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The cost-effectiveness and return-on-investment of a combined social and physical environmental intervention in office employees

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Abstract

This study explored the cost-effectiveness and return-on-investment of a combined social and physical environmental worksite health promotion program compared with usual practice, and of both intervention conditions separately. Participants were randomized to the combined intervention (n = 92), social environmental intervention (n = 118), physical environmental intervention (n = 96), or control group (n = 106). The social environmental intervention consisted of group motivational interviewing and the physical environmental intervention of workplace modifications. Both interventions were aimed at improving physical activity and relaxation. Effects included need for recovery (NFR), general vitality and job satisfaction. Cost-effectiveness analyses were performed from the societal and employer's perspective, and return-on-investment analyses from the employer's perspective. Compared with usual practice, the combined intervention was significantly more effective in improving NFR (−8.4; 95% CI: −14.6; −2.2) and significantly more expensive to the employer (3102; 95% CI: 598; 5969). All other between-group differences were non-significant. For NFR, the combined intervention became the preferred option at willingness-to-pays of ≥€170/point improvement (society) and ≥€300/point improvement (employer). For general vitality and job satisfaction, the interventions’ maximum probabilities of cost-effective were low (<0.55). All interventions had a negative return-on-investment. The combined intervention may be cost-effective for NFR depending on the decision-makers’ willingness-to-pay. Both separate interventions are not cost-effective for NFR. All interventions were neither cost-effective for general vitality and job satisfaction, nor cost-saving to the employer.

Introduction

During the last decades, the pressure at work has increased substantially [1]. Currently, 36% of Dutch workers ‘regularly have to work at a high work pace’ and 30% ‘regularly have to work under high time pressure’ [2]. Consequently, work stress is the most common reason for work-related absenteeism in the Netherlands [3]. If stress persists,
there may be changes in physiological functioning, leading to mental and physical ill health [4–6].

Need for recovery (NFR) is an early indicator for mentally and physically work-induced fatigue and reflects the need to recuperate and unwind from work-induced efforts [7]. NFR seems to be an important intermediate factor in the relationship between short-term work stress and longer-term mental and physical ill health [8–10], which in turn is related to increased healthcare and productivity costs [4–6]. Research indicates that a worker’s NFR may be enhanced by improving physical activity and relaxation [11–14]. Therefore, a combined social and physical environmental worksite health promotion program was developed aimed at reducing NFR among office employees by improving their physical activity and relaxation [15].

The program was developed in close co-operation with stakeholders of the participating company. The program was targeted at both the social and physical environment of the participating workers, because health promotion programs targeted at individual and environmental determinants of behaviours are expected to be more effective than those solely targeted at individual determinants [16–18]. Based on the results of a needs assessment, key determinants of physical activity and relaxation were chosen, and strategies were selected to affect these determinants. This resulted in a social environmental intervention consisting of Group Motivational Interviewing (GMI) and a physical environmental intervention consisting of environmental modifications (e.g. table tennis and sitting balls). GMI was derived from ‘Motivational Interviewing’, a counselling style that is aimed at enhancing a participant’s intrinsic motivation to behavioural change by exploring and resolving his or her ambivalence [19]. The motivational interviewing sessions were given in a group setting, as group-based counselling has several benefits over individual-based counselling (e.g. sharing experiences, providing feedback, giving support).

Evaluations of the program’s effectiveness have been reported elsewhere [17, 18]. As resources are restricted, however, employers are not just interested in the effectiveness of such programs, but also in their impact on a company’s bottom-line [20]. This can be determined using return-on-investment analyses (ROI analyses) [21]. Various program outcomes, however, are hard to monetize and can therefore not be included in a ROI analysis. As such, cost-effectiveness analyses (CEAs) that compare a program’s incremental costs to its incremental effects are also important [22].

The present study aimed to evaluate the cost-effectiveness and return-on-investment of the combined social and physical environmental intervention compared with usual practice, and of both intervention conditions separately. Additionally, the probabilities of the intervention conditions being cost-effective in comparison with each other were explored. CEAs were performed from both the societal and employer’s perspective, and the ROI analysis was performed from that of the employer. The combined intervention condition was hypothesized to produce the most favourable results [15].

Materials and methods

Design and population

This study was performed alongside a 12-month 2X2 factorial randomized controlled trial (RCT). Full trial details are published elsewhere [15]. The study was approved by the Medical Ethics Committee of the VU University Medical Center, Amsterdam, the Netherlands.

In September 2011, 1182 office employees of 24 departments of a financial service provider were invited to participate. Those who were on sick leave during the previous 4 weeks were not eligible for participation. After providing informed consent, 412 employees of 19 departments were enrolled in the study. Subsequently, their departments were stratified to the ‘physical environmental intervention’ or ‘no physical environmental intervention’ condition. Within these strata, departments were randomized to the ‘social environmental intervention’ or ‘no social environmental intervention’ condition. This resulted in four groups: (1) combined social and physical environmental intervention group (abbreviated as combined intervention...
group); (2) social environmental intervention group; (3) physical environmental intervention group; (4) control group (usual practice). Allocation was performed at the department level to minimize contamination between groups.

**Intervention conditions**

A detailed description of the rationale, development and content of the intervention conditions can be found elsewhere [15]. In brief, the social environmental intervention condition consisted of GMI, a group-based counselling technique that aims to stimulate behavioural change by exploring and resolving a participant’s ambivalence [19]. GMI was delivered by the departments’ team leaders after receiving a 2-day GMI-training course. Within a period of 6 weeks, team leaders provided three 90-min GMI-sessions to their own team. Two months after the final session, a booster GMI-session was provided. During the program, team leaders also participated in two GMI-coaching meetings of 90 min each, supervised by a GMI-professional, to share experiences and to learn from each other.

All GMI-sessions took place at the workplace, during work hours and were supported by a workbook and a social media platform.

As part of the physical environmental intervention condition, four ‘VIP zones’ were created at the workplace: (1) VIP Coffee Corner Zone: the coffee corner was modified by adding a bar with bar chairs, a large plant and a giant relaxing poster; (2) VIP Open Office Zone: the office was modified by introducing exercise balls and desk dividing curtains; (3) VIP Meeting Zone: conference rooms were modified by placing a standing table and a giant relaxing poster; (4) VIP Hall Zone: table tennis tables were placed and lounge chairs were introduced for informal meetings. To promote stair walking, footsteps were placed on the floor of the entrance hall. All modifications were promoted through digital flyers and banners.

**Baseline characteristics**

At baseline, potential confounders were assessed by questionnaire; gender, age, having a partner (yes/no), Dutch nationality (yes/no), education level (low = elementary school or less, intermediate = secondary education, high = college/university), weekly working hours, sickness absence, work performance, general health (range:1–5), job demands (range:1–5) and supervisor support (range:1–5).

**Effect measures**

Primary and secondary outcomes were assessed at baseline, 6 and 12 months.

The primary outcome was NFR. NFR was assessed using a subscale of the ‘Dutch Questionnaire on the Experience and Evaluation of Work’, which consists of 11 items (yes/no). The NFR Score ranges from 0–100, with lower scores indicating a better NFR [23]. Secondary outcomes were general vitality and job satisfaction. General vitality was assessed using the RAND-36 Vitality Scale, including four items assessing vitality during the previous 4 weeks. Items were scored on a 6-point scale ranging from ‘all of the time’ (1) to ‘none of the time’ (6). The RAND-36 Vitality Score ranges from 0–100, with higher scores indicating a better general vitality [24]. Job satisfaction was assessed using the ‘Netherlands Working Conditions Survey’. Participants were asked to rate their job satisfaction on a 5-point scale ranging from ‘very dissatisfied’ (1) to ‘very satisfied’ (5) [25].

**Cost measures**

Costs were measured from both the societal and employer’s perspective. When the societal perspective was applied, all costs related to the intervention were taken into account irrespective of who pays or benefits from them (i.e. intervention, healthcare, absenteeism, presenteeism, sports and active commuting costs). When the employer’s perspective was applied, only costs accruing to (Dutch) employers were included (i.e. intervention, absenteeism and presenteeism costs).

Intervention costs: For the societal perspective, micro-costing was used to estimate intervention costs [26]. Micro-costing provides an estimate of
the true cost to society, namely the amount of money forgone to society as a whole. Frequency and duration of GMI-training courses, GMI-sessions and GMI-coaching sessions were registered. Time investments of intervention providers were valued using their gross hourly salaries. VIP zone costs were based on invoices and were linearly depreciated over a period of 5 years [27]. Capital costs were valued using cost data collected from finance department staff. Material and website hosting costs were estimated using invoices. For the employer’s perspective, a gross-costing approach was used, in which intervention costs were valued using invoices only (i.e. the true cost to the employer, namely the amount of money employers have to pay when implementing the intervention conditions).

Healthcare costs: Healthcare utilization was assessed using 3-monthly questionnaires and included primary healthcare, secondary healthcare and medications. Primary and secondary healthcare utilization were valued using Dutch standard costs [27]. If unavailable, prices according to professional organizations were used. Medication use was valued using unit prices of the Dutch Royal Society of Pharmacy [28].

Absenteeism costs: Sickness absence and salary data were collected from company records. For the societal perspective, absenteeism costs were estimated using the ‘Friction Cost Approach’ (FCA), which assumes that production losses are confined to the time-span companies need to replace a sick worker to restore the company’s initial production level (i.e. friction period = 23 weeks) [27, 29]. For the employer’s perspective, absenteeism costs were estimated using the ‘Human Capital Approach’ (HCA). This was done because Dutch employers are obliged to pay at least 70% of the salary of sick employees for a period of 2 years, and most of them top up the wage payments from 70% to 100% during the first year of sickness absence. Thus, although the initial production level of a Dutch company may be restored after the friction period, employers still bear the additional cost of having to pay the salary of the sick worker.

Presenteeism costs: Presenteeism was assessed on a 3-monthly basis using ‘The World Health Organization Health and Work Performance Questionnaire’ (WHO-HPQ) [30, 31], and valued using salary data.

Sports costs: Participants’ expenses on sports memberships and sports equipment (e.g. gym membership, sportswear) were assessed using 3-monthly questionnaires.

Active commuting costs: Participants’ expenses on active commuting equipment (e.g. bike) were assessed using 3-monthly questionnaires.

All costs were converted to 2011 Euros [32]. Discounting of costs was not necessary due to the 1-year follow-up [22]. Table I lists the cost prices used.

Statistical analyses

Analyses were performed according to the intention-to-treat principle. Baseline characteristics of intervention and control group participants, and participants with complete and incomplete data were compared using descriptive statistics. Missing data were multiply imputed, stratified by treatment group. Using Predictive Mean Matching and Fully Conditional Specification, 15 complete data sets were created in IBM SPSS (v20) (Loss-of-Efficiency ≤ 5%) [33]. Datasets were analyzed separately as specified below. Pooled estimates were calculated using Rubin’s rules [33].

CEAs with NFR and general vitality were conducted from the societal perspective (i.e. all cost categories were included). CEAs with NFR and job satisfaction were conducted from the employer’s perspective (i.e. only costs accruing to employers were included). Effectiveness at 12-month follow-up was analysed using linear multilevel analyses, adjusted for baseline values and confounders. Three levels were identified: employees (n = 412), team leaders (n = 49) and departments (n = 19). Unadjusted cost differences between groups were calculated for total and disaggregated costs. Adjusted total cost differences were estimated using linear multilevel analyses (i.e. adjusted for confounders) [34]. The 95%CIs around all cost
Box 1: Incremental Cost Effectiveness Ratios (ICERs)

ICER societal perspective = Δ Societal costs/Δ Effects

where “Societal costs” include intervention, healthcare, absenteeism, presenteeism, sports, and active commuting costs and “Effects” include NFR or general vitality.

ICER employer’s perspective = Δ Employer’s costs/Δ Effects

where “Employer’s costs” include intervention, absenteeism, and presenteeism costs and “Effects” include NFR or job satisfaction.
ROI analyses were performed from the employer’s perspective (i.e. only costs accruing to employers were included, namely intervention, absenteeism and presenteeism costs). Three ROI-metrics were calculated: (1) Net Benefits (NB: amount of money gained after costs are recovered); (2) Benefit-Cost-Ratio (BCR: amount of money returned per Euro invested); (3) Return-On-Investment (ROI: percentage of profit per Euro invested) (Box 2) [21].

Using linear multilevel analyses, Benefits were adjusted for confounders. Bootstrapped 95%CIs were estimated using the percentile method, with 5000 replications–stratified by team leaders. The probability of financial return was estimated by determining the proportion of positive bootstrapped ROI-estimates (i.e. NB > 0, BCR > 1, ROI > 0%) [21].

Unless otherwise stated, analyses were performed using Stata (v12). Statistical significance was set at P < 0.05.

Sensitivity analyses
Five sensitivity analyses (SA) were performed: (1) in SA1, solely data of complete-cases were used; (2) in SA2, a slightly modified version of the ‘PROductivity and DISease Questionnaire’ (PRODISQ) was used for estimating presenteeism costs, in which presenteeism is conceptualized as reduced work performance due to health complaints [38]; (3) in SA3, absenteeism costs were valued using the HCA for the societal perspective; (4) in SA4, presenteeism costs were excluded; (5) in SA5, absenteeism and presenteeism were valued using Dutch age- and gender-specific price weights [27].

Results

Participants
Of the participants, 92 were allocated to the combined intervention group, 118 to the social environmental intervention group, 96 to the physical environmental intervention group and 106 to the control group (Fig. 1). At baseline, some meaningful differences were found between groups in age, education level, sickness absence and work performance (Table II). Age and education level were confounders for costs and effects, and sickness absence and work performance solely for costs. A total of 83 participants (20%) were lost to follow-up (Fig. 1). Of the participants, 8% had missing sickness absence data, and 41% and 62% had one or more missing values on the effect and all other cost measure items, respectively. Some meaningful differences were observed between participants with complete and incomplete data (not shown). These variables were included in the imputation model.

Effectiveness
During follow-up, NFR significantly improved in the combined intervention group compared with the control group (−8.4 95%CI: −14.6; −2.2), whereas this was not the case for the social environmental (0.1 95%CI: −8.8; 9.0) and physical environmental intervention group (−1.2 95%CI: −9.1; 6.6). No significant between-group differences were found for general vitality and job satisfaction.

Use of interventions
Two GMI-training courses, 72 GMI-sessions and four GMI-coaching sessions were provided. Also, 19 VIP zones were created: six VIP Coffee Corner
Fig. 1. Flow diagram of participants.
Zones, six VIP Open Office Zones, five VIP Meeting Zones and two VIP Hall Zones.

Costs

From the societal perspective, the costs of the combined, social environmental and physical environmental intervention were €428, €392 and €72 per employee, respectively (Supplementary Appendix A). From the employer’s perspective, these costs were €466 (combined), €430 (social) and €72 (physical). Please note that the intervention cost estimates differ across economic perspectives, because different costing methods were used for the societal perspective (i.e. micro-costing approach) and the employer’s perspective (i.e. gross-costing approach). Active commuting costs were significantly lower in all intervention groups compared with the control group. Combined intervention group participants had significantly lower sports costs than their control group counterparts. All other disaggregate cost differences were not significant (Table III). Societal and employer’s costs were higher in all intervention groups than in the control group, but only the difference in employer’s costs between the combined intervention and control group was significant (Table III).

**Societal perspective: cost-effectiveness**

For NFR, ICERs of -197 and –382 were found for the combined and physical environmental intervention, respectively. These figures indicate that the interventions cost €197 and €382 to society per point improvement in NFR compared with usual practice. For the social environmental intervention, an ICER of 1784 was found, indicating that it costs €1784 per point decline in NFR. For general vitality, ICERs of 479, 26 and 84 were found for the combined, social environmental and physical environmental intervention, respectively (i.e. more costly/more effective) (Table IV).

At willingness-to-pay values of €0/point improvement in NFR and general vitality, the probabilities of cost-effectiveness of the separate interventions and usual practice were about 0.3 and that of the combined intervention 0.09 (Fig. 2a and b). For NFR, the combined intervention became the preferred option at willingness-to-pay
### Table IV. Cost-effectiveness analysis results (main analysis)

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Sample size</th>
<th>Outcome</th>
<th>ΔC(95%CI)</th>
<th>ΔE(95%CI)</th>
<th>ICER</th>
<th>Distribution CE-plane (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combined</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Societal perspective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>92</td>
<td>Need for recovery</td>
<td>1647 (-653;4257)</td>
<td>-8.4 (-14.6;-2.2)</td>
<td>-197</td>
<td>81.4</td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>Points</td>
<td>1647 (-653;4257)</td>
<td>-8.4 (-14.6;-2.2)</td>
<td>-197</td>
<td>81.4</td>
</tr>
<tr>
<td>Employer’s perspective</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>92</td>
<td>Need for recovery</td>
<td>3102 (598;5969)</td>
<td>-0.1 (-8.8;9.0)</td>
<td>-370</td>
<td>94.9</td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>Points</td>
<td>3102 (598;5969)</td>
<td>-0.1 (-8.8;9.0)</td>
<td>-370</td>
<td>94.9</td>
</tr>
<tr>
<td>Social environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>118</td>
<td>Need for recovery</td>
<td>479 (-1895;2253)</td>
<td>-1.2 (-9.1;6.6)</td>
<td>-382</td>
<td>46.7</td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>Points</td>
<td>479 (-1895;2253)</td>
<td>-1.2 (-9.1;6.6)</td>
<td>-382</td>
<td>46.7</td>
</tr>
<tr>
<td>Physical environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>96</td>
<td>Need for recovery</td>
<td>922 (-1384;3156)</td>
<td>-1.2 (-9.1;6.6)</td>
<td>-763</td>
<td>52.3</td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>Points</td>
<td>922 (-1384;3156)</td>
<td>-1.2 (-9.1;6.6)</td>
<td>-763</td>
<td>52.3</td>
</tr>
</tbody>
</table>


Note: From the societal perspective, costs include intervention, healthcare, absenteeism, presenteeism, sports and active commuting costs. From the employer’s perspective, costs include intervention, absenteeism and presenteeism costs.
values of €170/point improvement, after which its probability of cost-effectiveness increased to 0.85 at a willingness-to-pay of €5200 (Fig. 2a). At higher willingness-to-pay values for general vitality, the social environmental intervention’s probability of cost-effectiveness slightly increased, while that of all other conditions remained about the same (Fig. 2b).

Employer’s perspective: cost-effectiveness

For NFR, ICERs of –370 and –763 were found for the combined and physical environmental intervention, respectively. These figures indicate that the interventions cost €370 and €763 to the employer per point improvement in NFR compared with usual practice. For the social environmental intervention, an ICER of 4256 was found, indicating that it costs €4256 per point decline in NFR. For job satisfaction, ICERs of –49 595, –2004, and –17 846 were found for the combined, social environmental, and physical environmental intervention, respectively, (i.e. more costly/less effective) (Table IV).

At employer willingness-to-pay values of €0/point improvement in NFR and job satisfaction, the interventions’ probabilities of cost-effectiveness were lower than that of usual practice. For NFR, the combined intervention became the preferred option at willingness-to-pay values of €300/point improvement, after which its probability of cost-effectiveness increased to 0.85 at a willingness-to-pay of €6000 (Fig. 2c). For higher willingness-to-pay values for job satisfaction, the probability of cost-effectiveness of all interventions remained lower than that of usual practice (figure not shown).

Employer’s perspective: return-on-investment

Total employer’s benefits, NBs, BCRs and ROIs were negative for all interventions. All interventions had a low probability of financial return (Table V).

Sensitivity analyses

The outcomes of SA1, SA2, SA4 and SA5 differed in some aspects from the main analysis, whereas those of SA3 were similar (Supplementary Appendix B and C). Three differences stand out. First, in the main analysis, NFR significantly improved in the combined intervention group compared with the control group, whereas this difference was not significant among the complete-cases (SA1). Second, the probability of financial return was low for all interventions in the main analysis, whereas it was relatively high for the combined (0.90) and physical environmental intervention (0.93) when using the PRODISQ (SA2). Third, in the main analysis, employer’s costs were significantly higher in the combined intervention group compared with the control group, whereas this difference was not significant when presenteeism costs were excluded (SA4), and when using age- and gender-specific price weights (SA5).

Discussion

Results of this study showed that the combined intervention may be cost-effective for NFR depending on the societal and employer’s willingness-to-pay and the probability of cost-effectiveness that they consider acceptable. Both separate interventions are not cost-effective for NFR. Furthermore, all interventions were neither cost-effective for general vitality and job satisfaction (due to low maximum probabilities of cost-effectiveness), nor cost-saving to the employer.

Comparison with existing literature

Few studies evaluated the (cost-) effectiveness and/or return-on-investment of a comparable intervention. Meijer et al. (2009), however, did evaluate the effect of an innovative office concept (e.g. open-office plan, flexible workplaces) among Dutch office employees, and found no significant improvements in NFR after 15 months [39]. Another study
Fig. 2. Cost-effectiveness acceptability curves for need for recovery (societal perspective) (a), general vitality (societal perspective) (b), and need for recovery (employer’s perspective) (c).
evaluated the cost-effectiveness and return-on-investment of a worksite vitality intervention (i.e. yoga and aerobic exercising, fruit, counselling) among older Dutch hospital employees compared with usual practice. After 12 months, the intervention was neither cost-effective for NFR and general vitality, nor cost-saving to the employer [40]. It should be noted, however, that the interventions of the aforementioned studies differed from those of the present one, as did their study population. Furthermore, a systematic review indicated that worksite physical activity and/or nutrition programs may generate positive return-on-investments through reduced absenteeism costs according to non-randomized studies (BCR:4.25), but not according to RCTs (BCR:0.51) [41]. When we solely included absenteeism costs (SA4), our results were similar to those of the review.

### Table V. Return-on-investment analysis results (main analysis)

<table>
<thead>
<tr>
<th>Intervention group</th>
<th>NB</th>
<th>BCR</th>
<th>ROI(%)</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>106</td>
<td>466</td>
<td>-2636</td>
<td>-666 (-1266; -20)</td>
</tr>
<tr>
<td>Total (95%CI)</td>
<td>106 (-5724; -590)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>106</td>
<td>430</td>
<td>-850</td>
<td>-1286 (-6564; 1424)</td>
</tr>
<tr>
<td>Total (95%CI)</td>
<td>106 (-3113; -1834)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>106</td>
<td>118</td>
<td>-16</td>
<td>-104 (-631; 262)</td>
</tr>
<tr>
<td>Control (95%CI)</td>
<td>106 (-2335; -2198)</td>
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<td></td>
<td></td>
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<tr>
<td>Combined</td>
<td>92</td>
<td>118</td>
<td>-922</td>
<td>-118 (-45; 85)</td>
</tr>
<tr>
<td>Environmental</td>
<td>96</td>
<td>96</td>
<td>-890</td>
<td>-128 (-65; 128)</td>
</tr>
<tr>
<td>Environmental (95%CI)</td>
<td>106 (-3113; -1834)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>106</td>
<td>118</td>
<td>-47</td>
<td>-922 (-4703; 2466)</td>
</tr>
<tr>
<td>Social (95%CI)</td>
<td>106 (-2715; 1899)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>118</td>
<td>96</td>
<td>-447</td>
<td>-118 (-5.3; 5.2)</td>
</tr>
<tr>
<td>Physical (95%CI)</td>
<td>118 (-2715; 1899)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NB: Net Benefit, BCR: Benefit-Cost Ratio, ROI: Return-On-Investment. Note: Costs include intervention costs, Benefits include absenteeism and presenteeism costs.

### Explanation of findings

The finding that the combined intervention had the most favourable results is in line with our hypothesis. It is noteworthy, however, that even though the combined intervention had a significant positive effect on NFR, it was also associated with significantly higher employer’s costs. This is striking, as absenteeism costs accounted for more than half of the difference in employer’s costs, while improvements in NFR were previously found to be related to reductions in absenteeism [42]. An explanation for this may be that worksite health promotion programs, such as ours, positively affect NFR at the short-term, while the related improvements in productivity solely occur at the long-term. Furthermore, even though all interventions were aimed at improving physical activity, sports and active commuting costs were lower in all intervention groups than in the control group. An explanation for this finding may be that control group participants were aware of the interventions’ content and/or aims, and purchased sports memberships, sports equipment and/or bicycles in an effort to compensate...
for the fact that they solely received usual practice.

**Robustness of the results**

Results of the sensitivity analyses differed in some aspects from the main analysis. Most notably, the combined intervention’s effect on NFR was significant in the main analysis (using multiple imputation), but not among the complete-cases. This probably resulted from the large difference in baseline NFR between combined intervention group participants with complete (mean:33.3) and incomplete data (mean:21.4), indicating that the complete-case analysis is likely biased by self-selection of participants. Furthermore, when presenteeism costs were estimated using the PRODISQ, the results were much more favourable than those of the main analysis (using the WHO-HPQ). Both instruments likely produced different results due to their difference in the conceptualization of presenteeism (WHO-HPQ: reduced overall work performance, PRODISQ: reduced work performance due to health complaints). The WHO-HPQ was used in the main analysis, because worksite health promotion programs are not just hypothesized to affect presenteeism through individual health improvements, but also directly from program impact [43].

**Strengths and limitations**

This study has several strengths. First, it was the first to evaluate the cost-effectiveness and return-on-investment of a combined social and physical environmental intervention, and of both intervention conditions separately. Second, the use of randomization reduced the possible influence of selection bias, while the study’s external validity was improved by its pragmatic design. Such a high quality trial design is important, as ROI estimates seem to differ between studies of low- and high methodological quality [41, 44]. Third, to minimize contamination between groups, allocation was performed at the department-level. To account for the possibly resulting clustering of data, this study was one of the first to use linear multilevel analyses for assessing the interventions’ cost-effectiveness and return-on-investment [34].

The study also had some limitations. First, the generalizability of the results may be hampered by the fact that the study was performed within a single company. Another limitation concerns the number of participants with missing data. Even though missing data are generally inevitable in trial-based economic evaluations and multiple imputation was used for filling in missing values, a 100% complete dataset would have produced more reliable results [33]. Also, all effect and some cost measures were assessed using questionnaires, which may have induced ‘recall bias’.

**Conclusion**

Depending on the societal and employer’s willingness-to-pay and the probability of cost-effectiveness that they consider acceptable, the combined intervention may be cost-effective for NFR; both separate interventions cannot. All interventions were neither cost-effective for general vitality and job satisfaction, nor cost-saving to the employer.

**Supplementary data**

Supplementary data are available at HEAL online.

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**Conflict of interest statement**

None declared.
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Economic evaluation worksite intervention


