Economic evaluations of worksite health promotion programs

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A cost-effectiveness and return-on-investment analysis of a worksite vitality intervention among older hospital workers: results of a randomized controlled trial

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ABSTRACT

Objective: To conduct a cost-effectiveness and return-on-investment analysis comparing a worksite vitality intervention with usual care.

Methods: A total of 730 older hospital workers were randomized to the intervention or control group. The 6-month intervention consisted of yoga and aerobic exercising, coaching, and fruit. At baseline, and 6 and 12 months, general vitality, work-related vitality, and need for recovery were determined. Cost data were collected on a 3-monthly basis. The cost-effectiveness analysis was performed from the societal perspective and the return-on-investment analysis from the employer's perspective using bootstrapping techniques.

Results: No significant differences in costs and effects were observed. Incremental cost-effectiveness ratios in terms of general vitality (range, 0 to 100), work-related vitality (range, 0 to 6), and need for recovery (range, 0 to 100) were, respectively, €280, €7506, and €258 per point improvement. Per euro invested, €2.21 was lost.

Conclusions: The intervention was neither cost-effective nor cost-saving.

INTRODUCTION

In various European countries, people aged 60 years and older will comprise up to one third of the population during the next decades. Because a shrinking labor force will have to support a growing number of retired people (1), there is a need for workers who are able to prolong their working life in good health (2). In the Vital@ Work study, a worksite vitality intervention was developed that aimed to improve physical activity, nutrition, and relaxation, as a potentially effective tool to keep older workers vital (ie, at a perceived high energy level, lowlevels of fatigue, and feeling fit) and healthy, thereby contributing to prolonged employability (2).

An evaluation of the Vital@Work intervention's effectiveness has been reported elsewhere (3,4). Nevertheless, budgets for occupational health care are restricted. Therefore, decisions about investments in worksite interventions may be guided not only by the evidence on their effectiveness, but also by considerations of their costs in relation to these effects (5). In occupational health care research, cost-effectiveness analyses (CEAs) are conducted to gain insight into the (additional) costs of an intervention per additional unit of effect gained. These results can be used by decision makers to decide how resources should optimally be allocated to maximize health or welfare (6,7). Within business administration, the primary interest may not be in maximizing health or welfare but in maximizing the financial return of an intervention (8). This is often determined using a return-on-investment (ROI) analysis, in which intervention costs are compared with their resulting financial benefits (ie, program outcomes converted to monetary values) (9–11). As CEAs and ROI analysis are based on the same data, both can be conducted simultaneously and doing so provides information that can be used by business managers and experts in occupational health care research.

The aim of the present study was to conduct a CEA and ROI analysis in which the Vital@Work intervention was compared with usual care. The CEA was performed from the societal perspective, which is generally advocated for when various stakeholders may be affected by an intervention (7,12). This is clearly the case for worksite health promotion interventions, as employers invest in the program and may benefit from it through reduced productivity-related spending, whereas (in the

Dutch situation) the government and health insurance companies may benefit from it through reduced medical costs. Because employers are the ones deciding whether or not to implement such intervention, and in doing so may have an explicit interest in its financial return, the ROI analysis was performed from the employer's perspective.

METHODS

Study population and design

The present study was conducted alongside a randomized controlled trial (RCT) (2). The follow-up was 12 months and data collection took place during 2009 and 2010. Older workers (45 years or older) from two Dutch academic hospitals were invited to participate: VU University Medical Center Amsterdam (VUMC, Amsterdam, the Netherlands) and Leiden University Medical Center (LUMC, Leiden, the Netherlands). The criteria for inclusion were: (1) working at least 16 hours a week, and (2) no risk for developing adverse health effects when becoming physically active. At enrollment, workers provided written informed consent. After baseline measurements, they were individually randomized to the intervention or control group by a research assistant using Random Allocation Software (version 1.0, May 2004, Isfahan University of Medical Sciences, Iran). The research assistant had no information about the workers to ensure concealment of treatment allocation. The study protocol was approved by the medical ethics committee of the VUMC Amsterdam (2). The sample size was based on detecting a 10% difference in work-related vitality, measured by the Utrecht Work Engagement Scale (UWES) (13). Assuming a mean baseline UWES Vitality Score (range, 0 to 6) of 3.99 (standard deviation [SD], 1.11) (14), a power of 0.90, and a confidence interval (CI) of 95% ($\alpha = 0.05$), 189 workers were needed per group at follow-up (2). Taking into account a loss to follow-up of 15%, at least 446 workers (223 per group) needed to be included at baseline.

Control and intervention condition

After randomization, all workers received written information about a healthy lifestyle regarding physical activity, nutrition, and relaxation. Subsequently, workers in the intervention group received the Vital@Work intervention.

A full description of the Vital@Work intervention has been given elsewhere (2). Briefly, the intervention consisted of a Vitality Exercise Program (VEP), three Personal Vitality Coach (PVC) visits, and free fruit (2).

The VEP lasted 24 weeks. Once a week, workers were invited to participate in a guided group yoga session, a guided group workout session, and 45 minutes of unsupervised vigorous physical activity (eg, fitness and spinning). Guided group sessions were provided in small groups (16 participants or fewer) and lasted 45 minutes as well. During working days (Monday to Friday), group sessions were provided in two time blocks: (1) during lunchtime, and (2) directly after working hours (after 4 PM). Yoga sessions were guided by qualified yoga instructors and took place at the worksite. Workout sessions were guided by certified fitness instructors and took place at a fitness center near the worksite (2).

PVC visits took place at the worksite. The first visit was scheduled at the start of the intervention and was followed by two visits at 4 to 6 and 10 to 12 weeks. Before the start of the intervention, the PVC protocol and accompanying materials (eg, coaching registration forms) were explained to the coaches during 4-hour training sessions (2). Free fruit was provided during the guided group sessions of the VEP (2).

Effect measures

Vitality and need for recovery (NFR) from work-induced efforts, which is thought to increase with age (15), were assessed at baseline and 6 and 12 months.

Vitality was measured using two questionnaires. The RAND-36 Vitality Scale was used to measure general vitality and included four items assessing a worker's general 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) (16). The RAND-36 Vitality Score ranged from 0 to 100 (higher scores indicate a better general vitality). The RAND-36 Vitality Scale has shown to be sufficiently reliable; internal consistency was 0.82 (Cronbach α), and the 6-month test–retest stability coefficient was 0.63 (16). Work-related vitality was measured using a subscale of the UWES (ie, UWES Vitality Scale). This scale included six items, scored on a 7-point scale ranging from "never" (0) to "always" (6). The UWES Vitality Score ranged from 0 to 6 (higher scores indicate a better work-related vitality) (13). The UWES Vitality Scale has shown sufficient internal consistency (Cronbach α =0.83). Also, two longitudinal studies carried out in Australia and Norway showed 1-year test–retest stability coefficients ranging between 0.64 and 0.71 (13).

The NFR was assessed using a subscale of the “Dutch Questionnaire on the Experience and Evaluation of Work” (ie, NFR scale). The NFR scale contains 11 statements, answered with “Yes” or “No”, and has shown sufficient internal consistency (Cronbach α =0.88) (17). Also, a 2-year test–retest intra class coefficient of 0.80 was found among Dutch hospital nurses (18). The NFR score ranged from 0 to 100 (lower scores indicate a better NFR) (17).

Resource use and valuation

Intervention costs were estimated using a bottom-up microcosting approach (ie, detailed data were collected regarding the quantity and unit prices of resources consumed). During the study period, data on other resource use (ie, health care, absenteeism, presenteeism, and sports activities) were collected on a 3-monthly basis using retrospective questionnaires. All costs were converted to 2010 Euros using consumer price indices (19). As the follow-up of the trial was 1 year, discounting of costs and effects was not necessary (7).

Intervention costs were those related to implementing and operating the Vital@Work intervention (ie, costs for VEP, PVC visits, fruit, and printed materials). The number of guided group sessions was monitored using attendance registration forms. The number of PVC visits per worker and their average duration were recorded by the coaches. Labor costs were valued using the total time investments of the intervention staff and their gross salaries including holiday allowances and premiums. Capital costs were valued using cost data collected from project and finance department staff. Costs of printed materials and the provision of fruit were estimated using invoices.

Health care utilization was assessed using 3-monthly retrospective questionnaires and included cost categories relevant to the study outcomes and intervention; primary health care (ie, general practitioner, allied health professionals, and complementary medicine) and secondary health care (ie, medical specialist and hospitalization). Dutch standard costs were used to value health care utilization (20). If these were unavailable, prices according to professional organizations were used.

Absenteeism was assessed using an item of the "Productivity and Disease Questionnaire" (PRODISQ) asking workers to report their total number of sick leave days during the past 3 months (21). The absenteeism module of the PRODISQ showed satisfactory responsiveness and construct validity (22). In accordance with the Dutch Manual of Costing, costs associated with one sick leave day were calculated per worker by dividing their gross annual salary including holiday allowances and premiums by their total number of workable days per year (20). Gross annual salaries including holiday allowances and premiums were calculated using a worker's self-reported net salary. Therefore, Dutch total tax on income rates (23) and the percentage of holiday allowances and premiums according to the Dutch Manual of Costing were used (20). Using the Friction Cost Approach (FCA), absenteeism costs were estimated by multiplying the total number of sick leave days during follow-up by their associated costs. The FCA assumes that costs are limited to the friction period (ie, period needed to replace a sick worker). A friction period of 23 weeks and an elasticity of 0.8 were used (20,24).

Presenteeism (ie, reduced productivity while at work) (25) was assessed using an item of The World Health Organization Health and Work Performance Questionnaire (WHO-HPQ) (26). Workers were asked to rate their overall work performance during the previous 4 weeks on an 11-point scale, ranging from "worst performance" (0) to "best performance" (10). The WHO-HPQ Work Performance Scale has been validated against objective measures of performance (ie, archival performance data) and good concordance was found between both measures (27). Assuming linearity, their average work performance during follow-up (Wown) was calculated. Because presenteeism is conceptualized in the WHO-HPQ as a measure of actual performance in relation to "best performance" (10) (26,28), a worker's average level of presenteeism during follow-up (presenteeism score) was calculated using the following formula:

presenteeism score = (10 - Wown)/10

Using the Human Capital Approach (HCA), presenteeism costs were calculated by multiplying a worker's presenteeism score by their gross annual salary including holiday allowances and premiums.

Costs related to the sports activities of the workers (eg, membership fees and sports equipment costs) were collected using two items with a 3-month recall period.

Potential confounders and effect modifiers

At baseline, data about potential confounders and effect modifiers were assessed by questionnaire, including age (years), sex (female/male), education level (low = elementary school or less, medium = secondary education, and high = college/university), chronic disease status (yes/no), smoking (yes/no), intervention location (VUMC/LUMC), and marital status (having a partner: yes/no).

Statistical analyses

Analyses were performed according to the intention-to-treat principle. All missing data about general vitality, work-related vitality, NFR, and costs were imputed using Fully Conditional Specification and Predictive Mean Matching (29,30). Forty different data sets were created and pooled estimates were calculated according to Rubin's rules (31). Baseline characteristics were compared between completers and non-completers using descriptive statistics. Missing data were imputed on the cost level and not on the level of resource use. Therefore, a descriptive analysis on resource use was performed based on the complete cases using t tests for normally distributed data and Mann-Whitney U tests for non-normally distributed data. Unless otherwise stated, data were analyzed in PASW (v18.0, SPSS Inc, Chicago, IL). Statistical significance was set at $P < 0.05$.

Societal perspective: CEA

The CEA was conducted from the societal perspective (ie, all costs related to the intervention were taken into account irrespective of who pays for them). The intervention effect on both vitality measures and NFR was analyzed using linear regression. Because the addition of potential confounders did not change the intervention effects by more than 10% and no effect modifiers were found, outcome measures were only adjusted for their baseline values. Mean cost differences between the intervention and control group were calculated for total and disaggregated costs. Using R (Version 2.13.1., Free Software Foundation Inc., Boston, MA), their

95% CIs were estimated by means of approximate bootstrap confidence intervals (32). Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the difference in total costs between both groups by the difference in effects. Bootstrapped incremental cost-effect pairs, using 5000 replications, were plotted on cost-effectiveness planes to graphically illustrate the uncertainty around the ICERs (33). A summary measure of the joint uncertainty of costs and effects was presented using cost-effectiveness acceptability curves. These indicate the probability of cost-effectiveness at different ceiling ratios (ie, the maximum amount of societal costs decision makers are willing to pay per unit of effect) (34).

Employer's perspective: ROI analysis

The ROI analysis was performed from the employer's perspective (ie, only the costs relevant to the employer were considered, including intervention, absenteeism, and presenteeism costs). Three ROI metrics were calculated; (1) net benefits (NBs), (2) benefit:cost ratio (BCR), and (3) ROI (10).

NB = benefits − costs
BCR = benefits/costs
*ROI = (benefits − costs)/costs [*100]*

Costs were defined as intervention costs. Benefits were defined as the difference in monetized outcome measures (ie, absenteeism, and presenteeism costs) between the intervention and control groups during follow-up, with positive benefits indicating reduced spending. To quantify precision, 95% CIs around the benefit estimates and NB were estimated by means of approximate bootstrap confidence intervals (32). Financial returns are positive if the following criteria are met: NB > 0, BCR > 1, and ROI > 0%.

Sensitivity analyses

To test the robustness of the results, four sensitivity analyses (SAs) were conducted. First, analyses were performed using the complete cases only (SA1). Second, analyses were performed in which intervention costs were based on prices paid (ie, intervention costs were solely valued using invoices) (SA2). Third, analyses were performed in which absenteeism costs were estimated using the HCA instead of the FCA (SA3). In the HCA, total sick leave days are neither “truncated” as in the FCA nor is elasticity considered (24). Fourth, because of the lack of overall consensus regarding the inclusion of presenteeism costs in economic evaluations, analyses were performed in which presenteeism costs were excluded (SA4) (10).

RESULTS

Participants

A total of 730 workers were randomized to the intervention (n = 367) or control group (n = 363). At baseline, no meaningful differences were found between both groups (Table 1). Complete follow-up data were obtained from 68.5% of the workers on the effect measures (n = 500; 250 intervention group workers and 250 control group workers) and from 53.4% of the workers on the cost measures (n = 390; 199 intervention group workers and 191 control group workers) (Figure 1). Data about VEP and PVC visits were complete for all intervention group workers. No significant differences in baseline characteristics were found between workers with complete and incomplete follow-up data.

Effectiveness

During follow-up, intervention group workers increased their general vitality by 2.5 points (range, 0 to 100) and their work-related vitality by 0.12 points (range, 0 to 6), whereas both remained about the same in the control group (general vitality, 0.0 points; work-related vitality, 0.03 points). Furthermore, the intervention group decreased their NFR by 1.8 points (range, 0 to 100), whereas that of the control group increased by 0.8 points. None of these between-group differences were statistically significant.

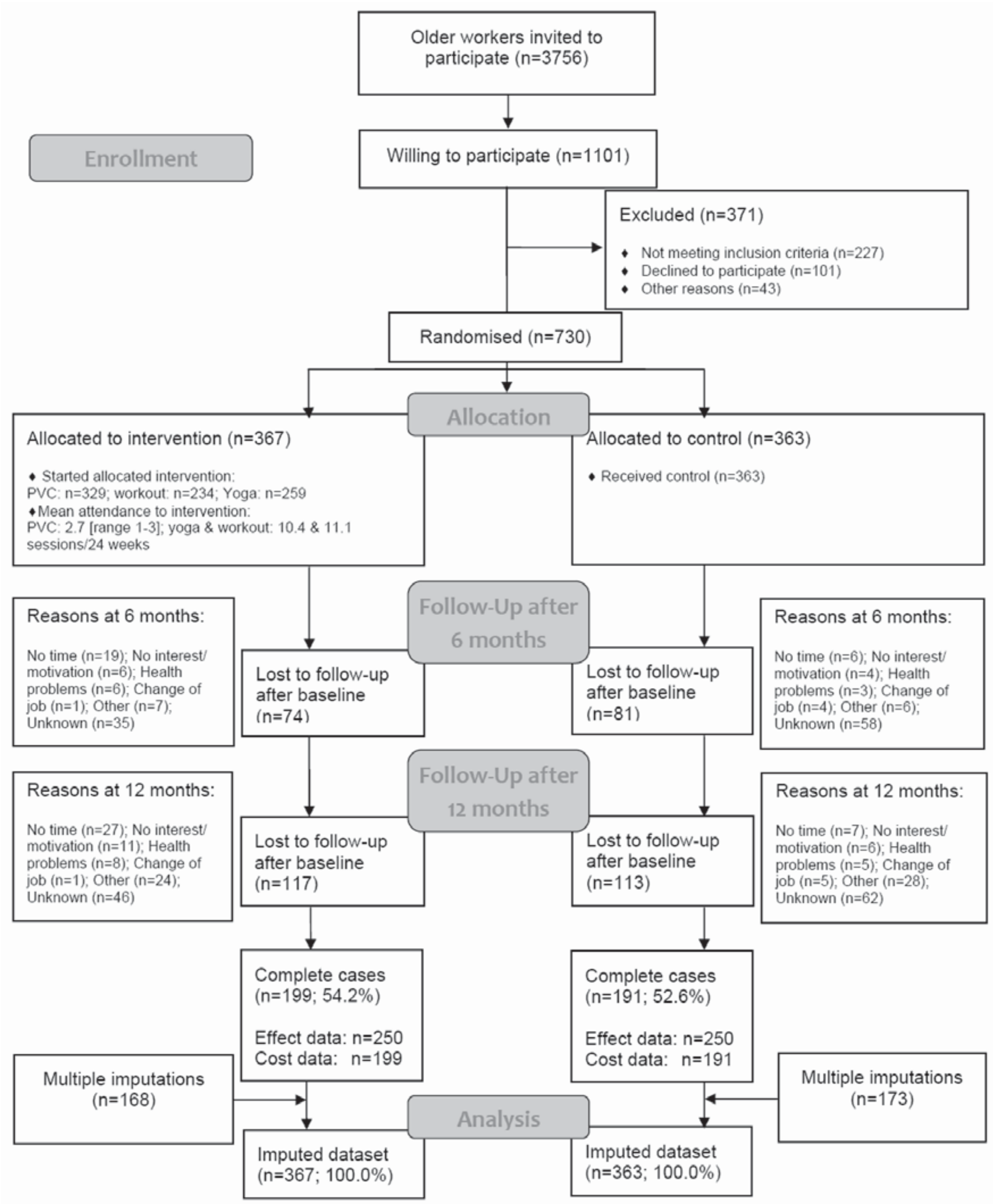

Figure 1: Flow diagram of older workers in the Vital@Work study

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Table 1: Baseline characteristics of the study population

Baseline characteristics	Intervention group All (n=367)	Control group All (n=363)
Female [n. (%)]	274 (74.7)	277 (76.3)
Age (years) [mean (SD)]	52.5 (4.8)	52.3 (4.9)
Education level [n. (%)][1]		
Low	42 (11.4)	32 (8.8)
Intermediate	100 (27.3)	110 (30.3)
High	225 (61.3)	221 (60.9)
Working hours per week [mean (SD)]	30.4 (7.3)	29.8 (7.0)
Irregular working hours [n. (%)]		
Yes	44 (12.0)	52 (14.3)
No	323 (88.0)	311 (85.7)
General vitality (Range 0-100) [mean (SD)]	66.7 (16.9)	68.1 (16.0)
Work-related vitality (Range 0-6) [mean (SD)]	4.9 (0.9)	4.9 (0.9)
Need for recovery (Range 0-100) [mean (SD)]	29.6 (27.7)	27.8 (28.1)

Abbreviations: n: number, SD: standard deviation
[1] Education level was classified according to the definition of Statistics Netherlands (http://www.cbs.nl)

Resource use

During the intervention period, 894 PVC visits, 459 workout sessions, and 392 yoga sessions were provided. On the basis of the complete cases, workers in the intervention and control groups did not differ in terms of their median number of visits to a care provider (2.0 vs 2.0; P = 0.96), median number of days of hospitalization (0.0 vs 0.0; P = 0.74), median number of sick leave days (2.0 vs 1.0; P = 0.127), and average presenteeism scores (0.2 vs 0.2; 95% CI, −0.01 to 0.02) during follow-up.

Costs

On average, intervention costs were €149 per worker (Table 2). Medical, absenteeism, presenteeism, and total costs were higher in the intervention than in the control group during follow-up. Sports costs, however, were lowest in the intervention group. None of these between-group differences were statistically significant (Table 3).

Table 2: Cost of the Vital@Work intervention per worker

Intervention components	Cost categories	Staff	Units	Unit prices	Total costs (Euros 2010) (n=367)	Costs per worker (Euros 2010)
Vitality Exercise Program (VEP)						
Workout sessions	Labor costs	Fitness instructors	459 sessions	€ 24.35/hour	€ 10,244.14	€ 27.91
	Capital costs		Total time investment: 420,75 hours	€ 25.33/hour	€ 10,655.49	€ 29.03
Yoga sessions	Labor costs	Yoga instructors	392 sessions	€ 24.35/hour	€ 8,748.81	€ 23.84
	Capital costs		Total time investment: 359.33 hours	€ 5.87/hour	€ 2,110.72	€ 5,75
					Total	**€ 86.54**
Personal Vitality Coaching (PVC)						
Training sessions	Labor costs	Principal investigator	2 sessions	€ 26.65/hour	€ 213.19	€ 0.58
		Research assistant	Total time investment: 8 hours	€ 25.45/hour	€ 203.57	€ 0.55
		PVC coaches		€ 29.79/hour	€ 714.99	€ 1.95
	Capital costs			€ 5.87/hour	€ 46.99	€ 0.13
PVC visits	Labor costs	PVC coaches	894 visits	€ 29.79/hour	€ 13,316.67	€ 36.29
	Capital costs		Total time investment: 447 hours	€ 2.94/hour	€ 1,312.84	€ 3.58
					Total	**€ 43.08**
Provision of free fruit			288 fruit-boxes (12 per week)	€ 20.52/box	€ 5,905.23	€ 16.09
					Total	**€ 16.09**
Printed materials						
General information folder			1900 folders	€ 0.33/folder	€ 623.13	€ 1.70
Intervention logbook			367 logbooks	€ 1.53/logbook	€ 561.99	€ 1.53
PVC protocol and accompanied materials			10 ring binders	€ 14.22/binder	€ 142.20	€ 0.39
					Total	**€ 3.62**
Total intervention costs						**€ 149.33**

Abbreviations: n: number.
Note: Costs are expressed in 2010 Euros

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

	Imputed dataset		
Cost category	**Intervention group n=367; mean (SEM)**	**Control group n=363; mean (SEM)**	**Mean cost difference (95% CI)**
Medical costs	847 (73)	593 (53)	254 (-246 – 670)
Absenteeism costs	2793 (250)	2570 (249)	223 (-1284 – 1637)
Presenteeism costs	11580 (408)	11475 (396)	106 (-1454 – 1650)
Sports costs	553 (37)	714 (38)	-162 (-466 – 228)
Intervention costs	149 (NA)	0 (NA)	149 (NA)
Total costs	15922 (624)	15353 (574)	570 (-1968 – 2905)
	Complete dataset		
Cost category	**Intervention group n=199; mean (SD)**	**Control group n=191; mean (SD)**	**Mean cost difference (95% CI)**
Medical costs	295 (587)	277 (562)	19 (-94 - 132)
Absenteeism costs	793 (1764)	686 (1779)	107 (-259 – 446)
Presenteeism costs	9466 (4963)	9782 (6745)	-315 (-1549 – 855)
Sports costs	449 (502)	505 (608)	-56 (-170 – 45)
Intervention costs	149 (NA)	0 (NA)	149 (NA)
Total costs	11153 (5828)	11249 (7671)	-96 (-1578 – 1237)

Abbreviations: n: number; SEM: standard error of the mean, CI: confidence interval, NA: not applicable, SD: standard deviation
Note: Costs are expressed in 2010 Euros

Societal perspective: Cost-effectiveness

For general vitality, an ICER of 280 was found. This indicates that the additional societal costs per 1-point improvement in general vitality were €280. ICERs in similar directions were found for work-related vitality (ICER, 7506) and NFR (ICER, −258) (Table 4). Note that the ICER for NFR was negative because lower scores indicate a better NFR. In all cost-effectiveness planes, the majority of incremental cost-effect pairs were located in the northeast quadrant (Figure 2 [1A–1C]), indicating that the intervention was more expensive than usual care in obtaining an additional unit of effect. The uncertainty surrounding the cost-effectiveness was large, as is reflected by the wide distribution of incremental cost-effect pairs (Table 4). Cost-effectiveness acceptability curves are presented in Figure 2 (2A–2C). To illustrate, if society is not willing to pay anything to obtain a 1-point improvement in general vitality, there is a probability of 0.3 that the intervention is cost-effective. If society is willing to pay ±€3500, there is a probability of 0.9.

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

Analysis	Sample size		Outcome	ΔC (95% CI)	ΔE (95% CI)	ICER	Distribution CE-plane (%)			
	I	C		€	points		NE[1]	SE[2]	SW[3]	NW[4]
Main analysis	367	363	General vitality	570 (-1968 – 2905)	2.0 (-0.2 - 4.3)	280	66.4	29.8	1.4	2.4
Imputed dataset	367	363	Work-related vitality	570 (-1968 – 2905)	0.08 (-0.02 - 0.18)	7506	63.8	29.5	1.7	5.1
	367	363	Need for recovery	570 (-1968 – 2905)	-2.2 (-5.5 – 1.1)	-258	62.4	28.5	2.8	6.6
SA1	199	191	General vitality	-96 (-1578 – 1237)	2.1 (-0.6 - 4.9)	-44	41.4	53.6	2.2	2.8
Complete dataset	199	191	Work-related vitality	-96 (-1578 – 1237)	0.08 (-0.04 - 0.2)	-1167	40.4	51.6	4.0	4.0
	199	191	Need for recovery	-96 (-1578 – 1237)	-3.7 (-7.5 - 0.1)	26	42.5	54.6	1.3	1.6
SA2	367	363	General vitality	557 (-1979 - 2892)	2.0 (-0.2 - 4.3)	274	66.2	30.2	1.4	2.2
Prices paid	367	363	Work-related vitality	557 (-1979 - 2892)	0.08 (-0.02 - 0.18)	7338	63.5	29.7	1.6	5.2
	367	363	Need for recovery	557 (-1979 - 2892)	-2.2 (-5.5 – 1.1)	-253	61.9	28.8	2.8	6.5
SA3	367	363	General vitality	604 (-2251 - 3184)	2.0 (-0.2 - 4.3)	297	66.0	30.2	1.4	2.3
HCA, elasticity: 1.0	367	363	Work-related vitality	604 (-2251 - 3184)	0.08 (-0.02 - 0.18)	7956	63.3	29.8	1.8	5.1
	367	363	Need for recovery	604 (-2251 - 3184)	-2.2 (-5.5 – 1.1)	-274	62.2	28.5	2.8	6.4
SA4	367	363	General vitality	464 (-1261 – 1911)	2.0 (-0.2 - 4.3)	228	71.2	25.2	1.2	2.4
Excluding presenteeism	367	363	Work-related vitality	464 (-1261 – 1911)	0.08 (-0.02 - 0.18)	6137	68.4	24.8	1.4	5.4
	367	363	Need for recovery	464 (-1261 – 1911)	-2.2 (-5.5 – 1.1)	-211	66.8	23.7	2.5	7.0

Abbreviations: CI: confidence interval, C: costs, E: effects, ICER: incremental cost-effectiveness ratio, CE-plane: cost-effectiveness plane, I: Intervention, C: Control, SA: sensitivity analysis, HCA: human capital approach

Note: Costs are expressed in 2010 Euros

[1] Refers to the northeast quadrant of the CE plane, indicating that the Vital@Work intervention is more effective and more costly compared to the control group

[2] Refers to the southeast quadrant of the CE plane, indicating that the Vital@Work intervention is more effective and less costly compared to the control group

[3] Refers to the northwest quadrant of the CE plane, indicating that the Vital@Work intervention is less effective and more costly compared to the control group

[4] Refers to the southwest quadrant of the CE plane, indicating that the Vital@Work intervention is less effective and less costly compared to the control group

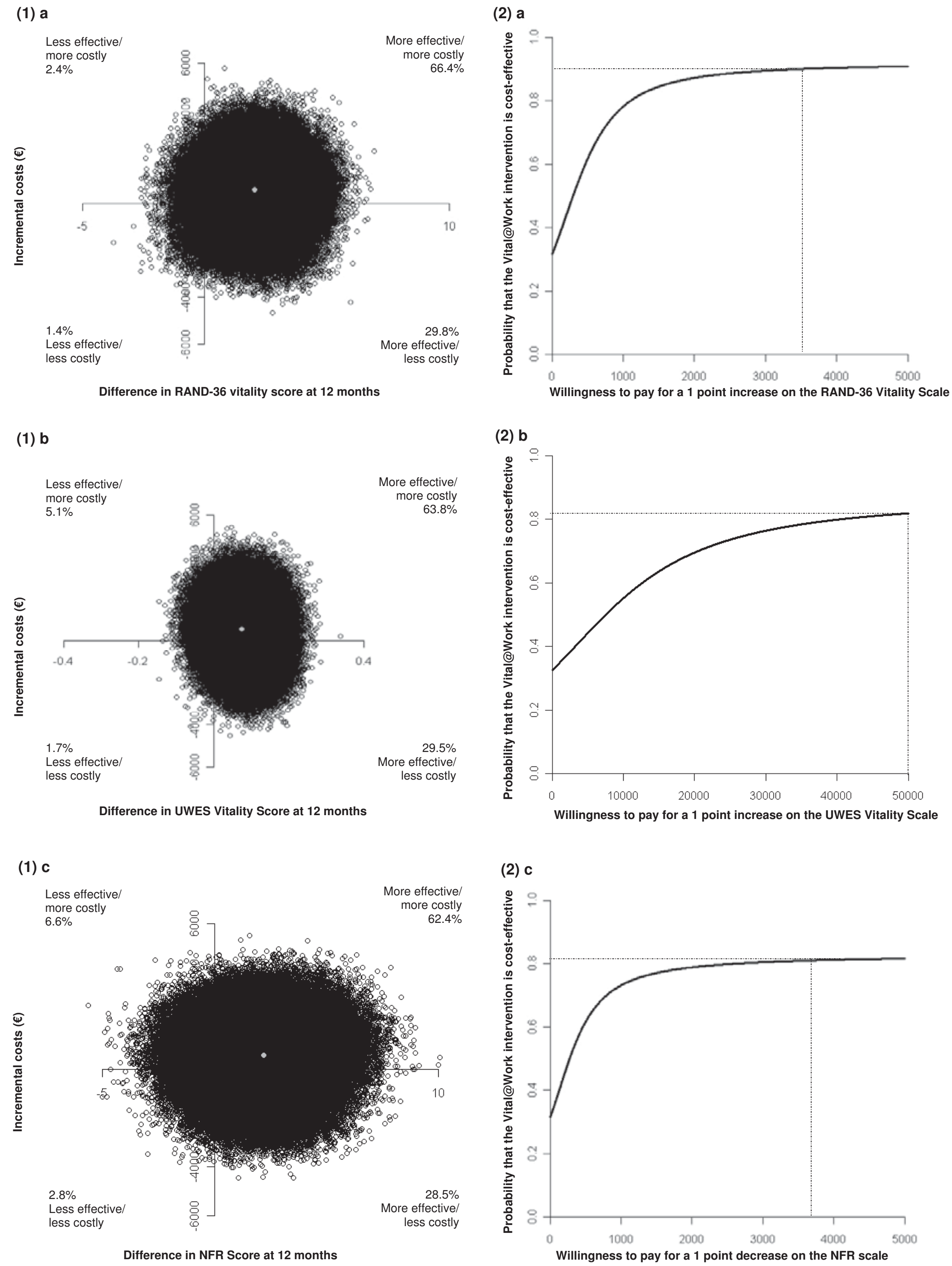

Figure 2: Cost-effectiveness planes indicating the uncertainty around the incremental cost-effectiveness ratios (1) and cost-effectiveness acceptability curves indicating the probability of cost-effectiveness for different values (€) of willingness to pay per unit of effect gained (2) for general vitality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

Employer's perspective: Financial return

During follow-up, average absenteeism (−€223; 95% CI, −1636 to 1284) and presenteeism (−€106; 95% CI, −1650 to 1454) benefits per worker were negative, suggesting that the intervention increased productivity-related spending (Table 5). The NB was on average −€478 (95% CI, −2663 to 1816) per worker, suggesting a net loss to the employer of €478. Nevertheless, as indicated by the 95% CIs, the uncertainty surrounding the benefit estimates and NB was large and they cannot be regarded as statistically significant. The BCR (ie, amount of money returned per euro invested) and ROI (ie, percentage of profit per euro invested) were −2.21 and −321%, respectively (11). Overall, these findings suggest that the intervention was not cost saving to the employer during the 12-month follow-up.

Sensitivity analyses

The overall conclusions would not change when using the results from SA2 (using prices paid), SA3 (using HCA), and SA4 (excluding presenteeism) (Tables 4 and 5). When solely analyzing the complete cases (SA1), however, total societal costs were lower in the intervention than in the control group, whereas they were highest in the intervention group according to the main analysis. This difference is mostly explained by differences in presenteeism costs, which were lowest in the intervention group among the complete cases, whereas they were lowest in the control group after multiple imputation (Table 3). Effect sizes, on the contrary, were about the same in both analyses. In the complete-case analysis, the majority of the incremental cost-effect pairs were located in the southeast quadrant of the cost-effectiveness plane, indicating that the intervention was less expensive than usual care to obtain an additional unit of effect. Nevertheless, the uncertainty surrounding this cost-effectiveness was large. For the employer, the complete-case analysis resulted in an NB of €59 (95% CI, −1137 to 1471), a BCR of 1.40, and an ROI of 40%, indicating that the intervention produced a positive financial return. Again, however, the range of uncertainty was large.

Table 5: Intervention costs, benefits, net benefit (NB), benefit cost ratio (BCR), and return-on-investment (ROI) per worker

Analysis	Sample size		Costs	Benefits			Financial return		
	I	C	I (95% CI)	Absenteeism (95% CI)	Presenteeism (95% CI)	Total (95% CI)	NB[1] (95% CI)	BCR[2]	ROI (%)[3]
Main analysis	367	363	149	-223	-106	-329	-478	-2.21	-321
Imputed dataset			(NA)	(-1636 – 1284)	(-1650 – 1454)	(-2514 – 1964)	(-2663 – 1816)		
SA1	199	191	149	-107	315	208	59	1.40	40
Complete dataset			(NA)	(-466 – 259)	(-855 – 1549)	(-993 – 1574)	(-1137 – 1471)		
SA2	367	363	137	-223	-106	-329	-466	-2.40	-340
Prices paid			(NA)	(-1636 – 1284)	(-1650 – 1454)	(-2514 – 1964)	(-2651 – 1829)		
SA3	367	363	149	-257	-106	-363	-512	-2.44	-344
HCA, elasticity: 1.0			(NA)	(-2042 – 1674)	(-1650 – 1454)	(-2806 - 2261)	(-2952 – 2115)		
SA4	367	363	149	-223	NA	-223	-372	-1.50	-250
Excluding presenteeism			(NA)	(-1636 – 1284)		(-1636 – 1284)	(-1785 – 1135)		

Abbreviations: CI: confidence interval, NB: net benefit, BCR: benefit cost ratio, ROI: return-on-investment, I: Intervention, C: Control, SA: sensitivity analysis, HCA: human capital approach, NA: not applicable

Note: Costs are expressed in 2010 Euros

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

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

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

DISCUSSION

The present study aimed to assess the cost-effectiveness and financial return of a worksite vitality intervention among older workers versus usual care. No significant differences in effects and costs were found. The intervention can neither be regarded as cost-effective from the societal perspective nor cost saving from that of the employer.

Effects and Costs

The lack of effect on the study outcomes might be due to their baseline values already being in the upper limit range of those measures, leaving less room for improvement. This might indicate a “healthy worker effect” (ie, healthier workers are more likely to stay in the workforce than those who are sick or physically unfit). Another explanation might be that attendance and compliance were lower than expected among intervention group workers. The attendance rates, defined as the mean percentage of attended group sessions in relation to the number of provided group sessions (n = 24), for the yoga and workout sessions were 51.7% and 44.8%, respectively (35). Furthermore, 108 (29.4%) intervention group workers did not attend any of the yoga sessions and 133 (36.2%) did not attend any of the workout sessions (35).

Until now, few studies evaluated the effectiveness of worksite health promotion intervention in terms of vitality or NFR. One study (36) found a worksite intervention consisting of vegan nutrition education sessions to increase general vitality by 11.0 points (range, 0 to 100) at 22-week follow-up. Their results, however, were based on a nonrandomized study, making it difficult to attribute the effect to the intervention and to rule out the possibility that the study was biased by confounders or baseline differences in group characteristics (ie, selection bias) (10,37). Furthermore, the content of the intervention was different from that of the Vital@Work intervention, the intervention was not specifically aimed at older workers, and it is unknown whether the effect was sustained over the long term.

As for the lack of significant cost differences, it is known that cost data are highly skewed and therefore require large sample sizes to detect relevant differences (38).

In our study, the sample size calculation was based on work-related vitality (2), which may have underpowered it to detect significant cost differences. Although not significant, it is noteworthy that despite the fact that intervention group workers reported a larger increase in weekly sports activities compared with their control group counterparts (3), sports costs were lowest in the intervention group. Further examination of the data revealed that this was mainly due to the fact that intervention group workers purchased fewer sports memberships than those of the control group (data not shown). Therefore, a possible explanation for this finding may be that workers regarded the Vital@Work intervention as a substitute for a membership of a sports club.

Societal perspective: Cost-effectiveness

Joint comparison of costs and effects revealed that a substantial amount of money has to be paid by society to reach a reasonable probability of cost-effectiveness. For example, for a 0.9 probability of cost-effectiveness, society should be willing to pay ±€3500 per 1-point improvement in general vitality (range, 0 to 100). Although it is unknown what relevant improvements on the main study outcomes are, and this will depend on their baseline values, it may be in the 10% to 20% range. Therefore, although it is currently unknown how much decision makers are willing to pay for a 1-point improvement on both vitality measures and NFR, the present study provides no evidence to support the implementation of the Vital@Work intervention on cost-effectiveness grounds. One might argue that this was expected because the intervention did not have a significant effect on the main study outcomes. Nevertheless, CEAs are about the joint distribution of differences in costs and effects, which could even show clear cost-effectiveness when neither cost nor effect differences are individually significant (39).

Comparing these results with previous studies is hampered by the lack of studies evaluating the societal cost-effectiveness of similar interventions in terms of vitality or NFR. Nevertheless, the previously mentioned study did report the intervention costs of their worksite vegan nutrition intervention ($3614/16 participants; $226/participant) (36), but the authors did not measure any other cost and did not perform a full economic evaluation.

Employer's perspective: Financial return

The ROI analysis indicated that the Vital@Work intervention cannot be regarded as cost saving to the employer. So far, only one other study (40) evaluated the financial return of a similar intervention in terms of both absenteeism and presenteeism benefits. On average, this worksite physical activity and nutrition program, consisting of a health risk assessment, a Web portal, and lifestyle seminars, resulted in a reduction of 4.3 absenteeism days (absenteeism benefits: $1236) and a 0.79-point (range, 0 to 10) increase in work performance (presenteeism benefits, $1364). Combining these findings with the reported intervention costs ($138/participant) results in a BCR of 18.84 and an ROI of 1784% (10). These findings differ enormously from those of our study, which might be explained by differences in intervention content, intervention participants (older workers vs general working population), study design (RCT vs nonrandomized study) or a combination of these. The latter is underscored by a recent systematic review, which indicated that worksite physical activity, nutrition programs, or both generate positive financial returns through reduced absenteeism, medical costs, or both according to nonrandomized studies, whereas they do not according to RCTs (10).

Robustness of study results

Sensitivity analyses revealed that the present findings were reasonably robust with respect to the valuation of intervention and absenteeism costs. Excluding presenteeism costs did not change the conclusions either. Nevertheless, differences were found between the main analysis, for which data were imputed, and the complete-case analysis. These differences were mainly caused by differences in presenteeism costs. This may be due to the complete cases being unrepresentative of the whole study population in terms of (presenteeism) costs and, therefore, not satisfying the missing completely at-random assumption (ie, the "missingness" of data does not depend on the unobserved or the observed data) required for a complete-case analysis to provide valid and unbiased results (32).

Strengths and limitations

Several strengths of the present study are noteworthy. First, analyses were performed alongside a pragmatic RCT, which is generally acknowledged as the best vehicle for economic evaluations as it enables the evaluation of an intervention's economic consequences under "real life" conditions and allows prospective collection of relevant cost and effect data (39,41). So far, few studies have used this design to evaluate the financial return of worksite physical activity or nutrition programs, although their results seem to differ from those of nonrandomized studies with a higher risk of bias (10). Second, the CEA was conducted from the societal perspective. Until now, many studies evaluating the cost-effectiveness of similar interventions have applied a rather restrictive perspective by including only intervention costs (42). Worksite interventions, however, are also thought to be associated with medical and productivity-related costs. Both were included in the present study as a result of the adoption of the societal perspective. Third, the present study was one of the first CEAs and ROI analyses of worksite physical activity or nutrition programs to incorporate presenteeism costs (10), which can represent a considerable proportion of total productivity-related costs (43). Nevertheless, it is important to mention that a "gold standard" for estimating presenteeism costs does not exist currently (25). Further research is needed to develop more sophisticated instruments for measuring and valuing presenteeism and to reach consensus about the best way to do so. Until then, the method used in the present study provides at least a crude estimate of the presenteeism costs associated with a worksite vitality intervention.

A first limitation concerns the amount of incomplete data. For 360 workers (48%), complete follow-up data were missing. This is comparable with the amount of missing data in other CEAs of worksite interventions that were conducted alongside RCTs with a follow-up of 1 year or more (44,45). Multiple imputation was used to deal with the missing data, which is acknowledged as a more appropriate way to deal with missing data than complete-case analyses (46). Complete-case analysis will always be inefficient, to some degree, as the sample size is reduced and it will ignore observed cost data, effect data, or both in the excluded participants (32). Multiple imputation, however, relies on the assumption that data are missing at random (ie, the "missingness" depends only on the observed data and not on unobserved data), an assumption that may not necessarily hold true. Therefore, the results of the present study should be interpreted with caution. In future studies, every endeavor should be made to minimize the amount of missing data (32). Another limitation may be that cost and effect data were obtained through self-reported retrospective questionnaires, which may have caused “social desirability bias,” “recall bias,” or both. For example, participants’ health insurance claim data could not be used for calculating medical costs, as these are often practically inaccessible in the Netherlands. As a consequence, self-report of medical resource utilization is the most commonly used method in Dutch economic evaluations and was therefore used in the present study as well. Furthermore, it is unknown whether the results may be generalized to other working populations (ie, “external validity”), as the intervention was specifically tailored to older hospital workers.

Conclusion

The Vital@Work intervention was neither cost-effective from the societal perspective nor cost saving from that of the employer. Therefore, the present study provides no evidence to support its implementation on cost-related grounds.

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