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*Cost-effectiveness and return-on-investment  
analysis of a combined social and physical  
environmental intervention in office employees*

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## ABSTRACT

**Objective:** To evaluate the cost-effectiveness and financial return of a combined social and physical environmental intervention in office employees in comparison with usual practice, and of both intervention conditions separately. Moreover, the probabilities of the interventions being cost-effective in comparison with each other were explored.

**Methods:** In a 2X2 factorial design, 412 employees were allocated at the department level 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. The physical environmental intervention consisted of environmental modifications to the workplace. Control group participants received usual practice. Data on need for recovery (NFR), general vitality, and job satisfaction were collected at baseline, six, and 12 months. Salary and sickness absence data were collected from company records. Data on healthcare utilization and expenses on sports memberships, sports equipment and active commuting equipment were collected using 3-monthly questionnaires. Using linear multilevel analyses, cost-effectiveness analyses were conducted from the societal and employer's perspective, and return-on-investment analyses from that of the employer. Uncertainty was assessed using bootstrapping techniques, and shown in cost-effectiveness planes and cost-effectiveness acceptability curves.

**Results:** At 12 months, combined intervention group participants significantly improved their NFR compared with the control group (-8.4; 95%CI -14.6 to -2.2). Their total employer's costs, however, were significantly higher than those of the control group (3102; 95%CI 598 to 5969). All other between-group differences in costs and effects were not significant. For NFR, the combined intervention became the preferred option in comparison with the other interventions at willingness-to-pay values of €170 (societal perspective) and €300 (employer's perspective) per point improvement, after which its probability of cost-effectiveness gradually increased to 0.85. For general vitality and job satisfaction, the probabilities that the interventions were cost-effective in comparison with each other were low at all ceiling ratios ( $\leq 0.55$ ), as were their probabilities of financial return ( $\leq 0.41$ ).

**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 considered cost-effective in improving NFR. Both separate interventions were not cost-effective in improving this outcome. Moreover, all interventions were neither cost-effective in improving general vitality (societal perspective) and job satisfaction (employer's perspective), 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). As a consequence, many workers experience higher levels of work stress compared to a couple of decades ago (3). Work stress is defined as the psychological and physical state that results when individual resources are insufficient to cope with the demands and pressures of work (4). If stress persists, there may be changes in immunological, neuroendocrine, cardiovascular, and autonomic functioning, leading to mental and physical ill health (e.g. mental disorders, cardiovascular disease) and an associated increase in healthcare and productivity-related costs (4-6).

Need for recovery (NFR) from work-related fatigue seems to be an important intermediate factor in the relation between short-term work stress and longer-term mental and physical ill health (7-10). Previous research indicates that the ability to recover from work may be enhanced by improving a worker’s level of physical activity and relaxation (11-14). Therefore, in the Be Active & Relax “Vitality In Practice” (VIP) study, a worksite health promotion program was developed aimed at reducing NFR among office employees by improving their physical activity and relaxation (15). The intervention was developed in close cooperation with stakeholders of the participating company and consisted of both a social and physical environmental component. Such a social ecological intervention approach was chosen because interventions targeted at both the individual and environmental determinants of behaviours are expected to be more effective in achieving health behaviour change than those that are solely targeted at individual determinants (15-17).

Evaluations of the intervention’s effectiveness in terms of health- and work-related outcomes have been reported elsewhere (18;19). However, as resources for occupational health are scarce, employers are not just interested in the effectiveness of worksite health promotion programs, but also in their impact on the company’s bottom-line (20). This can be determined with a return-on-investment (ROI) analysis, in which the costs of an intervention are compared to its resulting financial benefits to the employer (21;22). Various program outcomes, however, are hard to monetize

(e.g. health outcomes, job satisfaction) and can therefore not be included in a ROI analysis. Therefore, cost-effectiveness analyses (CEAs), in which the incremental costs of an intervention are compared to its incremental effects, are also important (23).

The present study aimed to evaluate the cost-effectiveness and financial return of the combined social and physical environmental intervention in office employees in comparison with usual practice, as well as those of both intervention conditions separately. Additionally, the probabilities of the interventions 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 from that of the employer. The combined intervention was hypothesized to produce the most favourable results.

## **METHODS**

### **Study design and study population**

This study was performed alongside a 12-month trial with a pragmatic 2X2 factorial design. Data collection took place in the Netherlands from September 2011 up until December 2012. Full details of the study design, development and content of the intervention, as well as the sample size calculation have been published elsewhere (15). The study design and informed consent procedure were approved by the Medical Ethics Committee of the VU University Medical Center, Amsterdam, the Netherlands.

In September 2011, all 1,182 office employees of 24 departments of a financial service provider were invited to participate in the study (i.e. they received an invitation letter, information on the study, informed consent form, and a baseline questionnaire). Those who were on sickness absence during the previous four weeks were not eligible to participate. A total of 412 employees (response: 35%) from 19 departments signed the informed consent form and completed the baseline questionnaire. Subsequently, their respective departments were either stratified to the "physical environmental intervention" or the "no physical environmental intervention" group. Within these strata, departments were subsequently randomized to either the "social environmental intervention" or the "no social environmental intervention" group by

means of tossing a coin. This resulted in four research groups: 1) combined social and physical environmental intervention group; 2) social environmental intervention group only; 3) physical environmental intervention group only; 4) control group (usual practice). Group allocation was performed at the department level, because the interventions under study acted on the group-level rather than on the individual-level as well as to minimize contamination between study groups. As a result of the nature of the intervention, blinding of participants and intervention providers was not possible.

### **Social and physical environmental intervention conditions**

#### *Social environmental intervention condition*

The social environmental intervention condition consisted of Group Motivational Interviewing (GMI). GMI was delivered by the team leaders of the departments after receiving a 2-day GMI-training course, which was provided by a GMI-professional. During the intervention period, team leaders also participated in two 90-minute GMI-coaching sessions. These sessions took place at the workplace and during work hours, and were provided by a GMI-professional as well. Within a period of six weeks (i.e. three weeks between sessions), team leaders provided three 90-minute GMI-sessions to their own team. Two months after the final session, a booster GMI-session was provided. All GMI-sessions took place at the workplace and during work hours. GMI-sessions were supported by a GMI-session workbook and a web-based social media platform.

#### *Physical environmental intervention condition*

As part of the physical environmental intervention condition, several so-called “VIP zones” were created at the workplace, including: 1) the VIP Coffee Corner Zone – the coffee corner was modified by adding a bar with bar chairs, a large plant, and a giant relaxing wall poster, 2) the VIP Open Office Zone – the office was modified by introducing exercise balls and curtains to divide desks in order to reduce background noise, 3) the VIP Meeting Zone – conference rooms were modified by placing a standing table and a giant relaxing wall poster, and 4) the VIP Hall Zone - table tennis tables were placed and lounge chairs were introduced in the hall for

informal meetings. Moreover, footsteps were placed on the floor of the entrance hall to promote stair walking. All environmental modifications were promoted through banners in the VIP Coffee Corner and digital flyers.

### **Effect measures**

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

#### *Primary outcome*

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 dichotomous items (yes/no). The NFR Score ranges from 0-100, with lower scores indicating a better NFR (24).

#### *Secondary outcomes*

Secondary outcomes were general vitality and job satisfaction. General vitality was assessed using the RAND-36 Vitality Scale, which includes four items assessing a participant’s general vitality during the previous four 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 (25). Job satisfaction was assessed using a 1-item question of the “Netherlands Working Conditions Survey”. Participants were asked to rate their overall job satisfaction on a 5-point scale ranging from “very dissatisfied”(1) to “very satisfied”(5) (26).

### **Measurement and valuation of resource use**

#### *Intervention costs*

For the societal perspective, a bottom-up micro-costing approach was used for estimating intervention costs, meaning that detailed data were collected regarding the quantity of resources consumed as well as their unit prices (27). Intervention costs included those related to the development, implementation, and operation of the intervention (conditions) (e.g. costs for recruiting participants, GMI-training courses, GMI-sessions, GMI-coaching sessions, GMI-website hosting and maintenance,

printed materials, VIP zones). Frequency and duration of GMI-training courses, GMI-sessions, and GMI-coaching sessions were registered by the team leaders and GMI-professionals. Labor costs of intervention providers were valued by multiplying their total time investments by their gross hourly salaries including overhead costs. VIP zone costs were based on invoices and were linearly depreciated over a period of 5 years with a scrap value of zero. Capital costs were valued using cost data collected from finance department staff. Printed material and website hosting costs were estimated using invoices. Development costs were estimated by dividing the total costs related to the development of the intervention by the expected number of program users during the first five years after implementing it broadly. For the employer's perspective, intervention costs were valued using charges paid.

#### *Healthcare costs*

Healthcare utilization was assessed using 3-monthly questionnaires and included primary healthcare (e.g. general practitioner, allied health professionals, complementary medicine), secondary healthcare (e.g. medical specialist, hospitalization), and both prescribed and over-the-counter medications. Primary and secondary healthcare utilization were valued using Dutch standard costs (28). If unavailable, prices according to professional organizations were used. Medication use was valued using unit prices derived from the Dutch Royal Society of Pharmacy (29).

#### *Absenteeism costs*

Baseline (i.e. a one year period prior to baseline) and follow-up sickness absence data as well as gross annual salaries of participants were collected from company records.

Costs associated with one sickness absence day were calculated per participant by dividing their gross annual salary (including overhead costs) by their total number of workable days per year (28). If the societal perspective was applied, absenteeism costs were estimated using the "Friction Cost Approach" (FCA), with a friction period of 23 weeks and an elasticity of 0.8 (30). For the employer's perspective, absenteeism costs were estimated using the "Human Capital Approach" (HCA), in which costs are neither truncated to the friction period, nor is an elasticity factor applied.



### *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) (31;32). 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. Participants were asked to rate their overall work performance during the previous three months on an 11-point scale (range: “worst performance” (0) to “best performance” (10)). Subsequently, their average work performance during follow-up (*Wown*) was estimated and the participants’ level of presenteeism ( $P_{HPQ}$ ) was calculated using the following formula:

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

The total number of days lost due to presenteeism 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. These days were subsequently valued using the participants’ gross annual salaries (including overhead costs).

### *Sports costs*

Participants’ expenses on sports memberships and sports equipment were assessed using 3-monthly questionnaires.

### *Active commuting equipment costs*

Participant’s expenses on active commuting equipment (i.e. a bike) were assessed using 3-monthly questionnaires.

All costs were converted to 2011 Euros using consumer price indices (33). Discounting of costs and effects was not necessary, because the follow-up of the trial was one year (23). An overview of the cost prices used for valuing resource use can be found in Table 1.

**Table 1: Price weights used for valuing resource use in the Be Active & Relax VIP study**

Resource use categories	Price weight	
	Societal perspective	Employer's perspective
Intervention costs		
Social and physical environmental intervention	€ 427.96 <sup>a</sup>	€ 465.92 <sup>b</sup>
Social environmental intervention	€ 392.28 <sup>a</sup>	€ 430.25 <sup>b</sup>
Physical environmental intervention	€ 71.65 <sup>a</sup>	€ 71.46 <sup>b</sup>
Medical costs		
Visits to a care provider		
General practitioner		
Office consultation	€ 28.96 <sup>c</sup>	N.A.
Telephone consultation	€ 14.48 <sup>c</sup>	N.A.
House call	€ 44.47 <sup>c</sup>	N.A.
Allied health professionals		
Psychologist	€ 82.47 <sup>c</sup>	N.A.
Dietician	€ 27.93 <sup>c</sup>	N.A.
Physical therapist	€ 37.23 <sup>c</sup>	N.A.
Other allied health professionals	Variable <sup>c,d</sup>	N.A.
Medical specialists		
Psychiatrist	€ 106.53 <sup>c</sup>	N.A.
Other medical specialists	€ 74.47 <sup>c</sup>	N.A.
Complementary medicine	Variable <sup>c,d</sup>	N.A.
Hospitalization		
Ward	€ 472.66 <sup>c</sup>	N.A.
Intensive care	€ 2257.82 <sup>c</sup>	N.A.
Medications	Variable <sup>e</sup>	N.A.
Absenteeism costs		
Sickness absence	Variable <sup>f</sup>	Variable <sup>f</sup>
Presenteeism costs		
Presenteeism	Variable <sup>f</sup>	Variable <sup>f</sup>
Sports costs	Variable <sup>g</sup>	N.A.
Active commuting equipment costs	Variable <sup>h</sup>	N.A.

Abbreviations: N.A.: Not Applicable

Note: Costs are expressed in 2011 Euros

Cost price sources: <sup>a</sup> Bottom-up micro-costed, valued using tariffs and depleted sources (See Appendix 1); <sup>b</sup> Market prices, valued using invoices; <sup>c</sup> Dutch Manual of Costing; <sup>d</sup> Professional organizations; <sup>e</sup> Dutch Society of Pharmacy; <sup>f</sup> Gross annual salaries of office employees including overhead costs; <sup>g</sup> Self-reported expenses on sports memberships and sports equipment; <sup>h</sup> Self-reported expenses on active commuting equipment

### **Potential confounders**

At baseline, several potential confounders were assessed by questionnaire, including gender (female/male), age (years), having a partner (yes/no), Dutch nationality (yes/no), education level (low=elementary school or less, intermediate=secondary education, and high=college/university), working hours per week, general health (range: 1-5), job demands (range: 1-5), and supervisor support (range: 1-5). Of these, only age and education level were found to be a confounder for both costs and effects. That is, the interventions' effects changed by more than 10% after adding these potential confounders to the crude models.

### **Statistical analyses**

Analyses were performed according to the intention-to-treat principle. Baseline characteristics of intervention and control group participants as well as those of participants with complete and incomplete data were compared using descriptive statistics. Missing data were imputed using multiple imputation. The imputation model included age, gender, number of working days, baseline sickness absence, baseline work performance, baseline effect measure values, and available midpoint and follow-up cost and effect measure values (i.e. 6- and 12 months). Imputations were performed per study group. Using Predictive Mean Matching and Fully Conditional Specification, 15 complete data sets were created in IBM SPSS (v20, Chicago, IL) (Loss of Efficiency  $\leq 5\%$ ) (34;35). All datasets were analysed separately as specified below, after which pooled estimates were calculated using Rubin's rules (36). Except for the multiple imputation, analyses were performed using Stata (V12, Stata Corp, College Station, TX). Statistical significance was set at  $p < 0.05$ .

### *Cost-effectiveness analysis*

CEAs with NFR and general vitality were conducted from the societal perspective, in which all costs and consequences related to the interventions were considered, regardless of where they occur. CEAs with NFR and job satisfaction were also conducted from the employer's perspective, in which only costs and consequences relevant to Dutch employers were taken into account.

Effectiveness at 12-month follow-up was analyzed using linear multilevel analyses, adjusted for baseline values and confounders (i.e. age, education level). Three levels were identified: employees (n=412), team leaders (n=49), and departments (n=19). Unadjusted cost differences between study groups were calculated for total as well as disaggregated costs. 95% CIs around these cost differences were estimated by means of bias-corrected (BC) intervals, with 5000 replications. Adjusted cost differences at 12-month follow-up were estimated using linear multilevel analyses (37). These cost differences were corrected for baseline sickness absence, baseline work performance, age, and education level. The 95% CIs around the adjusted cost differences were estimated by means of BC intervals as well (5000 replications). To account for the clustering of data, bootstrap replications were stratified for team leaders (38). Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the adjusted cost differences by those in effects. To graphically illustrate the uncertainty around the ICERs, bootstrapped incremental cost-effect pairs (CE-pairs) were plotted on cost-effectiveness planes (CE-planes) (39). A summary measure of the joint uncertainty of costs and effects was presented using cost-effectiveness acceptability curves (CEACs), which show the probability that each of the interventions is more cost-effective than the others at different ceiling ratios (i.e. the maximum amount of money decision-makers are willing to pay per unit of effect) (40).

#### *ROI analysis*

The ROI analysis was performed from the employer's perspective. Costs were defined as intervention costs. Benefits were defined as the difference in monetized outcome measures (i.e. absenteeism and presenteeism costs) between study groups during follow-up, with positive benefits indicating reduced spending. Using linear multilevel analyses, benefits were adjusted for baseline sickness absence, baseline work performance, age, and education level. Subsequently, three ROI-metrics were calculated; 1) Net Benefits (NB), 2) Benefit Cost Ratio (BCR), and 3) Return On Investment (ROI) (21;22).

$$NB = \text{Benefits} - \text{Costs}$$

$$BCR = \text{Benefits} / \text{Costs}$$

$$ROI = ((\text{Benefits} - \text{Costs}) / \text{Costs}) * 100$$

The NB indicates the amount of money gained after costs are recovered (i.e. net-loss or net-savings). The BCR indicates the amount of money returned per Euro invested. The ROI indicates the percentage of profit per Euro invested. To quantify precision, bootstrapped 95% CIs around the NB, BCR, and ROI were estimated using the percentile method, with 5000 replications. Again, bootstrap replications were stratified for team leaders (38). In addition, the probability of financial return was estimated by determining the proportion of bootstrapped financial return estimates was positive (i.e.  $NB > 0$ ,  $BCR > 1$ , and  $ROI > 0\%$ ) (21;22).

### **Sensitivity analyses**

To assess the robustness of the results, five univariate sensitivity analyses were performed. The first sensitivity analysis (SA1) was restricted to participants with complete cost and effect data at all measurement points (i.e. complete-case analysis). In the second sensitivity analysis (SA2), a slightly modified version of the “PROductivity and DISease Questionnaire” (PRODISQ) was used for estimating presenteeism costs, in which presenteeism was conceptualized as reduced work performance due to health complaints (41;42). In the third sensitivity analysis (SA3), absenteeism costs were valued using the HCA for the societal perspective and the FCA for the employer’s perspective. As overall consensus about the inclusion of presenteeism costs in economic evaluations does currently not exist, presenteeism costs were excluded in a fourth sensitivity analysis (SA4). Finally, a fifth sensitivity analysis (SA5) was performed, in which absenteeism and presenteeism were valued using age- and gender-specific Dutch price weights (28).

## **RESULTS**

### **Participants**

Of the participants, 92 were allocated to the combined social and physical intervention group, 118 to the social environmental intervention group, 96 to the physical environmental intervention group, and 106 to the control group (Figure 1). At baseline, some meaningful differences were found between study groups in age, education level, and sickness absence days (Table 2). A total of 83 participants (20%) were lost to follow-up (combined:  $n=29$ , social:  $n=20$ , physical:  $n=24$ , control:  $n=9$ ).

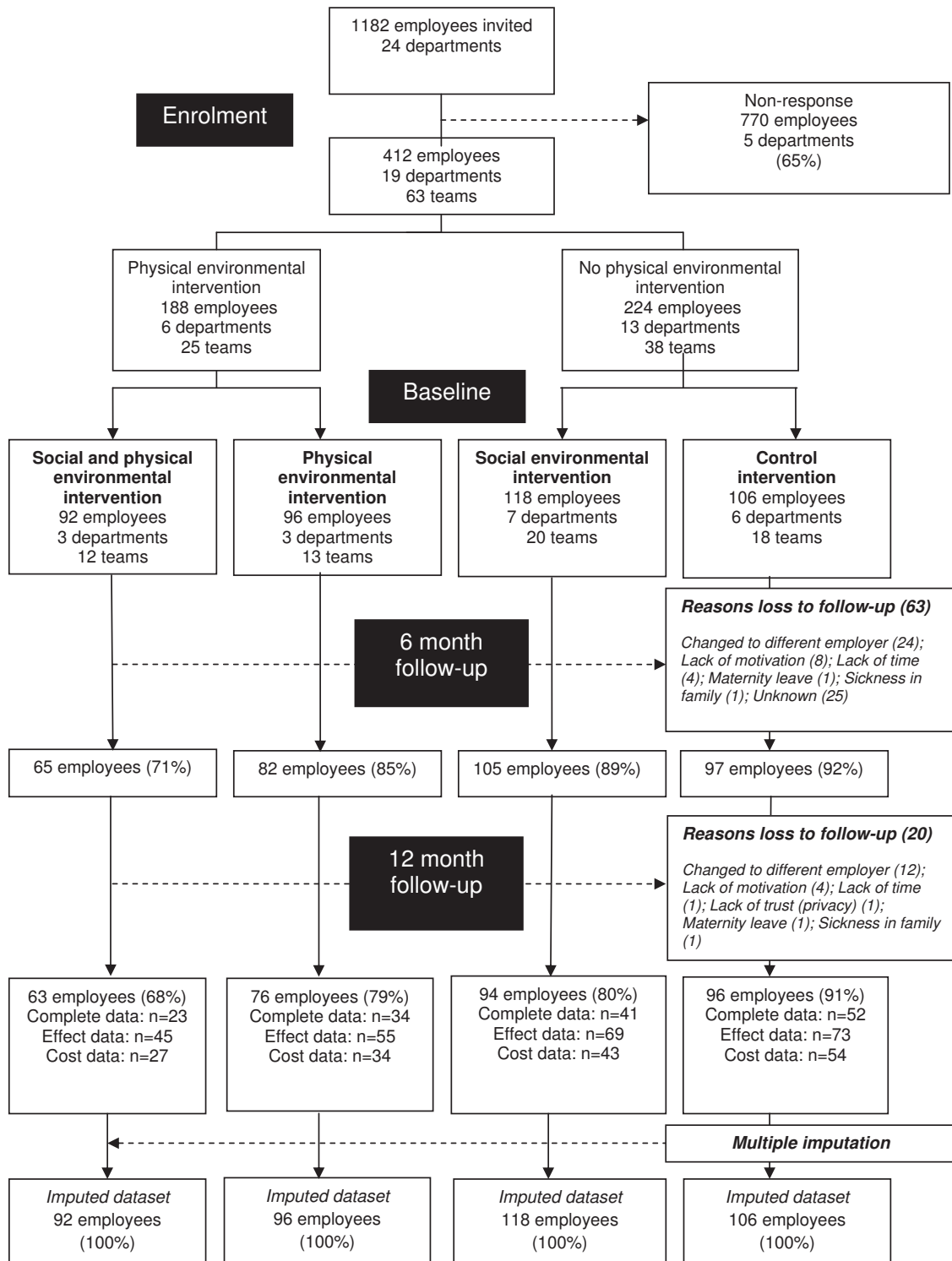


Figure 1: Flow diagram of participants

**Table 2: Baseline characteristics of participants**

Baseline characteristics	Social and physical environmental intervention group			Social environmental intervention group		
	All (n=92)	Complete (n=23)	Incomplete (n=69)	All (n=118)	Complete (n=41)	Incomplete (n=77)
Male [n (%)]	51 (55.4)	17 (73.9)	34 (49.3)	73 (61.9)	25 (61.0)	48 (62.3)
Age (years) [mean (SD)]	38.0 (10.5)	42.8 (9.8)	36.4 (10.3)	43.6 (10.3)	46.8 (9.2)	42.0 (10.5)
Having a partner [n (%)]	74 (80.4)	20 (87.0)	54 (78.3)	91 (77.1)	31 (75.6)	60 (77.9)
Dutch nationality [n (%)]	82 (89.1)	22 (95.7)	60 (87.0)	106 (89.9)	38 (92.7)	68 (88.3)
Education level [n (%)]						
Low	17 (18.5)	3 (13.0)	14 (20.3)	39 (33.1)	14 (34.1)	25 (32.5)
Intermediate	19 (20.7)	4 (17.4)	15 (21.7)	23 (19.5)	8 (19.5)	15 (19.5)
High	55 (59.8)	16 (69.6)	39 (56.5)	56 (47.5)	19 (46.3)	37 (48.1)
Working hours per week [mean (SD)]	35.1 (6.1)	36.0 (5.6)	34.7 (6.5)	36.9 (4.1)	37.1 (4.0)	36.9 (4.2)
General health (range: 1-5) [mean (SD)]	3.8 (0.9)	3.8 (0.8)	3.8 (0.9)	3.8 (0.7)	3.8 (0.8)	3.8 (0.7)
Job demands (range: 1-5) [mean (SD)]	2.6 (0.3)	2.6 (0.2)	2.6 (0.3)	2.7 (0.2)	2.7 (0.2)	2.7 (0.2)
Supervisor support (range: 1-5) [mean (SD)]	2.8 (0.5)	2.7 (0.8)	2.9 (0.4)	2.9 (0.5)	2.8 (0.4)	3.0 (0.5)
Need for recovery (range: 0-100) [mean (SD)]	33.3 (29.9)	21.4 (24.3)	37.2 (30.7)	31.8 (28.7)	25.7 (28.6)	35.1 (28.3)
General vitality (range: 0-6) [mean (SD)]	59.7 (18.0)	65.7 (13.5)	57.6 (18.9)	63.9 (18.3)	66.0 (19.4)	62.8 (17.8)
Job satisfaction (range: 1-5) [mean (SD)]	3.9 (0.7)	3.7 (0.6)	3.9 (0.7)	3.9 (0.8)	3.9 (0.7)	3.9 (0.8)
Sickness absence (days) [mean (SD)]	6.8 (18.5)	9.3 (31.5)	5.8 (9.3)	7.0 (14.2)	11.4 (18.7)	4.5 (10.2)
Work performance (range: 0-10) [mean (SD)]	7.5 (1.0)	7.6 (1.0)	7.5 (1.1)	7.6 (0.8)	7.5 (0.8)	7.7 (0.8)

Physical environmental intervention group			Control group		
All (n=96)	Complete (n=34)	Incomplete (n=62)	All (n=106)	Complete (n=52)	Incomplete (n=54)
60 (62.5)	21 (61.8)	39 (62.9)	65 (61.3)	34 (65.4)	31 (57.4)
42.2 (10.5)	42.7 (10.4)	42.0 (10.7)	40.7 (9.2)	41.3 (9.1)	40.2 (9.3)
82 (85.4)	29 (85.3)	53 (85.5)	85 (80.2)	40 (76.9)	45 (83.3)
87 (90.6)	31 (91.2)	56 (90.3)	95 (89.6)	47 (90.4)	48 (88.9)
16 (16.7)	4 (11.9)	12 (19.4)	21 (19.8)	10 (19.2)	11 (20.4)
20 (20.8)	8 (23.5)	12 (19.4)	24 (22.6)	15 (28.8)	9 (16.7)
60 (62.5)	22 (64.7)	38 (61.3)	61 (57.5)	27 (51.9)	34 (63.0)
35.7 (5.6)	35.1 (5.9)	36.0 (5.4)	36.2 (5.3)	36.1 (6.0)	36.3 (4.6)
3.8 (0.7)	3.8 (0.7)	3.7 (0.7)	3.8 (0.7)	3.7 (0.7)	3.9 (0.6)
2.6 (0.3)	2.7 (0.3)	2.6 (0.3)	2.7 (0.3)	2.7 (0.2)	2.6 (0.3)
2.9 (0.4)	2.9 (31.4)	2.9 (0.4)	2.9 (0.5)	2.9 (0.4)	2.8 (0.6)
33.7 (31.3)	31.2 (31.4)	35.1 (31.5)	30.4 (27.7)	28.9 (27.6)	31.9 (27.9)
63.4 (17.1)	62.2 (19.5)	64.1 (15.9)	66.5 (18.7)	66.4 (19.9)	66.6 (17.6)
4.1 (0.6)	4.1 (0.7)	4.0 (0.5)	4.0 (0.7)	4.0 (0.8)	4.0 (0.6)
11.0 (29.2)	11.2 (39.7)	10.8 (20.7)	3.7 (6.5)	2.9 (4.7)	4.5 (7.9)
7.7 (0.8)	7.9 (0.8)	7.6 (0.8)	7.7 (0.9)	7.8 (1.1)	7.6 (0.8)

The main reasons for loss to follow-up were lack of motivation and changing jobs. After 12 months, complete data were obtained from 59% of participants on the effect measures (combined: 49%, social: 58%, physical: 57%, control: 69%) and from 38% on the cost measures (combined: 29%, social: 36%, physical: 35%, control: 51%). Some meaningful differences were observed between participants with complete and incomplete data (Table 2). These characteristics were included in the imputation model.

### Effectiveness

During follow-up, NFR statistically significantly improved among participants of the combined intervention group compared to the control group (-8.4; 95%CI -14.6 to -2.2), whereas this was not the case for the social (0.1; 95%CI -8.8 to 9.0) and physical



environmental intervention group (-1.2; 95%CI -9.1 to 6.6). No statistically significant between-group differences were found for general vitality and job satisfaction.

### **Use of the interventions**

During the intervention period, two GMI-training courses for team leaders, 72 GMI-sessions (combined: 24 sessions, social: n 48 sessions), and four GMI-coaching sessions were provided. Also, 19 VIP zones were created; i.e. six VIP Coffee Corner 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 (Appendix 1). From the employer's perspective, these costs were €466 (combined), €430 (social), and €72 (physical). Active commuting equipment costs were statistically significantly lower in all intervention groups as compared to the control group. Moreover, combined intervention group participants had statistically significantly lower sports costs than their control group counterparts. All other disaggregate cost differences were not statistically significant (Table 3). Total employer's costs in the combined intervention group were statistically significantly higher than in the control group (3102; 95%CI 598 to 5969), but this was not the case for both the social and physical environmental intervention group. Societal costs in all intervention groups were higher than in the control group, but these differences were not statistically significant (Table 4).

**Table 3: Mean costs per participant in the intervention and control groups, and unadjusted mean cost differences between study groups during the 12-month follow-up period (based on the imputed dataset)**

Cost category	Control group n=106; mean (SEM)	Social and physical environmental group n=92; mean (SEM)	Δ Costs (95%CI)	Social environmental group n=118; mean (SEM)	Physical environmental group n=96; mean (SEM)	Δ Costs (95%CI)
<b>Societal perspective</b>						
Intervention costs	0 (NA)	428 (NA)	428 (NA)	392 (NA)	72 (NA)	72 (NA)
Healthcare costs	602 (116)	502 (74)	-99 (-276 to 95)	742 (114)	741 (183)	139 (-88 to 406)
Absenteeism costs	2345 (715)	3729 (1146)	1384 (-774 to 3737)	2901 (665)	2691 (677)	347 (-1394 to 1817)
Presenteeism costs	18068 (919)	19289 (1579)	1221 (-1028 to 3416)	17880 (923)	19284 (1276)	1216 (-638 to 3102)
Sports costs	799 (124)	372 (39)	-427 (-630 to -245)	635 (116)	184 (64)	-109 (-331 to 107)
Active commuting equipment costs	589 (149)	11 (5)	-578 (-755 to -428)	291 (124)	690 (125)	-405 (-595 to -214)
<b>Total</b>	<b>22402 (1155)</b>	<b>24331 (1626)</b>	<b>1929 (-846 to 4624)</b>	<b>22841 (1088)</b>	<b>237663 (1464)</b>	<b>1260 (-1176 to 3634)</b>
<b>Employer's perspective</b>						
Intervention costs	0 (NA)	466 (NA)	466 (NA)	430 (NA)	72 (NA)	72 (NA)
Absenteeism costs	2520 (843)	4410 (1507)	1889 (-803 to 4964)	3073 (778)	2691 (677)	171 (-1862 to 1752)
Presenteeism costs	18068 (919)	19289 (1579)	1221 (-1028 to 3415)	17880 (923)	19284 (1276)	1216 (-638 to 3102)
<b>Total</b>	<b>20588 (1189)</b>	<b>24164 (1783)</b>	<b>3577 (510 to 6699)</b>	<b>21384 (1141)</b>	<b>22047 (1388)</b>	<b>1459 (-1056 to 3830)</b>

Abbreviations: n: number; SEM: Standard Error of the Mean, CI: Confidence Interval, NA: Not Applicable

Note: Costs are expressed in 2011 Euros

**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 for the main analysis**

Perspective	Sample size		Outcome	ΔC (95% CI)		ΔE (95% CI)	ICER	Distribution CE-plane (%)			
	Intervention	Control		€	Points			€/point	NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>
<b>Social and physical environmental intervention</b>											
Societal perspective	92	106	Need for recovery	1647 (-653 to 4257)	-8.4 (-14.6 to -2.2)	-197	81.4	18.2	0.0	0.4	
Employer's perspective	92	106	General Vitality	1647 (-653 to 4257)	3.4 (-9.3 to 16.2)	479	56.0	16.2	2.0	25.7	
	92	106	Need for recovery	3102 (598 to 5969)	-8.4 (-14.6 to -2.2)	-370	94.9	0.5	0.0	0.4	
	92	106	Job satisfaction	3102 (598 to 5969)	-0.1 (-0.6 to 0.5)	-49595	36.2	3.7	1.0	59.2	
<b>Social environmental intervention</b>											
				€	Points	€/point	NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>	NW <sup>4</sup>	
Societal perspective	118	106	Need for recovery	187 (-1895 to 2253)	0.1 (-8.8 to -9.0)	1784	22.6	26.7	19.0	31.7	
Employer's perspective	118	106	General Vitality	187 (-1895 to 2253)	7.3 (-3.8 to 18.4)	26	44.5	43.8	2.4	9.3	
	118	106	Need for recovery	447 (-1609 to 2472)	0.1 (-8.8 to 9.0)	4256	26.0	23.3	16.3	34.4	
	118	106	Job satisfaction	447 (-1609 to 2472)	-0.2 (-0.9 to 0.5)	-2004	14.8	6.0	33.6	45.5	
<b>Physical environmental intervention</b>											
				€	Points	€/point	NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>	NW <sup>4</sup>	
Societal perspective	96	106	Need for recovery	479 (-1757 to 2779)	-1.2 (-9.1 to -6.6)	-382	46.7	27.7	12.4	13.3	
Employer's perspective	96	106	General Vitality	479 (-1757 to 2779)	5.7 (-5.6 to 17.1)	84	45.7	37.1	3.0	14.2	
	96	106	Need for recovery	922 (-1384 to 3156)	-1.2 (-9.1 to 6.6)	-763	52.3	21.1	9.6	17.1	
	96	106	Job satisfaction	922 (-1384 to 3156)	-0.1 (-0.5 to 0.4)	-17846	24.9	22.9	7.8	44.5	

Abbreviations: CI: Confidence Interval, C: Costs, E: Effects, ICER: Incremental Cost-Effectiveness Ratio, CE-plane: Cost-Effectiveness plane

Note: Costs are expressed in 2011 Euros

<sup>1</sup> Refers to the northeast quadrant of the CE-plane, suggesting that the intervention is more effective and more costly compared to usual practice

<sup>2</sup> Refers to the southeast quadrant of the CE-plane, suggesting that the intervention is more effective and less costly compared to usual practice

<sup>3</sup> Refers to the northwest quadrant of the CE-plane, suggesting that the intervention is less effective and more costly compared to usual practice

<sup>4</sup> Refers to the southwest quadrant of the CE-plane, suggesting that the intervention is less effective and less costly compared to usual practice

**Societal perspective: cost-effectiveness**

For NFR, an ICER of -197 was found for the combined intervention group in comparison with the control group. This indicates that for every 1-point improvement in NFR, the intervention costs €197 in comparison with usual practice (Note that this ICER is negative, as lower scores indicate a better NFR). An ICER in the similar direction was found for the physical environmental intervention group (ICER: -382). In both cases, the majority of incremental CE-pairs were located in the northeast quadrant of the CE-plane (Table 4, Figure 2-1a), suggesting that both intervention conditions were more costly and more effective in improving NFR than usual practice. For the social environmental intervention group, an ICER of 1784 was found. This indicates that the intervention costs €1784 per point decline in NFR in comparison with usual practice (Table 4, Figure 2-1a). For general vitality, ICERs of 479, 26, and 84 were found for the combined, social, and physical environmental intervention group, respectively. In all cases, the majority of incremental CE-pairs were located in the northeast quadrant of the CE-plane (Table 4, Figure 2-1b). This suggests that all intervention conditions were more costly and more effective in improving general vitality than usual practice.

A summary measure of the joint uncertainty of costs and effects is presented by the CEACs in Figure 2-2a and Figure 2-2b. These CEACs indicate that the probabilities of cost-effectiveness of both separate intervention conditions and usual practice were about 0.3 at societal willingness-to-pay values of €0/point improvement in NFR and general vitality, while that of the combined intervention was lower (i.e. 0.09). For NFR, the separate intervention conditions' probabilities of cost-effectiveness as well as that of usual practice decreased with an increasing willingness-to-pay, while that of the combined intervention gradually increased to 0.85 at a ceiling ratio of €3900. For general vitality, on the other hand, the social environmental intervention condition's probability of cost-effectiveness increased with an increasing willingness-to-pay, whereas that of all other intervention conditions remained about the same.

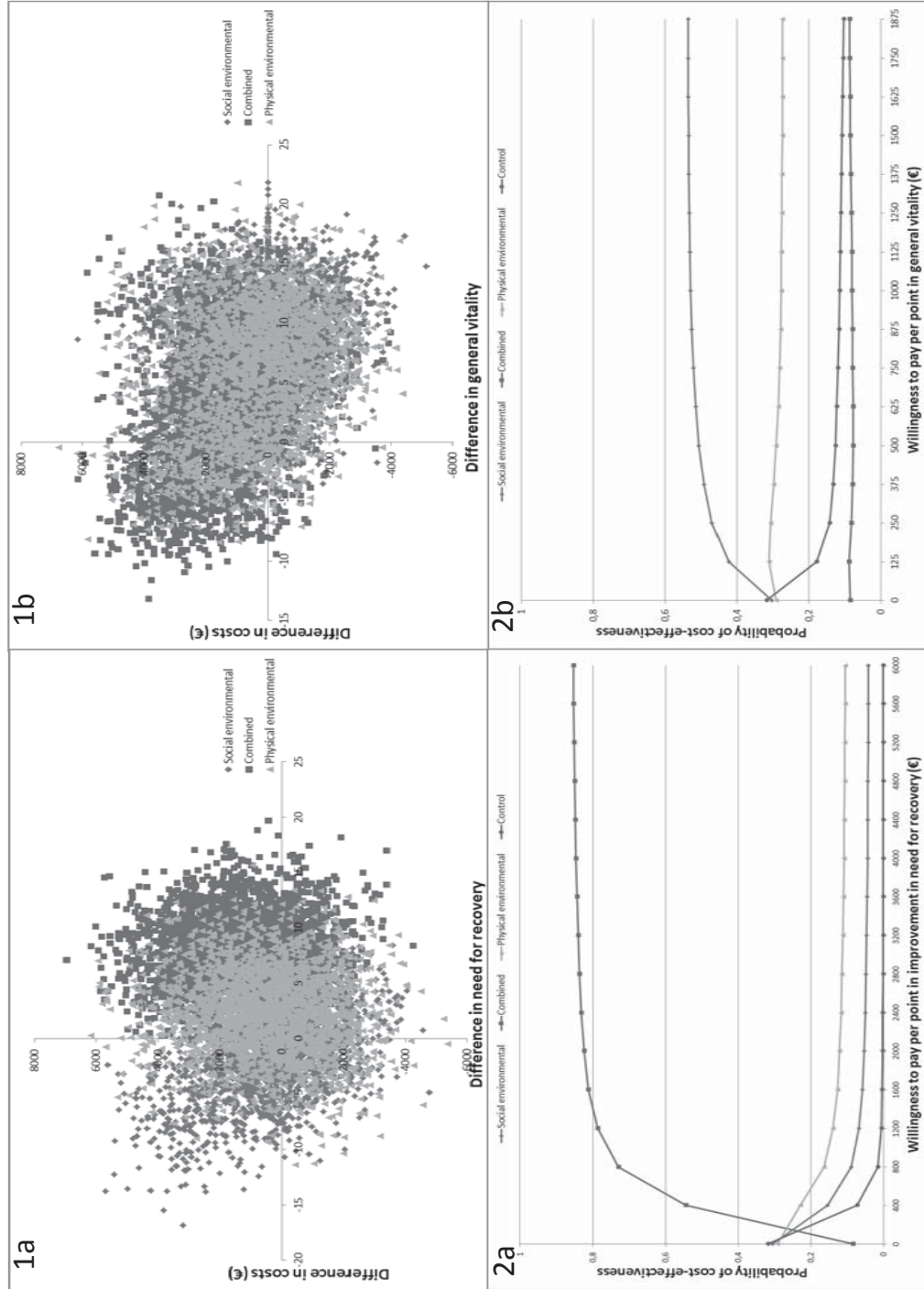


Figure 2: Cost-effectiveness planes indicating the uncertainty around the incremental cost-effectiveness ratios in comparison with usual practice (1) and cost-effectiveness acceptability curves indicating the probability of cost-effectiveness for different values (€) of willingness to pay per unit of effect gained (2) for need for recovery (a) and general vitality (b) (societal perspective, based on the imputed dataset)

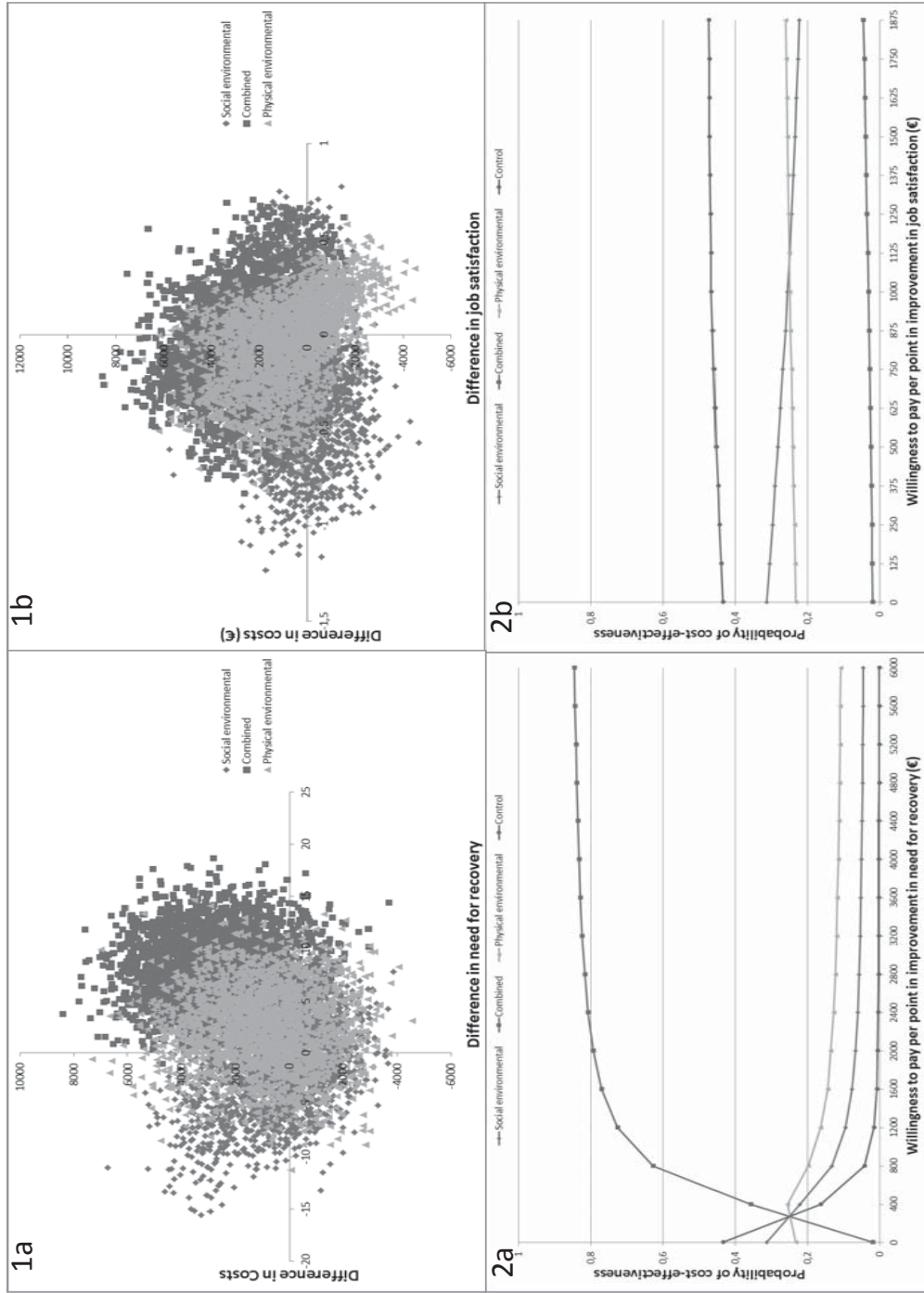
**Employer's perspective: cost-effectiveness**

For NFR, an ICER of -370 was found for the combined intervention group, suggesting that the intervention was associated with an additional cost to the employer of €370 per point improvement in NFR in comparison with usual practice. For the physical environmental intervention group, an ICER in the similar direction was found (ICER: -763). In both cases, the majority of incremental CE-pairs were located in the northeast quadrant of the CE-plane (Table 4, Figure 3-1a). For the social environmental intervention group, on the other hand, an ICER of 4256 was found. This indicates that the intervention costs €4256 to the employer in comparison with usual practice per point decline in NFR. For job satisfaction, ICERs of -49595, -2004, and -17846 were found for the combined, social, and physical environmental intervention group, respectively (Table 4). All of these intervention conditions were more costly and less effective than usual practice (Table 4, Figure 3-1b).

The CEACs presented in Figure 3-2a and Figure 3-2b indicate that the probabilities of cost-effectiveness of all intervention conditions were lower than that of usual practice at employer's willingness-to-pay values of €0/point improvement in NFR and job satisfaction. For NFR, the separate intervention conditions' probabilities of cost-effectiveness as well as that of usual practice decreased with an increasing willingness-to-pay, while that of the combined intervention increased to 0.85 at a ceiling ratio of €6000. For job satisfaction, on the other hand, the probability of cost-effectiveness of all intervention conditions remained lower than that of usual practice, irrespective of the employer's willingness-to-pay (Figure 3-2b).

**Employer's perspective: financial return**

During follow-up, total employer's benefits, NBs, BCRs, and ROIs were negative for all intervention conditions, indicating that the investments were larger than the benefits (Table 5). Moreover, the probabilities of financial return of all intervention conditions were low (combined: 0.05, social: 0.41, environmental: 0.30).



**Figure 3: Cost-effectiveness planes indicating the uncertainty around the incremental cost-effectiveness ratios in comparison with usual practice (1) and cost-effectiveness acceptability curves indicating the probability of cost-effectiveness for different values (€) of willingness to pay per unit of effect gained (2) for need for recovery (a) and job satisfaction (b) (employer's perspective, based on the imputed dataset)**

**Table 5: Intervention costs, benefits, Net Benefits (NB), Benefit Cost Ratio (BCR), and Return-On-Investment (ROI) per participant for the main analyses**

Intervention group	Sample size		Costs (€) Total (95% CI)	Benefits Total (95% CI)	NB <sup>1</sup> (95% CI)	Financial return		Probability
	Intervention	Control				BCR <sup>2</sup> (95% CI)	ROI (%) <sup>3</sup> (95% CI)	
Social and physical environmental intervention	92	106	466 (NA)	-2636 (-5724 to 90)	-3102 (-5897 to -93)	-5.7 (-11.7 to 0.8)	-666 (-1266 to -20)	0.05
Social environmental intervention	118	106	430 (NA)	-16 (-2335 to 2198)	-447 (-2715 to 1809)	-0.0 (-5.3 to 5.2)	-104 (-631 to 421)	0.41
Physical environmental intervention	96	106	72 (NA)	-850 (-3113 to 1834)	-922 (-4703 to 2466)	-11.8 (-65 to 35)	-1286 (-6564 to 3442)	0.30

Abbreviations: CI: Confidence Interval, NB: Net Benefit, BCR: Benefit Cost Ratio, ROI: Return-On-Investment, I: Intervention, C: Control; NA: Not Applicable

Note: Costs are expressed in 2011 Euros

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

<sup>1</sup> Indicates the amount of money returned after intervention costs are recovered

<sup>2</sup> Indicates the amount of money returned per Euro invested in the intervention

<sup>3</sup> Indicates the percentage of profit per Euro invested in the intervention



### **Sensitivity analyses**

Results of SA3 were similar to those of the main analysis. The outcomes of SA1 (complete-cases), SA2 (PRODISQ), SA4 (excluding presenteeism), and SA5 (age- and gender-specific price weights) differed in some aspects from the main analysis (Appendix 2, Appendix 3). Four differences stand out. First, in the main analysis, NFR statistically significantly decreased among combined intervention group participants in comparison with the control group, whereas the difference in NFR scores between both groups was not statistically significant among the complete-cases (SA1). Second, in the main analysis, total societal and employer's costs were higher among participants to all intervention groups in comparison with the control group, whereas they were lower when using a slightly modified version of the PRODISQ (SA2). Third, the probability of financial return was low for all intervention conditions in the main analysis, whereas that of the combined intervention condition (0.90) and that of the physical environmental intervention condition (0.93) were relatively high when using the PRODISQ (SA2). Fourth, in the main analysis, total employer's costs were statistically significantly higher among participants to the combined intervention in comparison with the control group, whereas this difference was not statistically significant when presenteeism costs were excluded (SA4).

## **DISCUSSION**

This study aimed to evaluate the cost-effectiveness and financial return of a combined social and physical environmental intervention in office employees in comparison with usual practice, and of both intervention conditions separately. Additionally, the probabilities of the interventions being cost-effective in comparison with each other were explored. The combined intervention statistically significantly improved NFR in comparison with usual practice, whereas both separate intervention conditions did not. No statistically significant between-group differences were found for general vitality and job satisfaction. Employer's costs were statistically significantly higher in the combined intervention group compared with the control group, whereas all other societal and employer's cost differences were not statistically significant. Whether the combined intervention can be regarded as cost-effective in improving

NFR from both the societal and employer's perspective depends on the respective decision-makers' willingness-to-pay per point improvement as well as the probability of cost-effectiveness that they consider acceptable. However, as both are currently unknown, strong conclusions cannot be made. Nonetheless, societal and company decision-makers 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. Both separate intervention conditions, on the other hand, cannot be regarded as cost-effective in improving NFR, because their probabilities of cost-effectiveness in comparison with the other study groups were low, regardless of the maximum willingness-to-pay. None of the intervention conditions seemed to be cost-effective in improving general vitality from the societal perspective, nor in improving job satisfaction from that of the employer. Moreover, the probability of financial return was low for all intervention conditions, indicating that none of them generated cost savings to the employer.

#### *Comparison with existing literature*

Until now, few studies evaluated the effectiveness of comparable interventions in improving NFR, general vitality, and/or job satisfaction. Meijer et al. (2009), evaluated the effect of a so-called innovative office concept (e.g. open-office plan, flexible workplaces) on NFR among Dutch office employees. No significant improvements were found at 15 months follow-up (43). Their study, however, did not include a comparison group and the content of their intervention differed from the intervention conditions evaluated here. Using an RCT, Strijk et al. (2012) evaluated the effectiveness of a worksite vitality intervention aimed at improving physical activity, nutrition, and relaxation among older Dutch hospital employees versus usual practice. Even though the intervention statistically significantly improved NFR at 6-month follow-up, this effect was not sustained at the long-term (44;45). Moreover, the intervention did not improve general vitality at 6- and 12-month follow-up (46). Again, however, the content of the worksite vitality intervention (i.e. yoga and aerobic exercising, fruit, and individual counselling) differed from that of the present intervention conditions and the intervention was not specifically targeted at office employees. This study also evaluated the societal cost-effectiveness of the worksite vitality intervention

in improving NFR and general vitality. The intervention was not considered cost-effective in improving both outcomes, because a substantial amount of money had to be paid by society to reach a reasonable probability of cost-effectiveness (45).

To our knowledge, studies evaluating the employer's cost-effectiveness of comparable interventions in improving NFR are lacking. One study, however, evaluated the employer's cost-effectiveness in improving job satisfaction of a mindfulness-based worksite health promotion program in comparison with usual practice (41). Irrespective of the maximum willingness-to-pay, the intervention had a low probability of cost-effectiveness (i.e.  $\leq 0.25$ ) and was therefore not considered to be cost-effective either.

A systematic review of the financial return of worksite physical activity and/or nutrition programs indicated that such programs may generate positive financial returns through reduced absenteeism costs according to non-randomized studies (BCR: 4.25), whereas they do not according to RCTs (BCR: 0.51) (47). When we solely included absenteeism costs in SA4, our results were in line with those of the review (BCR-combined: -2.2, BCR-social: 0.0, BCR-physical: 0.5). Moreover, a recent review of U.S. worksite health promotion studies published after 2000 found that only one of the seven studies showing cost savings utilized a randomized design. Based on these findings, the authors concluded that strong evidence of cost savings of worksite health promotion programs is currently lacking (48).

#### *Explanation of findings*

The finding that the combined intervention statistically significantly improved NFR in comparison with usual practice, whereas both separate intervention conditions did not, is in line with our hypothesis that the combined intervention would be most effective. Moreover, it is noteworthy that even though the combined intervention had a statistically significant positive effect on NFR, total employer's costs were statistically significantly higher among combined intervention group participants compared to their control group counterparts. This is striking, as absenteeism costs accounted for more than half of the difference in total employer's costs, while improvements in NFR were previously found to be related to lower absenteeism costs (49). Our finding might have resulted from the fact that worksite health promotion

programs, such as ours, may positively affect NFR at the short-term, while the related improvements in productivity occur at the long-term. However, further research is needed to confirm this. Furthermore, even though the intervention (conditions) were aimed at improving physical activity and active commuting, sports costs and active commuting equipment costs were lower in all intervention groups as compared with the control group. A possible explanation for this finding may be that control group participants were aware of the content and/or aims of the intervention conditions, 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 those of the main analysis. Most notably, the combined intervention's effect on NFR was statistically significant in the main analysis (for which data were imputed), whereas this was not the case when participants with missing data were eliminated from the analyses. This probably resulted from the large difference in baseline NFR scores between combined intervention group participants with complete (mean: 33.3) and incomplete data (mean: 21.4). This indicates that the complete-case analysis is likely to be biased by self-selection of participants. Moreover, when presenteeism costs were estimated using a slightly modified version of the PRODISQ, the results were much more favourable than those of the main analysis (for which the WHO-HPQ was used). Both instruments likely produced different results, because they conceptualize presenteeism in a slightly different way (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 indirectly affect presenteeism through individual health improvements, but also directly from program impact (50).

#### *Strengths and limitations*

This study has several strengths. First, this study was the first to evaluate the cost-effectiveness and financial return of a combined social and physical environmental intervention, as well as that of both intervention conditions separately. Second,

the use of randomization for allocating departments to the “social environmental intervention” and “no social environmental intervention” group reduced the possible influence of selection bias, while the study’s external validity was improved by its pragmatic design. Third, to minimize contamination between study groups, group allocation was performed at the department-level. Moreover, to account for the possible clustering of data resulting from this design, this study was one of the first to use linear multilevel analyses for assessing the intervention conditions’ cost-effectiveness and financial return. The latter is of great importance, as most economic evaluations alongside clustered studies ignore the possible clustering of data, whereas those that do seem to underestimate the statistical uncertainty and are likely to have inaccurate point estimates (51;52).

The study also had some limitations. First of all, the generalizability of the present findings to other companies, work settings, and/or the general working population may be hampered by the fact that the study was performed among office workers within a single company. Another limitation concerns the relatively large amount of missing data: i.e. 41% of participants had some missing effect data and 62% had some missing cost data. Even though missing data are generally inevitable in trial-based economic evaluations and multiple imputation techniques were used for filling in missing values, a 100% complete dataset would have produced more valid and reliable results. Therefore, the present results should be treated with caution and extensive efforts ought to be made in future studies to reduce the amount of missing data. Moreover, all effect measures and some resource use categories were assessed using retrospective questionnaires. This may have induced “recall bias”. Nonetheless, as it seems highly unlikely that the extent of impairment in recall systematically differed between study groups, we do not expect that our use of such questionnaires severely biased our results (53).

### **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 considered cost-effective in improving NFR. Both separate interventions were not cost-effective in improving this outcome. Moreover, all interventions were neither

cost-effective in improving general vitality (societal perspective) and job satisfaction (employer's perspective), nor cost saving to the employer.

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## Appendix 1: Cost of the Be Active &amp; Relax VIP interventions (societal perspective)

Cost categories	Description	Units	Unit Prices	Total Costs (Euros 2011)	Mean costs per employee (Euros 2011)
<b>Development costs<sup>a</sup></b>					
<b>Intervention development</b>					
				€ 108,793.35	€ 3.31
				<b>Subtotal:</b>	<b>€ 3.31</b>
<b>Intervention kick-off</b>					
<b>Management / teamleader kick-off meetings</b>	Labor costs	Intervention staff	16.5 hours	€ 31.43 / hour	€ 1.26
		Intervention staff	3 hours	€ 117.74 / hour	€ 0.86
		Intervention staff	2 hours	€ 64.03 / hour	€ 0.31
		Managers	54.5 hours	€ 78.44 / hour	€ 10.38
		Teamleaders	69 hours	€ 62.58 / hour	€ 10.48
	Capital costs		16.5 hours	variable	€ 0.84
	Material costs	Recruitment materials		variable	€ 8.54
				<b>Subtotal:</b>	<b>€ 32.67</b>
<b>Social environmental</b>					
<b>Group motivational interviewing (GMI)</b>					
<b>GMI-training</b>	Labor costs	GMI-professional	36 hours	€ 49.12 / hour	€ 8.42
		Intervention staff	36 hours	€ 31.43 / hour	€ 5.39
	Capital costs	Teamleaders	318.5 hours	€ 62.58 / hour	€ 94.91
	Material costs	GMI-workbooks (teamleaders)	28 hours	€ 8.55 / hour	€ 1.14
		Lunch	25 workbooks	€ 13.49 / workbook	€ 1.61
			50 lunches	€ 9.60 / lunch	€ 2.29
<b>GMI-coaching</b>	Labor costs	GMI-professional	4 hours	€ 49.12 / hour	€ 0.94
		Teamleaders	21 hours	€ 62.58 / hour	€ 6.26
	Capital costs		4 hours	€ 8.55 / hour	€ 0.16
<b>GMI-sessions</b>	Labor costs	Teamleaders	108 hours	€ 62.58 / hour	€ 32.18
		Employees	746.8 hours	€ 48.22 / hour	€ 36,015.93
	Capital costs		108 hours	€ 8.55 / hour	€ 4.40
	Material costs	GMI-workbooks (employees)	185 workbooks	€ 5.95 / workbook	€ 5.24
		Other materials		variable	€ 18.67
				<b>Subtotal:</b>	<b>€ 353.10</b>
<b>Social media platform</b>					
<b>Website hosting</b>				€ 672.92	€ 3.20
				<b>Subtotal:</b>	<b>€ 3.20</b>

Cost categories	Description	Total purchase costs (Euros 2011)	Total annual depreciation Costs (Euros 2011)	Mean costs per employee (Euros 2011)
<b>Physical environmental</b>				
<b>VIP zones</b>				
Material costs	Giant wall poster	€ 847.12	€ 169.42	€ 0.90
	Bar / standing tables	€ 2,632.00	€ 526.40	€ 2.80
	Bar chairs	€ 2877.00	€ 575.40	€ 3.06
	Plants	€ 2137.32	€ 427.46	€ 2.27
	Exercise balls	€ 1844.77	€ 368.95	€ 1.96
	Curtains	€ 659.73	€ 131.95	€ 0.70
	Table tennis	€ 607.50	€ 120.50	€ 0.65
	Lounge chairs	€ 2000.00	€ 400.00	€ 2.13
	Footsteps	€ 880.60	€ 176.12	€ 0.94
	VIP banners	€ 1071.00	€ 214.20	€ 1.14
	Other / office rebuilding	€ 17,977.55	€ 3,595.51	€ 19.13
	<b>Subtotal:</b>		<b>€ 35.86</b>	
<b>TOTAL COST OF THE SOCIAL ENVIRONMENTAL INTERVENTION</b>			<b>€ 392.28</b>	
<b>TOTAL COST OF THE PHYSICAL ENVIRONMENTAL INTERVENTION</b>			<b>€ 71.65</b>	
<b>TOTAL COST OF THE SOCIAL AND PHYSICAL ENVIRONMENTAL INTERVENTION</b>			<b>€ 427.96</b>	

<sup>a</sup> € 108,793.35 was paid for the development of the Be Active & Relax 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 (17,557). Workers in the business and financial service sector make up 19.5% (1461000 workers) of the total Dutch workforce (<http://www.cbs.nl>). During the five year period, it was hypothesized that the intervention will be offered to 5% of these workers and that 45% of them will participate to the intervention (35% during the first year after implementation and 2.5% during each consecutive year).

**Appendix 2: 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 for the sensitivity analyses**

Sensitivity analysis	Perspective	Sample size		Outcome	ΔC (95% CI)	ΔE (95% CI)	ICER	Distribution CE-plane (%)			
		Intervention	Control					€/point	NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>
<b>Social and physical environmental intervention</b>											
SA1 – complete cases	Societal perspective	23	52	Need for recovery	2801 (862 to 6119)	-0.5 (-6.5 to 5.6)	-5921	53.0	5.3	7.2	41.0
	Employer's perspective	23	52	General Vitality	2801 (862 to 6119)	1.4 (-3.0 to 5.8)	2008	71.3	22.7	7.2	5.3
SA1 – complete cases	Employer's perspective	23	52	Need for recovery	3120 (-36 to 5129)	-0.5 (-6.5 to 5.6)	-6606	56.0	2.3	0.3	41.4
	Societal perspective	23	52	Job satisfaction	3120 (-36 to 5129)	0.0 (-0.2 to 0.2)	635626	72.5	2.0	0.6	24.9
SA2 - PRODISQ	Societal perspective	92	106	Need for recovery	-4168 (-7319 to 989)	-8.4 (-14.6 to -2.2)	498	1.4	98.1	0.4	0.0
	Employer's perspective	92	106	General Vitality	-4168 (-7319 to 989)	3.4 (-9.3 to 16.2)	-1211	0.6	71.6	26.9	0.8
SA2 - PRODISQ	Employer's perspective	92	106	Need for recovery	-2750 (-6148 to 652)	-8.4 (-14.6 to -2.2)	328	9.3	90.3	0.4	0.0
	Societal perspective	92	106	Job satisfaction	-2750 (-6148 to 652)	-0.1 (-0.6 to 0.5)	43961	2.9	37.0	53.7	6.5
SA3 – HCA	Societal perspective	92	106	Need for recovery	1867 (-596 to 4754)	-8.4 (-14.6 to -2.2)	-223	82.4	17.2	0.0	0.4
	Employer's perspective	92	106	General Vitality	1867 (-596 to 4754)	3.4 (-9.3 to 16.2)	542	57.0	15.2	2.0	25.8
SA3 - FCA	Employer's perspective	92	106	Need for recovery	2888 (550 to 5503)	-8.4 (-14.6 to -2.2)	-345	94.9	4.7	0.0	0.4
	Societal perspective	92	106	Job satisfaction	2888 (550 to 5503)	-0.1 (-0.6 to 0.5)	-46180	36.3	3.5	1.1	59.0
SA4 – excluding presenteeism	Societal perspective	92	106	Need for recovery	86 (-1907 to 2325)	-8.4 (-14.6 to -2.2)	-10	95.0	4.5	0.0	0.4
	Employer's perspective	92	106	General Vitality	86 (-1907 to 2325)	3.4 (-9.3 to 16.2)	25	33.4	38.9	13.8	14.0
SA4 – excluding presenteeism	Employer's perspective	92	106	Need for recovery	1483 (-872 to 4103)	-8.4 (-14.6 to -2.2)	-177	83.3	16.3	0.0	0.4
	Societal perspective	92	106	Job satisfaction	1483 (-872 to 4103)	-0.1 (-0.6 to 0.5)	-23714	33.3	6.5	9.8	50.4
SA5 – age- and gender-specific price weights	Societal perspective	92	106	Need for recovery	-14 (-1274 to 1557)	-8.4 (-14.6 to -2.2)	2	40.2	59.4	0.1	0.2
	Employer's perspective	92	106	General Vitality	-14 (-1274 to 1557)	3.4 (-9.3 to 16.2)	-4	22.7	49.6	10.0	17.8
SA5 – age- and gender-specific price weights	Employer's perspective	92	106	Need for recovery	1436 (130 to 3180)	-8.4 (-14.6 to -2.2)	-171	87.3	12.3	0.0	0.3
	Societal perspective	92	106	Job satisfaction	1436 (130 to 3180)	-0.1 (-0.6 to 0.5)	-22959	31.3	8.5	3.8	56.3
<b>Social environmental intervention</b>											
<b>Intervention Control</b>											
SA1 – complete cases	Societal perspective	41	52	Need for recovery	105 (-2148 to 2404)	-3.3 (-10.9 to 4.3)	-32	47.1	43.4	3.9	5.6
	Employer's perspective	41	52	General Vitality	105 (-2148 to 2404)	3.5 (-0.6 to 7.5)	30	46.3	4.4	1.9	43.6
SA1 – complete cases	Employer's perspective	41	52	Need for recovery	359 (-1880 to 2901)	-3.3 (-10.9 to 4.3)	-110	51.0	39.5	3.6	5.9
	Societal perspective	41	52	Job satisfaction	359 (-1880 to 2901)	0.0 (-0.2 to 0.2)	-281037	23.7	17.0	26.1	33.2

SA2 - PRODISQ	Societal perspective	118	106	Need for recovery	-1812 (-5602 to 681)	0.1 (-8.8 to 9.0)	-17268	17.2	32.1	25.4	15.3
	Employer's perspective	118	106	General Vitality	-1812 (-5602 to 681)	7.3 (-3.8 to 18.4)	-248	26.7	61.3	6.2	5.5
SA2 - PRODISQ	Employer's perspective	118	106	Need for recovery	-1538 (-4974 to 1110)	0.1 (-8.8 to 9.0)	-14652	18.1	31.2	34.4	16.4
	Societal perspective	118	106	Job satisfaction	-1538 (-4974 to 1110)	-0.2 (-0.9 to 0.5)	6898	7.7	13.1	52.4	26.8
SA3 – HCA	Societal perspective	118	106	Need for recovery	77 (-2114 to 2178)	0.1 (-8.8 to 9.0)	729	9.3	90.3	0.4	0.0
	Employer's perspective	118	106	General Vitality	77 (-2114 to 2178)	7.3 (-3.8 to 18.4)	10.5	42.4	45.9	2.6	9.1
SA3 - FCA	Employer's perspective	118	106	Need for recovery	558 (-1381 to 2559)	0.1 (-8.8 to 9.0)	5321	27.3	22.0	15.3	35.4
	Societal perspective	118	106	Job satisfaction	558 (-1381 to 2559)	-0.2 (-0.9 to 0.5)	-2505	15.5	5.3	32.0	47.2
SA4 – excluding presenteeism	Societal perspective	118	106	Need for recovery	121 (-1565 to 1704)	0.1 (-8.8 to 9.0)	-1150	27.7	21.6	20.4	30.3
	Employer's perspective	118	106	General Vitality	121 (-1565 to 1704)	7.3 (-3.8 to 18.4)	17	49.0	39.3	3.4	8.3
SA4 – excluding presenteeism	Employer's perspective	118	106	Need for recovery	414 (-1241 to 1934)	0.1 (-8.8 to 9.0)	3941	32.7	16.6	15.3	35.4
	Societal perspective	118	106	Job satisfaction	414 (-1241 to 1934)	-0.2 (-0.9 to 0.5)	-1855	14.3	6.5	25.3	53.8
SA5 – age- and gender-specific price weights	Societal perspective	118	106	Need for recovery	67 (-1226 to 1475)	0.1 (-8.8 to 9.0)	639	19.6	29.7	21.5	29.2
	Employer's perspective	118	106	General Vitality	67 (-1226 to 1475)	7.3 (-3.8 to 18.4)	9	38.3	50.0	2.6	9.1
SA5 – age- and gender-specific price weights	Employer's perspective	118	106	Need for recovery	416 (-751 to 1789)	0.1 (-8.8 to 9.0)	3968	25.7	23.5	16.2	34.5
	Societal perspective	118	106	Job satisfaction	416 (-751 to 1789)	-0.2 (-0.9 to 0.5)	-1868	15.1	5.7	34.0	45.2
<b>Physical environmental intervention</b>											
		<b>Intervention</b>	<b>Control</b>		<b>€</b>	<b>Points</b>	<b>€/point</b>	<b>NE<sup>1</sup></b>	<b>SE<sup>2</sup></b>	<b>SW<sup>3</sup></b>	<b>NW<sup>4</sup></b>
SA1 – complete cases	Societal perspective	34	52	Need for recovery	1338 (-2247 to 4942)	-1.6 (-9.0 to 5.7)	-824	61.1	18.9	5.3	14.7
	Employer's perspective	34	52	General Vitality	1338 (-2247 to 4942)	3.8 (-0.1 to 7.7)	351	74.5	1.3	3.2	43.6
SA1 – complete cases	Employer's perspective	34	52	Need for recovery	1250 (-2162 to 4648)	-1.6 (-9.0 to 5.7)	-770	61.0	18.9	5.6	14.4
	Societal perspective	34	52	Job satisfaction	1250 (-2162 to 4648)	0.0 (-0.3 to 0.2)	-60588	32.7	15.0	9.6	42.7
SA2 - PRODISQ	Societal perspective	96	106	Need for recovery	-3917 (-6916 to -913)	-1.2 (-9.1 to 6.6)	3241	3.3	70.1	24.8	1.8
	Employer's perspective	96	106	General Vitality	-3917 (-6916 to -913)	5.7 (-5.6 to 17.1)	-692	1.8	80.0	14.9	3.3
SA2 - PRODISQ	Employer's perspective	96	106	Need for recovery	-3506 (-6528 to -543)	-1.2 (-9.1 to 6.6)	2901	3.9	69.4	24.2	2.5
	Societal perspective	96	106	Job satisfaction	-3506 (-6528 to -543)	-0.1 (-0.5 to 0.4)	67903	1.4	46.4	47.3	5.0
SA3 – HCA	Societal perspective	96	106	Need for recovery	436 (-1899 to 2790)	-1.2 (-9.1 to 6.6)	-361	43.8	29.5	12.9	13.8
	Employer's perspective	96	106	General Vitality	436 (-1899 to 2790)	5.7 (-5.6 to 17.1)	77	42.3	39.4	3.0	15.3
SA3 - FCA	Employer's perspective	96	106	Need for recovery	1092 (-1091 to 3300)	-1.2 (-9.1 to 6.6)	903	54.6	18.7	8.8	17.8
	Societal perspective	96	106	Job satisfaction	1092 (-1091 to 3300)	-0.1 (-0.5 to 0.4)	-21145	26.5	21.3	6.2	46.0
SA4 – excluding presenteeism	Societal perspective	96	106	Need for recovery	-317 (-1985 to 1359)	-1.2 (-9.1 to 6.6)	263	25.0	48.3	16.9	9.8
	Employer's perspective	96	106	General Vitality	-317 (-1985 to 1359)	5.7 (-5.6 to 17.1)	-56	26.5	55.2	10.0	8.3

Physical environmental intervention										
	Intervention	Control	€	Points	€/point	NE <sup>1</sup>	SE <sup>2</sup>	SW <sup>3</sup>	NW <sup>4</sup>	
SA4 – excluding presenteeism	Employer's perspective	106	Need for recovery	36 (-1739 to 1691)	-1.2 (-9.1 to 6.6)	-30	35.5	37.8	11.9	14.8
		96	Job satisfaction	36 (-1739 to 1691)	-0.1 (-0.5 to 0.4)	-696	23.6	24.2	25.5	26.8
SA5 – age- and gender-specific price weights	Societal perspective	106	Need for recovery	181 (-1184 to 1835)	-1.2 (-9.1 to 6.6)	-150	38.7	34.6	14.7	12.0
		96	General Vitality	181 (-1184 to 1835)	5.7 (-5.6 to 17.1)	32	36.8	45.0	4.3	13.9
SA5 – age- and gender-specific price weights	Employer's perspective	106	Need for recovery	546 (-766 to 2058)	-1.2 (-9.1 to 6.6)	-452	49.5	23.9	10.3	16.4
		96	Job satisfaction	546 (-766 to 2058)	-0.1 (-0.5 to 0.4)	-10570	24.6	23.1	11.0	41.3

Abbreviations: CI: Confidence Interval, C: Costs, E: Effects, ICER: Incremental Cost-Effectiveness Ratio, CE-plane: Cost-Effectiveness plane, SA: Sensitivity Analysis, PRODISQ: "PROductivity and DISease Questionnaire", FCA: Friction Cost Approach, HCA: Human Capital Approach

Note: Costs are expressed in 2011 Euros

<sup>1</sup> Refers to the northeast quadrant of the CE-plane, suggesting that the intervention is more effective and more costly compared to usual practice

<sup>2</sup> Refers to the southeast quadrant of the CE-plane, suggesting that the intervention is more effective and less costly compared to usual practice

<sup>3</sup> Refers to the northwest quadrant of the CE-plane, suggesting that the intervention is less effective and more costly compared to usual practice

<sup>4</sup> Refers to the southwest quadrant of the CE-plane, suggesting that the intervention is less effective and less costly compared to usual practice

### Appendix 3: Intervention costs, benefits, Net Benefits (NB), Benefit Cost Ratio (BCR), and Return-On-Investment (ROI) per participant for the sensitivity analyses

Sensitivity analysis	Sample size		Costs (€) Total (95% CI)	Benefits		Financial return			Probability
	Intervention	Control		Total (95% CI)	NB <sup>1</sup> (95% CI)	BCR <sup>2</sup> (95% CI)	ROI (%) <sup>3</sup> (95% CI)		
<b>Social and physical environmental intervention</b>									
SA1 – complete cases	23	52	466 (NA)	-2654 (-6958 to 758)	-3120 (-6947 to 662)	-5.7 (-13.7 to 2.4)	-670 (-1491 to 142)	0.06	
SA2 – PRODISQ	92	106	466 (NA)	3216 (-486 to 6787)	2750 (-731 to 6559)	6.9 (-0.6 to 15.1)	590 (-157 to 1407)	0.90	
SA3 – FCA	92	106	466 (NA)	-2377 (-5155 to -2377)	-2843 (-5408 to -69)	-5.1 (-10.6 to 0.9)	-610 (-1161 to -15)	0.05	
SA4 – Excluding presenteeism	92	106	466 (NA)	-1017 (-3844 to 1502)	-1483 (-4178 to 1156)	-2.2 (-8.0 to 3.5)	-318 (-897 to 248)	0.16	
SA5 – age- and gender-specific price weights	92	106	466 (NA)	-970 (-2820 to 466)	-1436 (-2832 to 470)	-2.1 (-5.1 to 2.0)	-308 (-608 to 101)	0.13	
<b>Social environmental intervention</b>									
SA1 – complete cases	41	52	430 (NA)	71 (-3415 to 3457)	-359 (-3584 to 3272)	0.2 (-7.3 to 8.6)	-84 (-833 to 761)	0.44	
SA2 – PRODISQ	118	106	430 (NA)	1968 (-978 to 5672)	1538 (-2167 to 4485)	4.6 (-4.0 to 11.4)	357 (-504 to 1042)	0.66	
SA3 – FCA	118	106	430 (NA)	128 (-2410 to 1970)	-558 (-2727 to 1662)	-0.3 (-5.3 to 4.8)	-130 (-634 to 386)	0.39	
SA4 – Excluding presenteeism	118	106	430 (NA)	17 (-1652 to 1738)	-414 (-2102 to 1293)	0.0 (-3.9 to 4.0)	-96 (-488 to 300)	0.33	
SA5 – age- and gender-specific price weights	118	106	430 (NA)	14 (-1543 to 1297)	-416 (-1696 to 1140)	0.0 (-2.9 to 3.6)	-97 (-394 to 265)	0.40	
<b>Physical environmental intervention</b>									
SA1 – complete cases	34	52	72 (NA)	-1250 (-5232 to 2740)	-1321 (-5536 to 2415)	-17.5 (-76.5 to 34.8)	-1849 (-7747 to 3381)	0.23	
SA2 – PRODISQ	96	106	72 (NA)	3578 (576 to 6976)	3506 (433 to 6820)	50.1 (7.0 to 94.4)	4907 (605 to 9543)	0.93	
SA3 – FCA	96	106	72 (NA)	-1007 (-3228 to -1007)	-1078 (-3480 to 1280)	-14.1 (-47.7 to 18.9)	-1509 (-4870 to 1791)	0.27	
SA4 – Excluding presenteeism	96	106	72 (NA)	36 (-1661 to 2049)	-36 (-1933 to 1768)	0.5 (-23.7 to 28.1)	-50 (-2705 to 2474)	0.49	
SA5 – age- and gender-specific price weights	96	106	72 (NA)	-474 (-2008 to 1072)	-546 (-2007 to 1076)	-6.6 (-27.1 to 16.1)	-764 (-2809 to 1505)	0.33	

Abbreviations: CI: Confidence Interval, NB: Net Benefit, BCR: Benefit Cost Ratio, ROI: Return-On-Investment, I: Intervention, C: Control, NA: Not Applicable, SA: Sensitivity Analysis, PRODISQ: “Productivity and Disease Questionnaire”, FCA: Friction Cost Approach

Note: Costs are expressed in 2011 Euros

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

<sup>1</sup> Indicates the amount of money returned after intervention costs are recovered

<sup>2</sup> Indicates the amount of money returned per Euro invested in the intervention

<sup>3</sup> Indicates the percentage of profit per Euro invested in the intervention



