

**Cost-effectiveness and cost-benefit of a lifestyle intervention for workers in the construction industry at risk for cardiovascular disease.**

Iris F Groeneveld

Marieke F van Wier

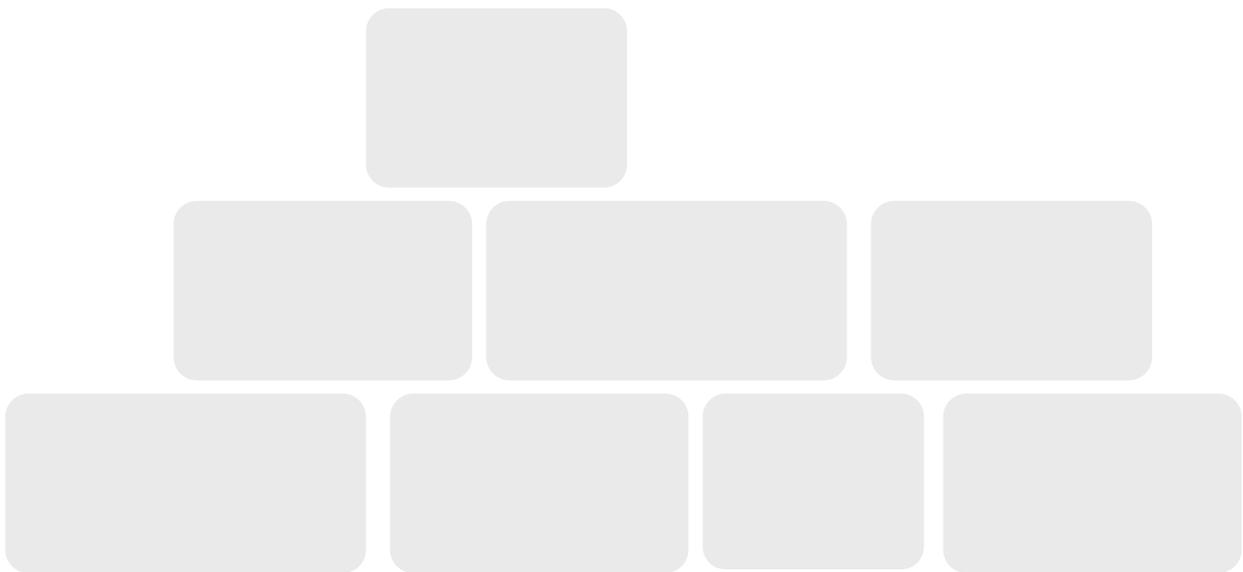
Karin I Proper

Judith E Bosmans

Willem van Mechelen

Allard J van der Beek

*Submitted for publication*



## Abstract

**Introduction** An unhealthy lifestyle and obesity are associated with cardiovascular disease risk, but also with increased costs for society and employers. The aim of this study was to investigate the cost-effectiveness and cost-benefit of an individual-based lifestyle intervention for male workers in the construction industry with an elevated risk of CVD.

**Methods** In this randomized controlled trial among 573 workers, usual care was compared to a 6-month individual-based lifestyle intervention consisting of face to face and telephone counseling sessions. The time horizon of the study was 12 months. Body weight was measured at baseline, 6, and 12 months. At 6 and 12 months, data were collected on health care use and lifestyle-related out-of-pocket expenses. Self reported absenteeism was measured with 2-month intervals. Missing data were imputed using multiple imputations. The intervention effect on body weight was analyzed by linear regression analysis, and the 95% confidence intervals around the cost-differences were estimated with approximate bootstrap confidence (ABC) intervals. A cost-effectiveness analysis was performed from a societal perspective, in which all costs were divided by the intervention effect on body weight, in order to obtain an incremental cost-effectiveness ratio (ICER). Uncertainty around the ICER was estimated by bootstrapped cost-effect pairs, with 5,000 replications. As to the cost-benefit analysis from the employer's perspective, the incremental (intervention) costs were subtracted from the incremental (absenteeism) benefits.

**Results** A significant intervention effect on body weight was found, i.e.  $\beta$  -2.0 (95%CI -2.9; -1.1). The intervention costs were €605 per participant. In the intervention and control group, health care use costs were €212 vs. €279, out-of-pocket expenses were €390 vs. €333, and absenteeism costs were €3,302 vs. €3,604. The ICER was €145/kg weight loss. In case of a willingness to pay of €2,000, the probability of cost-effectiveness would be 0.95. The difference between intervention and control group in net employer costs was €254 (95%CI -1,070; 1,536).

**Conclusion** From a societal perspective, this individual-based lifestyle intervention was more effective and more expensive than usual care. The probability of cost-effectiveness depends on the societal willingness to pay. As the intervention costs were higher than the benefits of absenteeism, the intervention could not be regarded as cost-saving from an employer's perspective. Since the results were based on an imputed dataset, conclusions should be interpreted with caution.

## Introduction

Worldwide, cardiovascular disease (CVD) is the number one cause of death (1). Important precursors of CVD are overweight and obesity, hypertension, and atherosclerosis. These abnormalities are caused to a large extent by an unhealthy lifestyle, i.e. an unhealthy diet (2) and insufficient physical activity (PA) (3). An unhealthy lifestyle and obesity not only affect health and health care expenditures (4-7), but may also have negative consequences for the employer. Insufficient PA is associated with poor work ability (8) and sickness absenteeism (9). Likewise, there is ample evidence that obesity is associated with decreased productivity, due to either presenteeism (10), absenteeism (11), or work disability (12, 13). Moreover, among obese workers, the incidence of workplace injuries is higher than among normal weight workers (14, 15). Thus, physical inactivity, obesity, and CVD are associated with elevated costs for health care, productivity loss, and work disability. Therefore, the necessity of developing and evaluating lifestyle interventions for workers is beyond doubt. Mixed effects of workplace lifestyle interventions have been achieved on lifestyle behaviors and body weight (16-20). It is difficult for employers or decision makers to decide upon implementation of a lifestyle intervention without insight into its costs and monetary benefits. Therefore, an economic evaluation is an important element of each lifestyle intervention trial.

An economic evaluation can comprise various types of analyses, such as a cost-effectiveness analysis, in which the incremental costs associated with an incremental change in a health outcome are determined, or a cost-benefit analysis, in which the incremental costs are subtracted from incremental monetary benefits (21). These analyses can be done from different perspectives, depending on the stakeholder responsible for the costs. In general, workplace lifestyle interventions are equally or more effective in improving health outcomes than usual care, but the costs borne by employers are usually higher (16, 22). Several workplace lifestyle interventions were shown to result in a net monetary gain for the employer, since they provided a positive return on investment through a reduction of productivity, and, for US employers, of health care costs (23). Thorough economic evaluations alongside high quality randomized controlled trials (RCTs) of workplace lifestyle interventions aimed at CVD risk reduction are scarce.

In the Health under Construction study, the effectiveness of an individual-based lifestyle intervention for workers in the construction industry with an elevated risk of CVD was investigated. A significant and sustained decrease in body weight was found (unpublished data). The current economic evaluation consisted of a cost-effectiveness analysis from the societal perspective, in which body weight was the outcome of interest. Also a cost-benefit analysis from the employer's perspective was performed. The time horizon of the economic evaluation was 12 months.

## **Methods**

### *Study design and participants*

Male workers in the construction industry aged 18-65 with an elevated risk of CVD, as based on a screening instrument adapted from the Framingham risk score (24), using the results of their periodical health screening (PHS), were invited to participate in the Health under Construction study. The workers who consented to participate were pre-stratified for work type (blue-collar workers performing the construction work versus white-collar workers involved in administration and supervision), and individually randomized into the control group or the intervention group by using Random Allocation Software (Version 1.0. Iran). The persons involved in data collection and data analysis were blinded to group allocation, whereas the participants and intervention providers were not. The design of the study and the characteristics of the study participants were published previously (25, 26). The Medical Ethics Committee of the VU University Medical Center approved the study protocol. In the baseline questionnaire, all participants had to indicate whether they preferred to improve PA or diet, or to quit smoking. Since the outcome of interest in the cost-effectiveness study was body weight, only workers who chose to aim at PA or diet were included in the analyses, i.e. two thirds of all participants. The participants in the control group received usual care, consisting of brief information from the occupational physician about their CVD risk profile. Participants in the intervention group received a 6-month intervention aimed at improving lifestyle.

### *Intervention*

The intervention consisted of three 45-60 minute face to face counseling sessions at the nearest occupational health service (OHS), and four 15-30 minute telephone counseling sessions with an occupational physician or occupational nurse. All counselors received a 2- or 3-day training in motivational interviewing (MI). In the first counseling session, certain predefined items were discussed, including the participant's risk profile, the advantages and disadvantages of behavior change, his willingness, readiness, and perceived confidence in his ability to change, and personal short- and long-term goals. In subsequent sessions, progress and barriers were discussed and goals could be adjusted. All participants, in the intervention and the control group, received brochures on healthy lifestyle and CVD. Information on the process of the intervention, such as counselors' compliance, has been described elsewhere (27).

### *Health outcome*

Body weight was measured at baseline, 6, and 12 months, by doctors' assistants at the OHS. Body weight was measured using a digital balance, with participants wearing no shoes and no jacket.

### *Resource use*

In order to provide insight into all resources used, the number of counseling sessions for each participant was administrated by the counselors between baseline and 6 months. At

6 and 12 months, the number of visits to providers of primary care, specialist care, paramedical care and alternative care, the use of blood pressure or cholesterol lowering medication, and the purchases of all products associated with improving diet and physical activity, e.g. sports equipment, were reported by the participants by means of a questionnaire. Moreover, every two months, at 2, 4, 6, 8, 10, and 12 months, the participants filled in the number of days absent from work in the previous two months, a question that was adapted from the questionnaire of Koopmanschap et al. (28). The time frame of two months was chosen to minimize the risk of recall bias while limiting participant burden (29). At 6 months, the participants reported the number of hours taken off for visits to counseling sessions at the OHS.

### *Costs*

Three cost categories were measured: direct health care costs, direct non-health care costs, and indirect non-health care costs. The direct health care costs included costs for the intervention and costs for other health care consumed. Intervention costs consisted of the costs for the trainer, for printing manuals, and for the face to face and telephone counseling sessions, according to prices paid. Also, a €15 reimbursement for the participants for each visit to a counseling session was included, as well as costs for the person who coordinated the counseling sessions, using the number of hours involved, valued as the gross salary including additional employers' costs such as premiums and holiday payments. Costs for visits to care providers were valued using Dutch standard costs (30). For the valuation of visits to care providers for whom standard cost prices were not available, prices according to professional organizations were used. Medication use was valued according to unit prices provided by the Royal Dutch Society for Pharmacy (31). All prices were adjusted to the year 2008, using consumer price indices (32). The direct non-health care costs, i.e. out-of-pocket costs for purchases associated with improving diet and PA, were self-reported by the participants. Indirect non-health care costs were costs associated with absenteeism. Data on the average gross year salaries for blue- and white-collar workers, including employer's costs, were provided by the Dutch Economic Institute for the construction industry. The costs associated with one working day of absenteeism were calculated by dividing the average gross year salary including additional employers' costs by the total amount of working days per year, i.e. 260. In the societal perspective, according to the equity principle, costs per working day were considered independent of work type and amounted to €229 per day. When calculating the average gross salary the proportions of white- and blue-collar workers in the study population, i.e. 0.32 vs. 0.68, were taken into account. However, for the cost-benefit analysis, which is conducted from an employer's perspective, the valuation of an absenteeism day was done according to work type, i.e. the costs for a working day of a white-collar worker were €264, and those for a working day of a blue-collar worker were €216.

*Multiple imputations of missing values*

All missing data on body weight, absenteeism, direct health care costs, direct non-health care costs, and indirect non-health care costs, were imputed using multiple imputations. Five different data sets were created in SPSS (version 17.0, Chicago, Ill) using Fully Conditional Specification and Predictive Mean Matching procedures. All available data on body weight at baseline, 6 and 12 months, group allocation, age, smoking status, absenteeism, and costs, were included in the imputation model. Thereafter the multiple datasets were analyzed as described below, using R (version 2.10.1) (33). Pooled estimates were computed following the rules as described by Rubin (34).

*Main analyses*

The main analyses were based on group allocation, regardless of adherence to the intervention. The intervention effect on body weight at 12 months was analyzed in SPSS (version 17.0, Chicago, Ill), using linear regression analysis, adjusted for baseline body weight. Outcomes with a p-value of <0.05 were considered statistically significant. The mean cost differences between intervention and control group were calculated for direct health care costs, direct non-health care costs, indirect non-health care costs, and total costs. The 95% confidence intervals of the cost differences were estimated with approximate bootstrap confidence (ABC) intervals (35). For the cost-effectiveness analysis, an incremental cost-effectiveness ratio (ICER) was estimated by dividing the difference in total costs between the intervention and control groups by the difference in effect on body weight. To graphically present uncertainty around the ratio, bootstrapped cost/effect pairs, using 5,000 replications, were plotted in cost-effectiveness planes (36). A cost-effectiveness acceptability curve (CEAC) was estimated in order to provide insight into the probability that the intervention was cost-effective (y-axis) for a range of potential maximum amounts (x-axis) that a decision maker is willing to pay (37). At a probability of 0.95 or higher, the intervention can be regarded as cost-effective. For the cost-benefit analysis, the incremental costs of the intervention itself were subtracted from the incremental benefits associated with absenteeism. Confidence intervals of the cost differences were estimated by ABC intervals.

*Sensitivity analyses*

In order to test the robustness of the results, and to evaluate the cost-effectiveness and cost-benefit of the intervention considering different scenarios, several sensitivity analyses were performed: 1) A cost-effectiveness analysis, in which all absenteeism costs were multiplied by 0.8. An elasticity of 0.8 is frequently used, implying that a 100% loss of work time corresponds to an 80% reduction in productivity (38); 2) A cost-effectiveness and a cost-benefit analysis using a dataset in which all costs for occupational physicians were replaced by costs for occupational nurses. These analyses were done since we found that an intervention performed by an occupational nurse was equally effective in lowering body weight as an intervention performed by a - more expensive - occupational physician (unpublished data); 3) A cost-effectiveness and cost-benefit analysis including the

complete cases only. The 95% confidence intervals around the mean cost differences were estimated by using a bootstrap method with 5,000 replications.

## Results

Of the 816 participants included in the Health under Construction study, 573 participants chose to aim at diet or PA, of whom 293 had been allocated to the intervention group and 280 to the control group. For 285 participants, at any time point, one or more variables were missing, which were mainly cost data. For those cases, the missing data were imputed. A participant flow is presented in **Figure 1**.

In **Table 1**, the baseline characteristics for the intervention and control group are presented as well as the differences between completers and non-completers, as derived from the original, unimputed database. Also, the differences between completers and non-completers in body weight at 12 months are presented. Non-completers were on average 3 years younger and had a 2 kg higher baseline body weight than completers. The difference in 12-month body weight between completers and non-completers was 2.7 kg in the intervention group and 3.7 kg in the control group.

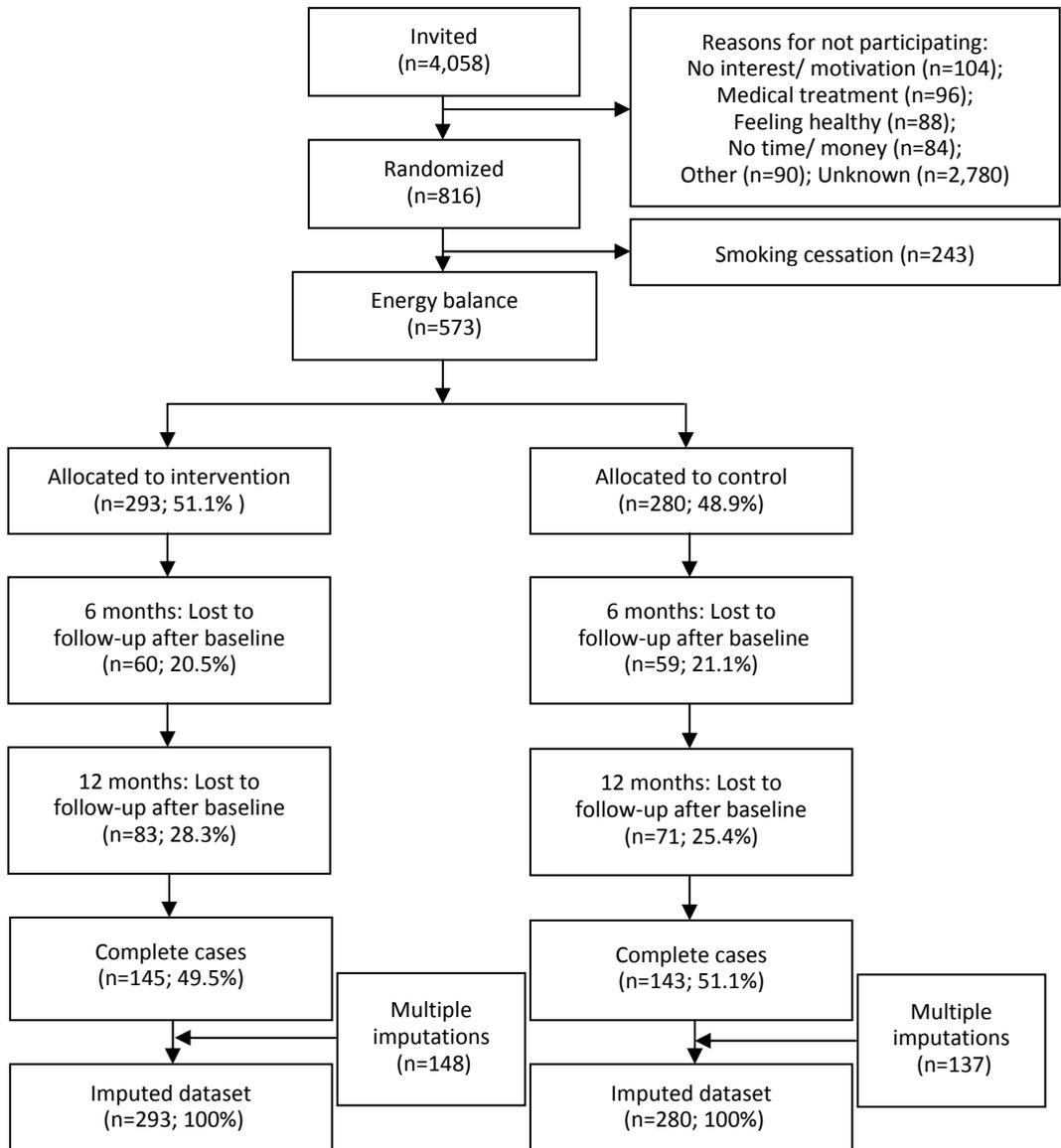
### *Effectiveness*

Linear regression analysis on the imputed datasets showed a statistically significant effect of the intervention on body weight ( $\beta$  -2.0, 95%CI -2.9; -1.2). From baseline to 12-month follow-up, the control group gained on average 1.0 kg, whereas the intervention group lost on average 1.1 kg of body weight.

### *Resource use*

For the participants in the intervention group, the average number of counseling sessions was 5 (SD 2.3). As missing data on health care use were not imputed, the following data were derived from the unimputed dataset. Participants in the intervention group had on average 5.7 (SD 8.8) visits to a care provider, as opposed to 7.1 (SD 11.1) in the control group. This difference was mainly caused by the number of visits to the physiotherapist; 3.7 (SD 9.8) in the control group and 1.8 (SD 5.7) in the intervention group. In the intervention group, 29% used cholesterol or blood pressure lowering medication at some period during the 12 months, while in the intervention group this was 30%. In the intervention group, 69% bought one or more diet- or PA-related products, as compared to 64% in the control group. Of the complete cases, participants in the intervention and control group reported on average 12.3 (SD 29.7) and 9.1 (24.0) days of absenteeism, respectively, and 7.5% vs. 5.8% were absent from work for more than 3 months in total. In contrast, based on the imputed dataset, the average number of days absent from work was 14.4 in the intervention group, as opposed to 15.7 in the control group.

**Figure 1.** Flow diagram through the phases of the Health under Construction study.



**Table 1.** Baseline characteristics and body weight at 12 months of participants in the intervention and control group in the economic evaluation of the Health under Construction study, in the original (unimputed) dataset.

Characteristic	Intervention group				Control group			
	All n; mean (SD)	Completers n; mean (SD)	Non-completers n; mean (SD)	Δ Incomplete- complete (95% CI)	All n; mean (SD)	Completers n; mean (SD)	Non-completers n; mean (SD)	Δ Incomplete- complete (95% CI)
Age (years)	293 46.0 (9.2)	145 47.6 (8.7)	148 44.5 (9.5)	-3.1 (-5.2; -1.0)*	280 46.7 (9.3)	143 48.3 (7.7)	137 45.1 (10.4)	-3.2 (-5.4; -1.0)*
Body weight (kg) baseline	293 95.3 (12.6)	145 94.1 (12.0)	148 96.5 (13.1)	2.4 (-0.5; 5.3)	280 93.8 (12.7)	143 93.0 (11.7)	137 94.5 (13.6)	1.5 (-1.5; 4.5)
Body weight (kg) 12 months	NA	145 92.5 (12.3)	65 95.2 (14.4)	2.7 (-1.1; 6.5)	NA	143 93.6 (12.1)	66 96.7 (15.0)	3.7 (-0.7; 7.0)
Characteristic	n %	n %	n %	Δ Incomplete- complete (%)	n %	n %	n %	Δ Incomplete- complete (%)
Blue-collar	293 71.7	145 70.3	148 73.0	2.7	280 66.9	143 67.8	137 76.6	8.8

\*p<0.05. kg: kilogram; SD: standard deviation; CI: confidence interval

**Table 3.** Cost and effect differences, incremental cost-effectiveness ratios, and the distribution of cost/ effect pairs in the cost- effectiveness plane for the main analysis and three sensitivity analyses in the economic analysis of the Health under Construction study.

Analysis	Sample size (n)		Δ Costs € (95% CI)	Δ Weight loss kg (95% CI)	ICER €/kg	Distribution CE plane (%)			
	Intervention	Control				NE	SE	SW	NW
Main analysis	293	280	293 (-1,070; 1,646)	-2.0 (-2.9; -1.2)*	145	66.6	33.4	0	0
Elasticity 0.8 <sup>†</sup>	293	280	353 (-747; 1,443)	-2.0 (-2.9; -1.2)*	175	73.7	26.3	0	0
Intervention provider <sup>‡</sup>	293	280	258 (-1,107; 1,601)	-2.0 (-2.9; -1.2)*	128	64.7	35.3	0	0
Complete cases	145	143	1,373 (-175; 2,834)	-2.1 (-3.1; -1.1)*	658	96.3	3.7	0	0

\*p<0.05. CI: confidence interval; ICER: incremental cost-effectiveness ratio; CE: cost-effectiveness; NE: northeast; SE: southeast; SW: southwest; NW: northwest.

<sup>†</sup>Elasticity 0.8: 100% absenteeism is associated with 80% productivity loss. <sup>‡</sup>Intervention provider: all 3 occupational physicians are replaced by occupational nurses.

### Costs

All average costs and cost differences are presented in **Table 2**. The mean intervention costs were €605 (SD 230) per intervention group participant. The direct health care costs, excluding the intervention costs, were significantly lower in the intervention group than in the control group. The total costs, i.e. direct health care, direct non-health care, and indirect non-health care costs, were higher in the intervention group than in the control group.

**Table 2.** Mean costs for each participant in the intervention and the control group, and the mean differences between groups at 12 months follow-up, in a multiply imputed dataset.

Cost category	Intervention group n=293; € (SD)	Control group n=280; € (SD)	Mean difference € (95% CI)
Direct health care	817 (409)	279 (370)	539 (472; 605)*
Intervention	605 (230)	0 (0)	605 (572; 629)*
Other health care	212 (313)	279 (370)	-67 (-126; -9.4)*
Direct non-health care	390 (508)	333 (534)	57 (-35; 146)
Indirect non-health care	3,302 (7,743)	3,604 (7,956)	-302 (-1,651; 1,021)
Total costs	4,508	4,215	293 (-1,084; 1,670)

\*p<0.05. SD: standard deviation; CI: confidence interval

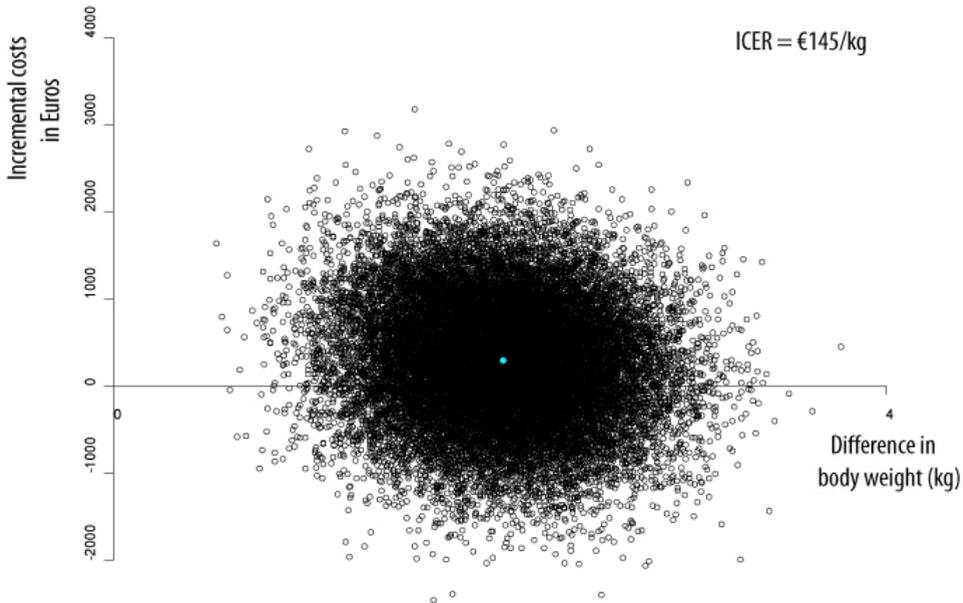
### Cost-effectiveness

The ICER was €145/kg weight loss, implying that for one additional kg of body weight lost, the additional societal costs were €145. The uncertainty around this ICER was large, as shown in **Figure 2**. In this cost-effectiveness plane, 66.6% of the cost/effect pairs were in the northeast quadrant; in these cases, the intervention was more effective and more expensive than usual care, and 33.4% of the cost/effect pairs were in the southeast quadrant. In these cases, the intervention was more effective and less expensive than usual care. According to the CEAC, as presented in **Figure 3**, if society is not willing to have extra expenses to attain 1 kg extra weight loss, there is a probability of 0.33 that the intervention can be regarded as cost-effective. If society would be willing to pay €2,000, the probability would be higher than 0.95, and the intervention could be regarded as cost-effective.

### Cost-benefit

Based on the imputed datasets, the employer had a net loss of €254 (95%CI -1,070; 1,536) as a result of the intervention. Again, the uncertainty around this amount was large, as indicated by the 95% confidence interval. The intervention can therefore not be regarded as cost-saving.

**Figure 2.** Cost-effectiveness plane for an individual-based lifestyle intervention aimed at body weight loss for workers in the construction industry with an elevated risk of cardiovascular disease.

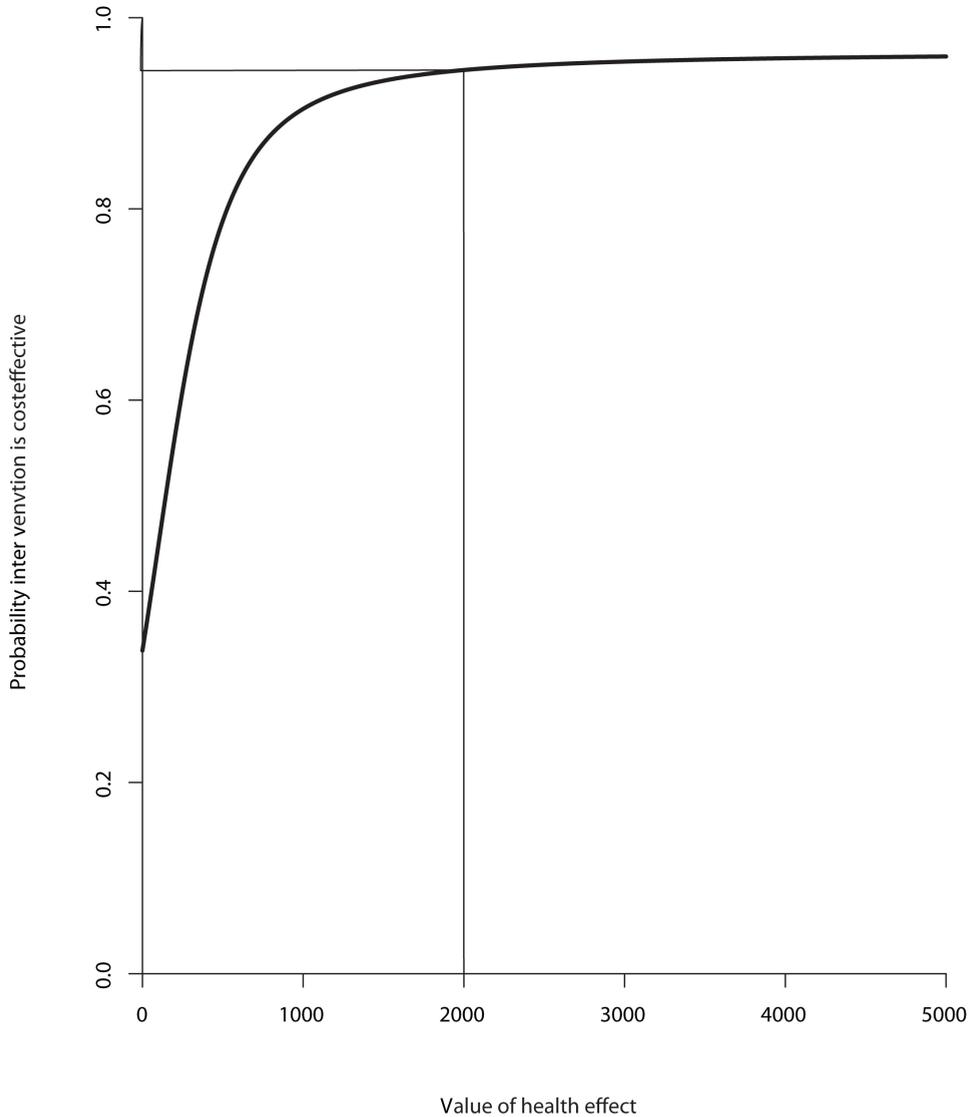


ICER: incremental cost-effectiveness ratio

### *Sensitivity analyses*

All cost and effect differences and the ICERs of the main and sensitivity analyses are presented in **Table 3**. When applying an elasticity of 0.8, the ICER would be €175/kg weight loss. In case all occupational physicians would be replaced by occupational nurses, the ICER would be €128/kg weight loss. When only analyzing the complete cases, an ICER of €658/kg weight loss was found, which means that the society would have to invest €658 for one kg of additional body weight loss. As to the cost-benefit analysis, assuming the scenario of nurses instead of occupational physicians, the employer would have a monetary loss of €219 (95% CI -1,097; 1,501) per employee. The cost-benefit analysis on complete cases resulted in a monetary loss of €1,132 (95%CI -328; 2,601) for the employer.

**Figure 3.** Cost-effectiveness acceptability curve indicating the probability of cost-effectiveness for different values (€) of willingness to pay for an incremental kg of body weight loss.



## Discussion

### *Main findings*

The aim of this economic evaluation was to assess the cost-effectiveness and cost-benefit of an individual-based lifestyle intervention for workers in the construction industry with an elevated risk of CVD. The 6-month intervention had a significantly positive effect on body weight at 12 months follow-up. The intervention was more effective, but also more expensive than usual care. To attain one kg of body weight loss, as compared to usual care, would cost society €145. If society would be willing to pay €2,000, the intervention could be regarded as cost-effective. The cost-benefit analysis showed a monetary loss for the employer of €254 (95%CI -1,070; 1,536) per employee. Hence, the intervention did not appear cost-saving.

The intervention effect on body weight of 2 kg was larger than the effect of 1.2 (95%CI -0.7; 1.6) found by Verweij et al. (2010) in a meta-analysis of 9 workplace physical activity and dietary behavior intervention studies (20). The relatively large effect in our study may be related to the individual and client-centered approach. Not unexpectedly, due to this individual approach, and the number and duration of sessions, the intervention was relatively expensive. The costs for visits to other care providers and medication costs were significantly lower in the intervention group than in the control group, but did by far not offset intervention costs. When looking more closely to the data, we found that the direct health care costs were lower in the intervention group than in the control group only in the first six months of the evaluation period, i.e. during the intervention. However, between 6 and 12 months, there was no difference between groups in direct health care use anymore. In other studies, lasting reductions in health care use costs resulting from workplace lifestyle-related interventions have been described (39, 40). In those studies, the type of intervention and the health care resources included may have differed from our study. Furthermore, standard costs for health care differ considerably between countries, impairing comparability of studies (41). In our study, there was a non-significant reduction in absenteeism costs of €302 during the entire period, between baseline and 12 months. In general, absenteeism costs are skewed and therefore extremely large sample sizes are required to reach significance. Our study was underpowered to be certain about the observed change in absenteeism costs we found.

With respect to cost-effectiveness, most other workplace lifestyle cost-effectiveness studies only took the intervention costs into account (42, 43). If we would do so, one kg of body weight loss would cost €300, which is 10 times as much as in several other studies. An intervention of Rasu et al. (2010), consisting of tailored internet messages and two telephone calls for overweight workers, was equally effective but far less expensive than ours; 1 kg of body weight loss after 6 months could be achieved at the cost of US \$25.92 (~€19.38) per participant (43). Whether this effect was sustained at the long term was not reported. In the British Counterweight study, on the effects of group and individual-based sessions among 642 overweight adults, the intervention led to a significant weight loss at

12 months of 3.0 kg, at the cost of UK £60 (~€45) per participant (42). In comparison to those studies, additional costs were included in our analyses to obtain a more realistic estimation of the overall societal costs associated with this intervention. One of the few comparable studies in which the cost-effectiveness for weight loss from a societal perspective was investigated was the study of Van Wier et al. (2010; unpublished data). From their individual-based lifestyle intervention delivered by internet, aimed at weight loss of Dutch overweight office workers, an ICER of €16/kg was concluded. This ICER seems more favorable than the one found in our study. Nonetheless, according to Van Wier et al. the probability that the internet intervention would be cost-effective at a willingness to pay of €1,000 was 0.8, whereas in our study this probability would be 0.9. Thus, not only the ICER but also the probability of cost-effectiveness should be considered in interpreting the results of an economic evaluation. With respect to cost-benefit studies, we found one study in which a comparable approach, a 9-month individual counseling intervention for Dutch civil servants, was investigated. In that study, the intervention costs were €430 per participant and the absenteeism-related monetary benefit was €125 per participant (22). These results are in line with our study; both workplace lifestyle intervention studies with a moderately long follow-up period resulted in a monetary loss for the employer, as the positive trend towards lower absenteeism costs in the intervention group did not outweigh the intervention costs. Pronk and Aldana (2001) concluded from the scientific literature that workplace health promotion intervention-induced decreases in absenteeism were usually modest, and that absenteeism reductions did not appear until the end of the evaluation period, after 1 - 4 years (44).

As said, the intervention was relatively expensive. Therefore, a cost-effectiveness analysis and a cost-benefit analysis were done assuming a strategy in which only the relatively inexpensive but equally competent occupational health professionals were deployed. Because of all 27 counselors, only three were occupational physicians and thus replaced for the analyses, the difference in ICERs between the main (€145/kg) and the sensitivity (€128/kg) analysis was only modest. Still, the results of these sensitivity analyses indicate the advantages of deploying less expensive care providers. Another sensitivity analysis concerned the valuation of absenteeism. When assuming an elasticity of 0.8, the societal costs associated with the intervention became higher because the absolute difference in absenteeism costs between intervention and control group decreased. If a lower elasticity than 0.8 would be applied, the difference in absenteeism costs would become even lower. It should be noted that for the Dutch construction industry, no data are available on elasticity. In fact, in each job type, a different elasticity might apply. In order to estimate the cost-benefit and cost-effectiveness of an intervention as accurate as possible, the elasticity that is applicable to the working population under study should be determined first.

Strikingly, there were substantial differences in mean absenteeism between the complete cases and the cases for which data were imputed. Among the complete cases,

absenteeism was highest in the intervention group, whereas after multiple imputations, total absenteeism was highest in the control group. Apparently, the participants in the control group who had incomplete data at certain time points were more likely to have a high absenteeism, or predictors of absenteeism, at one or more other time points. A possible predictor that might have led to an underestimation of absenteeism was body weight gain during the study, as can be seen in table 1. This underestimation may have been (partly) corrected for in the imputed datasets. When applying multiple imputations, it is assumed that data are missing at random; an assumption that may not necessarily hold true. Especially when large amounts of data are missing, multiple imputations may lead to flawed results. In our study, for half of all participants, one or more missing values had to be imputed. In order to make an accurate estimation of the cost-effectiveness of a study, non-completion should thus be prevented.

### *Strengths & limitations*

Several strengths of the study need to be mentioned. First, a full economic evaluation was performed within a study with a strong design, i.e. a randomized controlled trial. Second, the cost-effectiveness of the intervention was not assessed until 6 months after the intervention had ended. Third, sensitivity analyses were done to indicate the impact of a change in assumptions. All three strengths are proposed by Tompa et al. (2006) as quality indicators for economic evaluations of workplace interventions (45). Last, this trial can be regarded as pragmatic instead of exploratory, since the intervention took place within the OHS and was delivered by OHS professionals. A pragmatic trial is the preferred option for an economic evaluation, as it reflects the costs and effects that will be generated in 'real life' (46).

A first limitation concerns the fact that the economic evaluation was underpowered to detect differences in costs, as the sample size calculation was based on a clinical outcome. This is problematic since cost data usually follow a highly skewed distribution, implying a need for larger sample sizes in cost-effectiveness studies as compared to effectiveness studies (47). In the design of a trial, the sample size needed for the economic evaluation should already be determined, and sufficient time for recruitment should be planned. Another weakness may be the lack of data on presenteeism. We chose not to measure presenteeism, since it relies on self-report of a difficult concept (48), and there is no golden standard for measuring presenteeism yet (49). A major limitation is that non-completion was relatively large and partly selective. Hence, many imputations had to be done, part of which were probably not accurate since the missings may not have been completely at random.

### **Conclusion**

In the Health under Construction study, the intervention was more effective but also more expensive than usual care, resulting in an ICER of €145/kg weight loss. Although the absenteeism costs were slightly lower in the intervention group, the intervention costs

## chapter 8

were high, resulting in an average monetary loss for the employer of €254. Implementation of the intervention depends, among others, on the societal and employer's willingness to pay for an extra kg of body weight loss. By measuring absenteeism on the longer term, insight could be gained in possible future monetary benefits. As the results we found appeared after the imputation of missing data, these conclusions should be interpreted with caution.

## Reference List

1. World Health Organization. Cardiovascular diseases (CVDs). 2009. <http://www.who.int>.
2. Mente A, de Koning L, Shannon HS, Anand SS. A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. *Arch Intern Med* 2009; 169:659-669.
3. Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. *Stroke* 2003;34:2475-2481.
4. Muller-Riemenschneider F, Reinhold T, Berghofer A, Willich SN. Health-economic burden of obesity in Europe. *Eur J Epidemiol* 2008; 23:499-509.
5. Raebel MA, Malone DC, Conner DA, Xu S, Porter JA, Lantý FA. Health services use and health care costs of obese and nonobese individuals. *Arch Intern Med* 2004; 164:2135-2140.
6. Sturm R. The effects of obesity, smoking, and drinking on medical problems and costs. *Health Aff (Millwood)* 2002; 21:245-253.
7. Colditz GA. Economic costs of obesity and inactivity. *Med Sci Sports Exerc* 1999; 31:S663-S667.
8. van den Berg TI, Elders LA, de Zwart BC, Burdorf A. The effects of work-related and individual factors on the Work Ability Index: a systematic review. *Occup Environ Med* 2009; 66:211-220.
9. Proper KI, van den Heuvel SG, De Vroome EM, Hildebrandt VH, van der Beek AJ. Dose-response relation between physical activity and sick leave. *Br J Sports Med* 2006;40:173-178.
10. Gates DM, Succop P, Brehm BJ, Gillespie GL, Sommers BD. Obesity and presenteeism: the impact of body mass index on workplace productivity. *J Occup Environ Med* 2008;50:39-45.
11. van Duijvenbode DC, Hoozemans MJ, van Poppel MN, Proper KI. The relationship between overweight and obesity, and sick leave: a systematic review. *Int J Obes (Lond)* 2009; 33:807-816.
12. Neovius K, Johansson K, Rossner S, Neovius M. Disability pension, employment and obesity status: a systematic review. *Obes Rev* 2008;9:572-581.
13. van den Berg TI, Elders LA, de Zwart BC, Burdorf A. The effects of work-related and individual factors on the Work Ability Index: a systematic review. *Occup Environ Med* 2009; 66:211-220.
14. Schmier JK, Jones ML, Halpern MT. Cost of obesity in the workplace. *Scand J Work Environ Health* 2006; 32:5-11.
15. Tsai SP, Ahmed FS, Wendt JK, Bhojani F, Donnelly RP. The impact of obesity on illness absence and productivity in an industrial population of petrochemical workers. *Ann Epidemiol* 2008;18:8-14.

16. Anderson LM, Quinn TA, Glanz K, 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; 37:340-357.
17. Benedict MA, Arterburn D. Worksite-based weight loss programs: a systematic review of recent literature. *Am J Health Promot* 2008; 22:408-416.
18. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Lifestyle-focused interventions at the workplace to reduce the risk of cardiovascular disease - a systematic review. *Scand J Work Environ Health* 2010; 36:202-215.
19. 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; 13:106-117.
20. Verweij LM, Coffeng J, van Mechelen W, Proper KI. Meta-analyses of workplace physical activity and dietary behaviour interventions on weight outcomes. *Obes Rev* 2010: accepted for publication.
21. Drummond MF, Schulpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Methods for the Economic Evaluation of Health Care Programmes. New York: Oxford University Press Inc.; 2005.
22. Proper KI, de Bruyne MC, Hildebrandt VH, Van der Beek AJ, Meerding WJ, van Mechelen W. Costs, benefits and effectiveness of worksite physical activity counseling from the employer's perspective. *Scand J Work Environ Health* 2004; 30:36-46.
23. Baicker K, Cutler D, Song Z. Workplace wellness programs can generate savings. *Health Aff (Millwood)* 2010; 29:304-311.
24. Wilson PW, D'Agostino RB, Levy D, Belanger AM, Silbershatz H, Kannel WB. Prediction of coronary heart disease using risk factor categories. *Circulation* 1998; 97:1837-1847.
25. 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.
26. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Factors associated with non-participation and drop-out in a lifestyle intervention for workers with an elevated risk of cardiovascular disease. *Int J Behav Nutr Phys Act* 2009; 6:80.
27. Groeneveld IF, Proper KI, Absalah S, van der Beek AJ, van Mechelen W. An individually-based lifestyle intervention for workers at risk for cardiovascular disease: A process evaluation. *Am J Health Promot* 2010: accepted for publication.
28. Koopmanschap MA, Meerding WJ, Evers S, Severens JL, Burdorf A, Brouwer WB. Manual for the use of PRODISQ version 2.1. (PROductivity and DISease Questionnaire). Rotterdam/ Maastricht: 2004.

29. Severens JL, Mulder J, Laheij RJ, Verbeek AL. Precision and accuracy in measuring absence from work as a basis for calculating productivity costs in The Netherlands. *Soc Sci Med* 2000; 51:243-249.
30. Oostenbrink JB, Bouwmans CAM, Koopmanschap MA, Rutten FFH. Handleiding voor Kostenonderzoek. Diemen: CVZ College Voor Zorgverzekeringen, 2004.
31. Z-index. G-Standard. The Hague, The Netherlands: Z-Index BV, 2006.
32. Statistics Netherlands. Consumer Prices. 2010. <http://www.cbs.nl>.
33. R Development Core Team. R. A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2008.
34. Rubin DB. Multiple Imputation for Nonresponse in Surveys. New York: J Wiley & Sons, 1987.
35. Burton A, Billingham LJ, Bryan S. Cost-effectiveness in clinical trials: using multiple imputation to deal with incomplete cost data. *Clin Trials* 2007; 4:154-161.
36. Black WC. The CE plane: a graphic representation of cost-effectiveness. *Med Decis Making* 1990; 10:212-214.
37. Fenwick E, O'Brien BJ, Briggs A. Cost-effectiveness acceptability curves--facts, fallacies and frequently asked questions. *Health Econ* 2004; 13:405-415.
38. Koopmanschap MA, Rutten FF, van Ineveld BM, van Roijen L. The friction cost method for measuring indirect costs of disease. *J Health Econ* 1995; 14:171-189.
39. Aldana SG. Financial impact of health promotion programs: a comprehensive review of the literature. *Am J Health Promot* 2001; 15:296-320.
40. Milani RV, Lavie CJ. Impact of worksite wellness intervention on cardiac risk factors and one-year health care costs. *Am J Cardiol* 2009; 104:1389-1392.
41. Drummond M, Barbieri M, Cook J. Transferability of Economic Evaluations Across Jurisdictions: ISPOR Good Research Practices Task Force Report. *Value Health* 2009; 12(4).
42. Counterweight Project Team. Influence of body mass index on prescribing costs and potential cost savings of a weight management programme in primary care. *J Health Serv Res Policy* 2008; 13:158-166.
43. Rasu RS, Hunter CM, Peterson AL, Maruska HM, Foreyt JP. Economic evaluation of an Internet-based weight management program. *Am J Manag Care* 2010; 16:e98-104.
44. Aldana SG, Pronk NP. Health promotion programs, modifiable health risks, and employee absenteeism. *J Occup Environ Med* 2001; 43:36-46.
45. Tompa E, Dolinschi R, 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.
46. Ramsey S, Willke R, Briggs A, et al. Good research practices for cost-effectiveness analysis alongside clinical trials: the ISPOR RCT-CEA Task Force report. *Value Health* 2005; 8:521-533.
47. Briggs A. Economic evaluation and clinical trials: size matters. *BMJ* 2000; 321:1362-1363.

## chapter 8

48. Koopmanschap M, Burdorf A, Jacob K, Meerding WJ, Brouwer W, Severens H. Measuring productivity changes in economic evaluation: setting the research agenda. *Pharmacoeconomics* 2005; 23:47-54.
49. Meerding WJ, IJzelenberg W, Koopmanschap MA, Severens JL, Burdorf A. Health problems lead to considerable productivity loss at work among workers with high physical load jobs. *J Clin Epidemiol* 2005; 58:517-523.