. Koopmanschap M, Meeding WJ, Evers S, Severens J, Burdorf A, Brouwer W. *Handleiding voor het gebruik van PRODISQ versie 2.1.* [Handbook on use of PRODISQ.] Rotterdam/Maastricht, Erasmus MC - Instituut voor Medical Technology Assessment, Instituut Maatschappelijke Gezondheidszorg, Universiteit van Maastricht - Beleid Economie en Organisatie van de Zorg; 2004.

48. Viester L, Verhagen EALM, Bongers PM, van der Beek AJ. Process evaluation of a multifaceted health programme aiming to improve physical activity levels and dietary patterns among construction workers. 2013

49. Anderson LM, Quinn TA, Glanz K, Ramirez G, Kahwati LC, Johnson DB, et al. The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *Am J Prev Med* 2009;37(4):340-357.

50. Groeneveld IF, Proper KI, van der Beek AJ, van Mechelen W. Sustained body weight reduction by an individual-based lifestyle intervention for workers in the construction industry at risk for cardiovascular disease: results of a randomized controlled trial. *Prev Med* 2010;51:240-246.

51. Groeneveld IF, van Wier MF, Proper K, Bosmans JE, Van Mechelen W, van der Beek A. Cost-effectiveness and cost-benefit of a lifestyle intervention for workers in the contruction industry at risk for cardiovascular disease. *J Occup Environ Med* 2011;53(6):610-617.

52. van Wier MF, Verweij LM, Proper KI, Hulshof CTJ, van Tulder MW, van Mechelen W. Economic evaluation of an occupational health care guideline for prevention of weight gain among employees. J Occup Environ Med 2013; 55(9):1100-1109.

53. van Dongen JM, Proper KI, van Wier MF, van der Beek AJ, Bongers PM, van Mechelen W, et al. A systematic review of the cost-effectiveness of worksite physical activity and/or nutrition programs. Scand J Work Environ Health 2012;38(5):393-408.

54. van Dongen JM, van Berkel J, Boot CRL, Bosmans JE, Proper KI, Bonges PM, van der Beek AJ, van Tulder MW, van Wier MF. Cost-effectiveness and financial return of a mindfulness-based worksite intervention aimed at improving work engagement: results of a randomized controlled trial. Submitted

55. Tompa E, Dolinschi J, de Oliveira C. Practice and potential of economic evaluation of workplace-based interventions for occupational health and safety. *J Occup Rehabil* 2006;16:375-400.

56. Petrou S, Gray A. Economic evaluation alongside randomised controlled trials: design, conduct, analysis, and reporting. *BMJ* 2011;342: d1548.

57. Caverley N, Cunningham JB, MacGregor JN. Sickness Presenteeism, Sickness Absenteeism, and Health Following Restructuring in a Public Service Organization. *Journal of Management Studies* 2007;44(2):304-319.

58. Sterne JAC, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* 2009;29:338.

59. Zhang W, Bansback N, Anis AH. Measuring and valuing productivity loss due to poor health: A critical review. *Soc Sci Med* 2011;72(2):185-192.

60. Verbeek J, Pulliainen M, Kankaanpaa E, Taimela S. Transferring results of occupational safety and health cost-effectiveness studies from one country to another - a case study. *Scand J Work Environ Health* 2010;36(4):305-312.

61. Tompa E, Culyer AJ, Dolinschi J. *Economic evaluation of interventions for occupational health and safety: Developing good practice*. New York: Oxford University Press; 2008.

62. OECD. Sickness and Disability Schemes in the Netherlands: Country memo as a background paper for the OECD Disability Review. 2007. http://www.oecd.org/social/soc/41429917.pdf.

63. Groeneveld IF, Proper KI, van der Beek AJ, van Duivenbooden C, van Mechelen W. Design of a RCT evaluating the (cost-) effectiveness of a lifestyle intervention for male construction workers at risk for cardiovascular disease: the health under construction study. *BMC Public Health* 2008;8:1.

64. UWV. Brancheschets Bouw. Oktober 2012. https://www.werk.nl/pucs/groups/public/documents/document/wdo_007277.pdf

Appendix 1. Price weights used for valuing resource use and resources consumed by the intervention and control group participants during follow-up (based on the complete-cases)

Units [Units of measurement]	Price weight		Resources consumed	
	Societal perspective	Employer's perspective	Intervention group (n=51)	Control group (n=48)
Intervention costs	€ 177.77	€ 287.56		
Medical costs				
Visits to a care provider [No. of visits; mean (SD)]				
General practitioner				
Office consultation	€ 28.96[c]	N.A.	1.3 (1.9)	1.6 (2.2)
Telephone consultation	€ 14.48[c]	N.A.	0.2 (0.5)	0.2 (0.8)
House call	€ 44.47[c]	N.A.	0.0 (0.3)	0.0 (0.2)
Allied health professionals				
Psychologist	€ 82.47[c]	N.A.	0.8 (3.3)	0.2 (0.1)
Dietician	€ 27.93[c]	N.A.	0.0 (0.0)	0.0 (0.3)
Physical therapist	€ 37.23[c]	N.A.	0.7 (2.3)	3.8 (8.0)*
Other allied health professionals	Variable[c,d]	N.A.	0.7 (3.7)	0.5 (1.9)
Medical specialists				
Psychiatrist	€ 106.53[c]	N.A.	0.0 (0.0)	0.0 (0.0)
Other medical specialists	€ 74.47[c]	N.A.	0.8 (1.7)	0.8 (1.8)
Complementary medicine	Variable[c,d]	N.A.	0.2 (1.7)	0.4 (1.8)
Hospitalization [No. of days; mean (SD)]				
Ward	€ 472.66[c]	N.A.	0.2 (0.2)	0.3 (0.8)
Intensive care	€ 2257.82[c]	N.A.	0.0 (0.0)	0.0 (0.0)
Medications [No. of participants using medication; Number (%)]	Variable[e]	N.A.	30 (58.8)	25 (52.1)
Absenteeism costs				
Sickness absence [days; Mean (SD)]	198.20[f]	213.10[g]	6.7 (9.5)	9.4 (21.9)
Presenteeism costs				
Presenteeism [days; Mean (SD)]	198.20[f]	213.10[g]	43.7 (14.5)	46.3 (19.7)
Sports costs [No. of participants with sports costs; Number (%)]	Variable[h]	N.A.	36 (70.6)	23 (47.9)*
Occupational health costs				
In-company fitness [No. of months; mean (SD)]	€ 10.00[i]	€ 10.00[i]	0.9 (2.5)	0.4 (1.6)

* Significant at $p<0.05$

Abbreviations: n: Number, SD: Standard Deviation, N.A.: Not ApplicableNote: Costs are expressed in 2011 Euros

Price weight sources: [a] Bottum-up micro-costed, valued using tariffs and depleted sources (See Appendix 2); [b] Market prices, valued using invoices of contractors; [c] Dutch Manual of Costing; [d] Professional organizations; [e] Dutch Society of Pharmacy; [f] Average gross annual salary of Dutch construction workers including holiday allowances and premiums; [g] Average gross annual salary of blue collar workers of the participating construction company including holiday allowances and premiums; [h] Self-reported expenses on sports memberships and sports equipment; [i] Height of the employer's gym membership subsidy

Appendix 2. Cost of the VIP in Construction intervention from the societal perspective, valued using a bottom-up micro-costing approach (Euros 2011)

	Cost categories	Intervention staff / Worker	Units	Unit Prices	Total Costs (Euros 2011)	Mean costs per worker (SD) (Euros 2011)
			VARIABLE COSTS			
Personal Health Coaching (PHC)						
Face-to-face contacts	Labor costs	Health coach	297.2 hours[a]	€ 35.72/ hour	€ 10,615.98	€ 65.53 (35.93)
		Construction worker	104.0 hours	€ 27.53/ hour	€ 2,863.12	€ 17.67 (11.11)
	Capital costs		114.5 hours	€ 0.44/ hour	€ 50.07	€ 0.31 (0.19)
	Travelling costs		14563.6 kilometres	€ 0.21/ km	€ 3,077.52	€ 18.95 (10.15)
Telephone contacts	Labor costs	Health coach	65.9 hours	€ 35.72/ hour	€ 2,353.86	€ 14.53 (16.12)
		Construction worker	52.3 hours	€ 27.53/ hour	€ 1,440.18	€ 8.89 (10.22)
	Capital costs	Health coach	65.9 hours	€ 0.44/ hour	€ 29.16	€ 0.18 (0.20)
	Capital costs	Construction worker	52.3 hours	€ 0.44/ hour	€ 22.68	€ 0.14 (0.16)
	Phone costs		3132 minutes	€ 0.09/ min	€ 281.88	€ 1.74 (2.00)
					Subtotal:	**€ 127.96 (76.81)**
Health information brochure						
PHC-group A			40 brochures	€ 4.68/ brochure	€ 187.08	€ 1.16 (2.02)
PHC-group B			61 brochures	€ 4.68/ brochure	€ 285.30	€ 1.76 (2.28)
PHC-group C			48 brochures	€ 3.20/ brochure	€ 153.60	€ 0.95 (1.47)
No counselling			13 brochures	€ 4.80/ brochure	€ 62.40	€ 0.39 (1.31)
					Subtotal:	**€ 4.25 (0.69)**
TOTAL VARIABLE COSTS						**€ 132.21 (76.88)**
			FIXED COSTS			
Quick scan processing	Labor costs	Occupational physician	27 hours	€ 168.47/ hour	€ 5,548.69	€ 28.08
	Capital costs			€ 3.90/ hour	€ 105.30	€ 0.65
	Material costs		162 quick scans	€ 0.20/ quick scan	€ 32.40	€ 0.20
					Subtotal:	**€ 28.93**
VIP in Construction toolbox						
Waist circumference measuring tape / BMI card			162 packages	€ 3.10/ package	€ 502.66	€ 3.10
Calorie guide			162 calorie guides	€ 0.74/ guide	€ 119.63	€ 0.74
Pedometer			162 pedometer	€ 2.00/ pedometer	€ 324.00	€ 2.00
Cookbook			162 cookbooks	€ 0.80/ cookbook	€ 129.60	€ 0.80
Exercise card / Personal energy plan forms			162 packages	€ 0.74/ package	€ 119.63	€ 0.74
					Subtotal:	**€ 7.38**

Recruitment folder	162 folders	€ 0.77/ folder	€ 123.74	€ 0.77
			Subtotal:	**€ 0.77**
Development intervention[b]			€ 116,107.80	€ 8.48[c]
			Subtotal:	**€ 8.48**
TOTAL FIXED COSTS				**€ 45.56**
TOTAL INTERVENTION COSTS				**€ 177.77 (76.88)**

Abbreviations: SD: Standard Deviation, PHC: Personal Health Coaching, BMI: Body Mass Index
[a] The time investment of the health coaches includes travelling, preparation, and coaching time
[b] €116,107.80 was paid for the development of the VIP in Construction intervention. For calculating the development costs per participant, these were divided by the expected number of program users during the first five years after implementation (13,695). In the Netherlands, 221,250 construction workers are employed by a medium- (10-100 employees) or large-scale (>100 employees) construction company(63;64). During the five year period, it was hypothesized that the intervention will be offered to 20% of these construction workers and that 31% of them will participate to the intervention(48).