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Cost-Effectiveness and Return-on-Investment of the Dynamic Work Intervention Compared With Usual Practice to Reduce Sedentary Behavior

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Objective: To assess the cost-effectiveness and return-on-investment (ROI) of the Dynamic Work (DW) Intervention, a worksite intervention aimed at reducing sitting time among office workers. **Methods:** In total, 244 workers were randomized to the intervention or control group. Overall sitting time, standing time, step counts, quality-adjusted life years (QALYs), and costs were measured over 12 months. The cost-effectiveness analysis was performed from the societal perspective and the ROI analysis from the employers' perspective. **Results:** No significant differences in effects and societal costs were observed between groups. Presenteeism costs were significantly lower in the intervention group. The probability of the intervention being cost-effective was 0.90 at a willingness-to-pay of 20,000€/QALY. The probability of financial savings was 0.86. **Conclusion:** The intervention may be considered cost-effective from the societal perspective depending on the willingness-to-pay. From the employer perspective, the intervention seems cost-beneficial.

Keywords: cost-benefit analysis, economic evaluation, financial return, randomized controlled trial, sedentary behavior, sit-stand desk

Sedentary behavior (ie, sitting too much) has become an important public health concern due to its association with chronic diseases, such as diabetes and cardiovascular disease, and premature mortality.[1–3] It has also been associated with productivity losses related to paid work (ie, sickness absenteeism and presenteeism).[4–6] Studies have shown that 18.5% and 32.1% of European and Dutch adults spend more than 7.5 hours per day sitting.[7] The economic burden of sedentary behavior has been estimated at €8 million in the UK.[8] As occupational sitting time is one of the largest contributors to daily or overall sitting time for many office workers, the workplace provides a potentially attractive setting to reduce sedentary behavior.[9]

Multi-component interventions integrating individual (eg, coaching), environmental (eg, sit-stand desks and cycling workstations), and organizational components (eg, ambassador role of management) have been proposed to reduce workplace sitting time.[10] Two recent large trials have found multi-component interventions providing workers with sit-stand desks and including extensive one-on-one coaching sessions to result in long-term reductions in occupational sitting time.[11,12] Investigation of whether the additional costs of such interventions are justified by the resulting improvements in health and work-related outcomes is warranted to aid decision-making on deciding whether or not to implement multi-component interventions.[10] To date, only one economic evaluation of the aforementioned trials was published showing that a multi-component intervention was cost-effective for health-adjusted life years (HALYs) as compared with no intervention from a societal perspective.[13]

From an employer's perspective, it might not be feasible to replace all desks with sit-stand desks and/or to provide high-intensity one-on-one coaching to all employees. The use of sit-stand desks, for example, may be perceived by the employer as too costly to implement.[14] Therefore, a pragmatic cluster randomized trial—the Dynamic Work (DW) study—was designed to assess whether a less intensive multi-component intervention consisting of partial replacement of sitting desks with sit-stand desks (eg, in a ratio of 1:4) and group coaching sessions was effective to reduce overall sitting time compared with usual practice.[15] The impact of such a less intensive multi-component intervention on healthcare utilization, informal care, and lost productivity costs was also investigated.[15] This study presents the results of the DW intervention's cost-effectiveness analysis (CEA) from a societal perspective and the return-on-investment (ROI) analysis from an employer's perspective.

METHODS

Design and Target Population

This economic evaluation was conducted alongside a pragmatic cluster randomized trial—the DW study—at a Dutch insurance company between February 2017 and April 2018, which is described in detail in the protocol paper and in the trial registry (ClinicalTrials.gov, number NCT03115645).[15] The study was approved by the Medical Ethics Committee of the Vrije University Medical Center Amsterdam (number 2016.533).

Randomization was performed at the department level. All office workers working at the participating departments were eligible for participation in the study. Office workers were excluded if they: (1) had a contract for less than 0.6 full-time equivalent, (2) had a condition affecting the use of the intervention (eg, wheelchair bound), or (3) were pregnant. At enrollment, workers provided written informed consent. After baseline measurements, departments were randomized by a blinded researcher. Fieldwork staff was

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Conflicts of Interest statement: None declared.
Clinical significance: The Dynamic Work intervention is likely to be cost-beneficial from societal and employers' perspectives. However, the intervention might not be implemented due to non-significant effect on sedentary behavior compared with usual practice. More research is needed on the impact of such less intensive multi-component intervention on lost productivity costs.
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blinded to group allocation as well. The sample size was based on detecting a minimal relevant difference of 45 minutes in overall sitting time with a standard deviation (SD) of 80.7, an intraclass correlation within departments (ICC) of 0.021, a power of 90%, and an alpha of 0.05.[12] Considering a dropout of 25%, at least 250 workers (125 per group) needed to be included at baseline.

Setting and Location

The staff of the insurance company consists of approximately 14,000 permanent and 3000 casual workers on five locations in the Netherlands (ie, Apeldoorn, Leeuwarden, Leusden, Tilburg, and Zwolle). Employees work in open-space offices without fixed desks and can work at home for 1 or 2 days a week. Work tasks comprise mostly computer-based work, but also involve meetings and traveling to meet with customers. Since 2014, the insurance company has a specialized department (healthy work) that is responsible for a variety of health promotion programs.

Study Perspective and Time Horizon

This study was performed from a societal and an employers' perspective over a time horizon of 8 months. Therefore, costs and effects were not discounted. When the societal perspective was applied, costs related to the intervention, healthcare utilization, informal care, and productivity losses (ie, sickness absenteeism from paid and unpaid work and presenteeism) were included in the analysis.[16] When the employer's perspective was applied, only health-related expenses incurred by the employer (ie, lost productivity costs) were included in the analysis.[16]

Intervention

All participating departments had flexible workplaces (eg, no one had a fixed, personal workplace). The control group received usual practice, consisting of prompts to use the stairs, walking routes and telephone routes with footsteps on the floor, and lunch bags to take along on a lunch walk.

The intervention group received the DW intervention in addition to usual practice. The DW intervention is a multi-component intervention containing organizational components (ie, one face-to-face meeting between occupational physiotherapists and department managers), environmental components (ie, sit-stand desks [ratio 1 to 4 with regular desks], cycling workstations [1 for every second sit-stand desk], and office sit balls [at least 2]), and individual components (ie, two team meetings, four on-site counselling sessions, and an activity/sitting self-monitoring tracker with self-help program booklet).

During the face-to-face meeting between occupational physiotherapists and department managers, the department managers' expectations regarding the intervention and placement of equipment were discussed. During the first team meeting, occupational physiotherapists explained the proper use of the environmental components and the potential health risks of sedentary behavior to the workers. During the second team meeting, the workers' experiences with the equipment were discussed and strategies were developed to overcome the behavioral barriers to reduce sitting. On-site counselling sessions were intended to reflect on the DW intervention, answer individual questions and provide tips.

Choice of Effect Outcomes

The effect outcomes were overall sitting time, standing time, step counts, and Quality-Adjusted Life-Years (QALYs). Overall sitting time, standing time, and step counts were chosen as effect outcomes because they are all measures of sedentary behavior (ie, any waking behavior characterized by an energy expenditure less than or equal to 1.5 metabolic equivalent while in a sitting, reclining or lying posture).[17] QALY is routinely used as an outcome measure in economic evaluations due to the fact that it summarizes the impact of interventions on both the quantity and quality of life in a single value.[18] Another advantage of QALYs is that they provide a general score allowing decision makers to compare the consequences of a range of interventions for different health issues.[16] However, QALYs may not reflect what occupational health decision makers feel is most important in terms of outcomes.[16] Given that, a ROI analysis was performed considering lost productivity costs (ie, sickness absenteeism from paid work and presenteeism) as effect outcome (ie, benefit), which is more likely to be of interest to occupational decision makers.

Effect Outcome Measures

Overall sitting time, standing time, and step counts were objectively assessed using the activPAL (PAL Technologies Ltd., Glasgow, UK) over 7 days, 24/7, at baseline, 4- and 8-months follow-up. The measurements were conducted at the office locations by trained researchers and were standardized to a 16-hour day. Health-related quality of life (HRQoL) was measured using the EQ-5D-5L questionnaire at baseline, 4- and 8-months follow-up.[19] Workers were asked to rate five dimensions of quality of life (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) using five response levels (ie, no problems, slight problems, moderate problems, severe problems, or extreme problems). The workers' responses to the EQ-5D-5L described their health state. These health states were then converted into utility values (ie, a single value representing an individual's preferences for a given health state) using the value set from the Dutch population.[20] Subsequently, the obtained utility values were used to calculate QALYs by means of the area under the curve method (ie, the duration of a health state is multiplied by the utility value related to that health state).

Cost Outcome Measures

Intervention Costs

The DW intervention's costs were estimated using a bottom-up micro-costing approach (ie, detailed data were recorded on the number of resources consumed as well as their respective unit costs).[21] Resources at the individual level were number of activPAL devices, self-help program booklets, and time spent in intervention meetings by each worker. Resources at the department level were sit-stand desks, cycling workstation, office sit balls, placement of items, and time spent by occupational physiotherapists, department managers, team leaders, and the occupational health team on intervention-related activities. Labor costs were valued using the workers' average gross hourly salary derived from the financial department. The department level costs were allocated over all 366 workers of the participating departments (ie, also those not participating in the study), because these resources were available for all workers independent of their participation in the study (Supplementary Table 1, http://links.lww.com/JOM/A773).

Healthcare Utilization and Informal Care Costs

An adapted version of the iMTA Medical Cost Questionnaire (iMCQ)[22,23] was used to measure healthcare utilization and care provided by family and/or friends (ie, informal care), using a 4-month recall period at 4- and 8-months follow-up. Healthcare utilization costs included primary care costs (eg, costs of visits to general practitioners, health professionals, and complementary healthcare providers), secondary care costs (eg, costs of outpatient hospital visits to specialist care, ambulance transportation, admissions to the hospital, and visits to other healthcare organizations such as mental healthcare institutions), and medication costs. Medication use was valued using data from the Dutch Healthcare Institute in 2018 (www.medicijnkosten.nl).[24] Informal care costs were based on the amount of time the worker needed help in performing household tasks or receiving care from family and/or friends due to health problems. Unit prices provided by the Dutch manual for costing in economic evaluations were used to value healthcare utilization and informal care costs (reference year 2018).[25]

Lost Productivity Costs

Information on sickness absenteeism from paid work between baseline and 8-month follow-up was obtained from company records with the consent of participants. In addition, the iMTA Productivity Cost Questionnaire (iPCQ)[22] was used to measure self-reported sickness absenteeism from paid and unpaid work, and presenteeism, using a 4-month recall period at baseline, 4- and 8-months follow-up.

The friction cost approach (FCA) was used to calculate sickness absenteeism costs from paid work.[26] The FCA assumes that sickness absenteeism costs are limited to the period needed to replace an absent, sick worker, which has been estimated to be 12 weeks (85 days) in the Netherlands.[25] Sex-specific estimates of the mean wages of the Dutch population were used to calculate sickness absenteeism costs from paid work (reference year 2018).[25]

To measure sickness absenteeism from unpaid work, the participants were asked whether they had difficulty in performing unpaid work activities due to sickness (eg, housework, childcare, voluntary work).[22] Costs related to sickness absenteeism from unpaid work were valued using a shadow price for legally employing a domestic assistant (reference year 2018).[25]

To measure the workers' level of presenteeism, workers were asked to rate how efficiently they worked while suffering from health complaints on a scale from 0 (I was unable to do anything) to 10 (I was able to do as much as usual). The resulting efficiency score was used to calculate presenteeism costs: Presenteeism costs = number of days working with complaints × (1-[efficiency score/10]) × number of working hours per day × sex-specific mean wage rates.[23]

Other Variables

At baseline, data were collected on sociodemographic characteristics (ie, age [years], sex, level of education [no/primary education, secondary education, professional education and university education], marital status [married/living with partner, single], household income [less than or equal to €2800, €2800 to 4000, more than €4000, and unknown]), employment characteristics (ie, years in the company, working h/wk, absenteeism from paid work, and presenteeism using iPCQ[22]), health characteristics (ie, body mass index [BMI] and musculoskeletal symptoms). Trained researchers measured body height in centimeters and body weight in kilograms after workers removed heavy items of clothing and their shoes. BMI score was calculated in $kg\,m^{-2}$. Musculoskeletal symptoms in the past 3 months were assessed using the modified Nordic questionnaire. The responses to the modified Nordic questionnaire were dichotomized into experiencing complaints (Frequently; For a longer period of time) or not (Never; Once in a while).[27] The responses to the iPCQ were dichotomized into reported and unreported sickness absenteeism from paid work, and presenteeism.

Statistical Analysis

Analyses were performed according to the intention-to-treat principle using STATA version 14SE. Multivariate Imputation by Chained Equations, stratified by group allocation, was used to impute missing data. Variables associated with having missing observations (yes/no) and outcomes as well as potential confounders were included in the imputation model (ie, age, sex, level of education, marital status, household income, employment characteristics, sickness absenteeism from paid work, HRQoL, and musculoskeletal complaints). Predictive mean matching was used to account for the skewed distribution of the costs.[28] The number of imputations was increased until it resulted in a loss of efficiency of less than or equal to 5%, resulting in 10 imputed datasets.[28,29] The 10 imputed datasets were analyzed separately and estimates were then pooled using Rubin rules.[30] Descriptive statistics at baseline were calculated using pooled data. Mean and standard deviations (SD) were used to describe continuous variables and absolute number and percentages to describe categorical variables.

Societal Perspective: CEA

The CEA was conducted from a societal perspective. Cost and effect differences were estimated using seemingly unrelated regression analyses at 8-month follow-up, adjusting for outcomes measured at baseline, and accounting for the correlation between costs and effects.[31] Bias-corrected accelerated bootstrapping with 5000 replications was used to estimate the joint uncertainty surrounding effects and costs. Incremental Cost-Effectiveness Ratios (ICERs) were calculated by dividing the difference in societal costs by the difference in effect. Bootstrapped cost-effect pairs[32] were plotted on cost-effectiveness planes (CE-plane).[33] Cost-effectiveness acceptability curves (CEACs) were estimated, showing the probability of the intervention being cost-effective compared with control for a range of willingness-to-pay thresholds (ie, the maximum amount of money society is willing to pay for a unit of effect gained).[34] For the step counts outcome, we considered a unit of effect equivalent of 1000 steps, which is more informative on the number of steps taken daily.

Employer's Perspective: ROI Analysis

In the ROI analysis, costs were defined as intervention costs. Benefits were defined as the difference in lost productivity costs (ie, sickness absenteeism from paid work and presenteeism) between control and intervention groups at 8-month follow-up, with positive benefits indicating reduced spending.[16] Linear regression was used to estimate benefits. Three ROI metrics were calculated: (1) Net Benefit (NB), (2) Benefit-cost Ratio (BCR), and (3) Return-on-investment (ROI)[16]:

$$NB = benefits - costs$$
$$BCR = benefits/costs$$
$$ROI = (benefits - costs)/costs\ [\times 100]$$

Financial returns of the intervention are positive if the following criteria are met $NB > 0$, $BCR > 1$, and $ROI > 0\%$. The probability of financial return was calculated as the probability that NB was larger than 0.[16]

Sensitivity Analyses

Five sensitivity analyses (SA) for overall sitting time and QALYs were performed to assess the robustness of results. Due to a delay in recruitment of departments for participation in the study and delays in the delivery of the sit-stand workstations, there were on average 4 months between the baseline measurement and the start of the intervention. Four workers ($n = 3$ intervention group, $n = 1$ control group) were absent from work due to sickness at the end of this period and did not receive the intervention but were included in the main analysis. The first SA (SA1) excluded these four workers to determine how this would impact the results. SA2 was based on self-reported sickness absenteeism to calculate sickness absenteeism costs from paid work, instead of using the company sickness absenteeism records. SA3 used the Human Capital Approach (HCA) to calculate sickness absenteeism costs from paid work. SA4 also used the HCA and excluded the four workers from SA1. The HCA represents financial losses for the entire duration of sickness absence.[23] In SA5 only workers with complete follow-up data were included.

RESULTS

Participants

A total of 607 office workers from 14 departments were invited to participate in the study. Among those who agreed to participate ($n = 304$), 60 were excluded (ie, 29 did not meet the inclusion criteria and 31 declined to participate in the study). A total of 244 workers from 14 departments (40%) were then allocated to the intervention group ($n = 121$) and to the control group ($n = 123$).[35] At baseline, no meaningful differences were found between both groups (Table 1). Complete follow-up data were obtained from 75% of workers for the activPAL outcomes ($n = 184$, 92 intervention group and 92 control group) and for QALYs ($n = 184$, 93 intervention group and 91 control group). Seventeen workers did not provide consent to use their sickness absenteeism company record data, which resulted in 89% of complete follow-up on sickness absenteeism ($n = 218$, 106 intervention group and 112 control group). Due to non-responses at the item level, complete follow-up data were obtained from 74% of the workers for presenteeism ($n = 182$, 92 intervention group and 90 control group), from 68% of workers for lost productivity costs ($n = 165$, 82 intervention group and 83 control group) and from 52% of workers for societal costs ($n = 126$, 65 intervention group and 61 control group).

Effectiveness

Table 2 reports the effect outcomes in the two groups and the differences between groups at 8-month follow-up. Overall, differences in the activPAL outcomes and QALYs were not statistically or clinically relevant. More details on the effectiveness of the DW intervention compared with usual practice have been published elsewhere.[35]

Costs

On average, intervention costs were €284/worker (Supplementary Table 1, http://links.lww.com/JOM/A773). The biggest cost driver was the sit-stand desks (€150/worker). There were no statistically significant differences between groups in total healthcare utilization costs (€–4; 95% CI, –258; 333) and total societal costs (€–994; 95% CI, –2487; 160, [Table 2]) at 8-month follow-up. However, total lost productivity costs (eg, the sum of sickness absenteeism from both paid and unpaid work and presenteeism) were statistically significantly lower in the intervention group compared with the control group (€–1274; 95% CI, –2632; –248, [Table 2]).

Societal Perspective: CEA

For overall sitting time, the intervention was on average less costly, but not more effective compared with control (Table 3). Due to the lack of effect on sitting time, the percentages of bootstrapped cost-effect pairs were more or less equally distributed across the eastern (42%) and western (58%) quadrants of the CE-plane (Table 3). For standing time, the intervention was on average less costly and less effective compared with the control group. Hence, most of the bootstrapped cost-effect pairs (77%) were in the south-west quadrant of the CE-plane (Table 3). For an increase of 1000 steps per day, the intervention was less costly and more effective compared with control with 89% of the bootstrapped cost-effect pairs in the south-east quadrant of the CE-plane (Table 3). For QALYs, the intervention was on average less costly and less effective than control, and most of the bootstrapped cost-effect pairs (53%) were in the south-west quadrant of the CE-plane (Table 3).

The CEACs shows that the probability of the intervention being cost-effective compared with control was 0.92 at a

TABLE 1. Baseline Characteristics of Participants in the Intervention or Control Groups

	Intervention ($n = 121$)	Control ($n = 123$)
Self-reported socio demographics characteristics		
Gender, female, *n* (%)	69 (57.0)	77 (62.6)
Age, yrs, mean (SD)	43.0 (10.3)	41.5 (10.1)
Marital status, *n* (%)		
Married/living with partner	96 (79.3)	104 (84.6)
Level of education, *n* (%)		
No/primary education	5 (4.1)	2 (1.6)
Secondary education	31 (25.6)	47 (38.2)
Professional education	30 (24.8)	35 (28.5)
University education	55 (45.4)	39 (31.7)
Household income *n* (%)		
≤€2800	22 (18.2)	31 (25.2)
€2800–4000	24 (19.8)	41 (33.3)
>€4000	59 (48.8)	45 (36.6)
Unknown	16 (13.2)	6 (4.9)
Employment characteristics		
Years in the company, mean (SD)	14.2 (10.2)	11.8 (9.9)
Working hours/week (contract), mean (SD)	34.5 (4.6)	33.7 (4.7)
Sickness absenteeism from paid work,* *n* (%)	35 (28.9)	26 (21.1)
Presenteeism,* *n* (%)	43 (35.5)	53 (43.1)
Health characteristics		
BMI, kg m^{-2}	25.5 (4.5)	25.8 (4.3)
Musculoskeletal complaints	43 (35.5)	48 (39.0)
Objectively measured overall sitting time, standing time, and step counts		
Overall sitting time, mean h/16-hr day (SD)	10.1 (1.3)	10.0 (1.2)
Standing time, mean h/16-hr day (SD)	4.1 (1.1)	4.1 (1.0)
Step counts, mean steps/16-h day (SD)	9,462 (2,591)	9,685 (3,106)

n, number of participants; SD, standard deviation.
*Measured by iMTA Productivity Cost Questionnaire.

TABLE 2. Mean Effects and Costs by Group and Mean Difference at 8-month Follow-up

	Intervention Mean (SE)	Control Mean (SE)	Mean Difference[a] (95% CI)
Effects			
Overall sitting time (h/16-hr day)	10.20 (0.15)	10.15 (0.12)	0.034 (−0.301; 0.369)
Standing time (h/16-hr day)	3.90 (0.12)	4.03 (0.10)	−0.120 (−0.366; 0.127)
Step counts (steps/16-hr day)	9,474 (381)	8,956 (308)	0.643 (−20; 21)
QALY's gained	0.600 (0.006)	0.596 (0.005)	−0.001 (−0.013; 0.010)
Costs			
Intervention costs per worker	284 (NA)	0	284 (NA)
Primary health care costs	182 (34)	202 (32)	−20 (−94; 59)
Secondary health care costs	106 (32)	252 (70_	−146 (−316; −27)*
Medication costs	214 (147)	52 (24)	162 (24; 533)*
Total healthcare utilization costs	502 (158)	506 (96)	−4 (−258; 333)
Informal care costs	0	0	0
Sickness absenteeism costs from paid work	783 (265)	1,001 (283)	−218 (−952; 507)
Sickness absenteeism costs from unpaid work	257 (70)	610 (169)	−353 (−670; −109)*
Presenteeism costs	577 (116)	1,280 (294)	−703 (−1,361; −264)*
Total lost productivity costs	1,617 (328)	2,891 (537)	−1,274 (−2,632; −248)*
Total societal costs	2,403 (380)	3,397 (598)	−994 (−2,487; 160)

CI, confidence interval; QALY, quality-adjusted life-years; SE, standard error.
[a]Adjusted for the effect outcome at baseline.
*Statistically significant.

willingness-to-pay of 0€/unit of effect gained. At a willingness-to-pay threshold of 20,000€/QALY gained (Fig. 1), which is recommended by the Dutch Health Care Institute, the probability that the intervention was cost-effective in comparison with control was 0.90.[36] The probability of cost-effectiveness decreased with increasing willingness-to-pay thresholds for all effect outcomes, because costs in the intervention group were on average lower than in the control group. This means that it is inefficient to invest additional resources in this specific intervention.

TABLE 3. Results of the Cost-effectiveness Analysis (Societal Perspective)

Effect Outcome	Societal Costs Difference, € (95% CI)	Effect Difference (95% CI)	ICER€/Effect Gained	Distribution of the Cost-Effectiveness Plane: North-East	South-East	South-West	North-West
Main analysis							
Overall sitting time (h/16-h day)	−994 (−2,487; 160)	−0.034* (−0.369; 0.301)	29246	2%	40%	53%	5%
Standing time (h/16-h day)	−994 (−2,487; 160)	−0.120 (−0.366; 0.127)	8295	1%	16%	77%	6%
Step counts (1,000/16-h day)	−994 (−2,487; 160)	0.643 (−20; 21)	−1545	7%	89%	4%	0%
QALY	−994 (−2,487; 160)	−0.001 (−0.013; 0.010)	777691	2%	40%	53%	5%
SA1							
Overall sitting time (h/16-h day)	−1,101 (−2,621; 45)	−0.061* (−0.374; 0.253)	18100	1%	34%	61%	4%
QALY	−1,101 (−2,619; 54)	−0.003 (−0.014; 0.008)	380615	1%	29%	65%	5%
SA2							
Overall sitting time (h/16-h day)	−1,108 (−2,360; −64)	−0.034* (−0.372; 0.304)	32718	1%	41%	56%	2%
QALY	−1,109 (−1,377; −72)	−0.001 (−0.013; 0.011)	952012	1%	42%	55%	2%
SA3							
Overall sitting time (h/16-h day)	−129 (−2,116; 2,089)	−0.034* (−0.372; 0.305)	3827	18%	24%	32%	26%
QALY	−129 (−2,136; 2,093)	−0.001* (−0.013; 0.010)	93713	17%	24%	32%	27%
SA4							
Overall sitting time (h/16-h day)	−1,352 (−3,256; 51)	−0.061 (−0.374; 0.253)	22220	2%	34%	61%	4%
QALY	−1,352 (−3,242; 85)	−0.003 (−0.014; 0.008)	453610	1%	29%	65%	5%
SA5							
Overall sitting time (h/16-h day)	466 (−472; 1,756)	0.083 (−0.277; 0.455)	5605	51%	15%	6%	28%
QALY	459 (−473; 1,742)	−0.012 (−0.022; 0.002)	−39474	1%	0%	20%	79%

Main analysis: sickness absenteeism costs from paid work based on company records using FCA.
SA1 = sensitivity analysis 1: main analysis leaving out the four workers on sick leave at the start of the intervention (intervention $n = 120$; control $n = 120$).
SA2 = sensitivity analysis 2 absenteeism costs from paid work based on self-reported data using FCA.
SA3 = sensitivity analysis 3: absenteeism costs from paid work based on company records using the HCA.
SA4 = sensitivity analysis 4: absenteeism costs from paid work based on company records using the HCA leaving out the four workers on sick leave at the start of the intervention (intervention $n = 120$; control $n = 120$).
SA5 = sensitivity analysis 5: main analysis including only workers with complete data for overall sitting time, QALYs and societal costs (intervention $n = 61$; control $n = 63$).
CI, confidence interval; ICER, incremental cost-effectiveness ratio; FCA, friction cost approach; HCA, human capital approach; QALY, Quality-adjusted Life-Years.
*Overall sitting time was multiplied by −1 in the cost-effectiveness analysis to keep the CE-plane and CEAC interpretable.

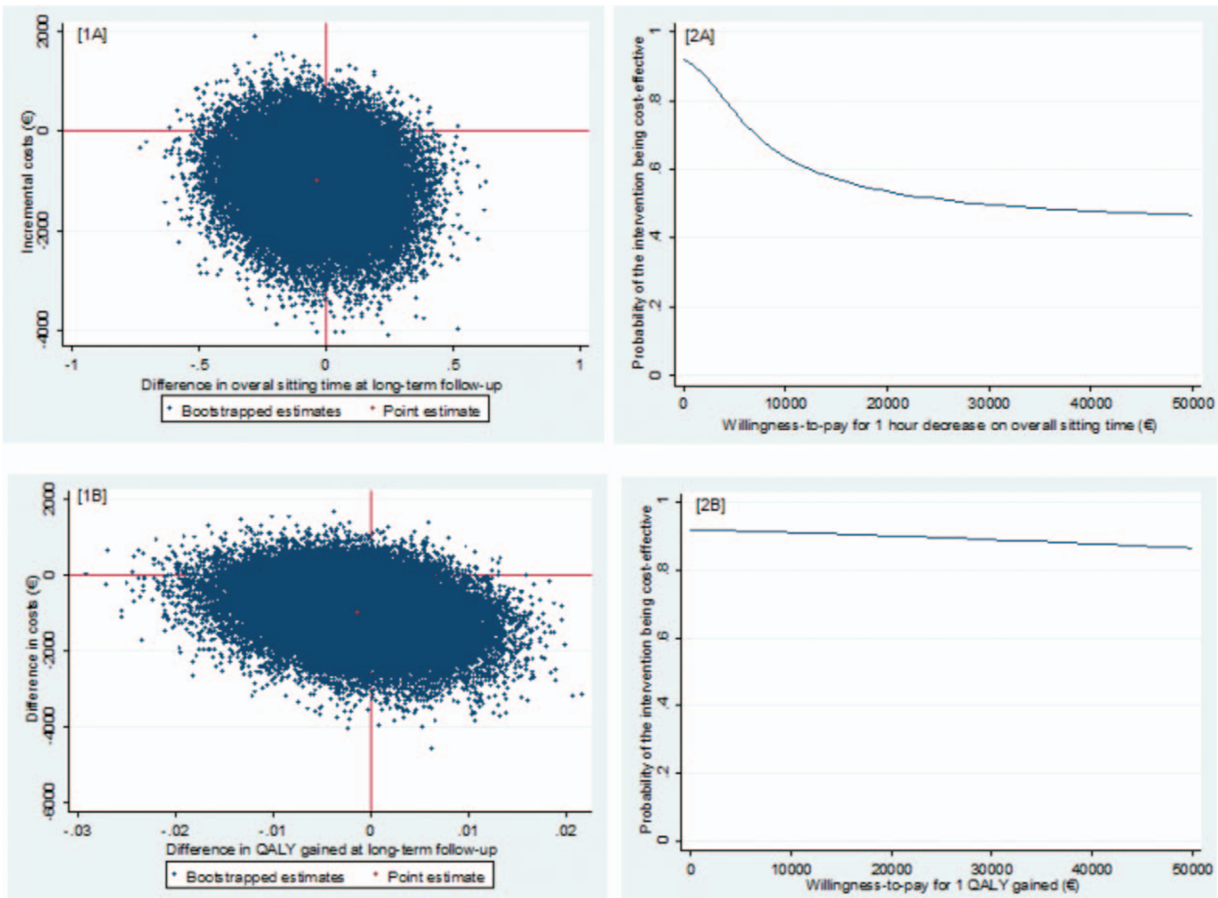

FIGURE 1. Cost-effectiveness planes [1] and cost-acceptability curves [2]. [1A] Cost-effectiveness plane indicating the uncertainty around the point estimate of the incremental cost-effectiveness ratio regarding overall sitting time. [2A] Cost acceptability curve indicating the probability of cost-effectiveness for different willingness-to-pay thresholds per unit of overall sitting time gained. [1B] Cost-effectiveness plane indicating the uncertainty around the point estimate of the incremental cost-effectiveness ratio regarding QALY. [2B] Cost acceptability curve indicating the probability of cost-effectiveness for different willingness-to-pay thresholds per unit of QALY gained. QALY, quality-adjusted life years.

Employer's Perspective: ROI Analysis

At 8-month follow-up, the intervention's monetary benefit per worker was €922 (95% CI, −79; 2,092), indicating that on average the intervention may result in financial benefits for the employer, but this was not statistically significant (Table 4). The NB was on average €637 per worker (95% CI, −394; 1770), suggesting a net financial gain to the employer of €637, although this was not statistically significant. The BCR (eg, amount of money returned per invested euro) and ROI (eg, percentage of profit per invested euro) were 3.24 (95% CI, −0.39; 7.22) and 224% (95% CI, −139; 622), respectively, but these results were not statistically significant either. Nevertheless, 86% of bootstrapped replications resulted in an NB more than zero indicating that the probability of financial return to the employer was relatively high.

Sensitivity Analyses

The results of SA1 and SA2 were similar to those of the main analyses (Tables 3 and 4). When using the HCA to calculate sickness absenteeism costs from paid work (SA3), the savings in lost productivity costs in the intervention group compared with control became smaller. As a result, the probability of the intervention being cost-effective at a willingness-to-pay of 0€/unit of effect gained decreased from 0.92 (main analysis) to 0.55 and the probability of financial return decreased from 0.86 (main analysis) to 0.43 (Table 4). However, when a sensitivity analysis was performed using the HCA without the four participants who went on sick leave during intervention period (SA4), the probability of the intervention being cost-effective was 0.93 at a willingness-to-pay of 0€/unit of effect gained and the probability of financial return was 0.89 (Table 4), which were similar to the results of the main analyses. In SA5, the probability of the intervention being cost-effective decreased from 0.88 (main analysis) to 0.20 at a willingness-to-pay of 0€/unit of effect gained, whereas the intervention's probability of financial return only slightly changed from 0.85 (main analysis) to 0.77 (Table 4).

DISCUSSION

Summary of the Main Findings

The present study evaluated the cost-effectiveness and ROI of the DW intervention compared with usual practice. Even though the intervention showed no statistically significant differences in effects and in costs individually, the current analyses suggest that the intervention is likely to be cost-effective from a societal perspective and might provide a financial return from the employer perspective. This was due to statistically significantly lower productivity-related costs in the intervention group compared with the control group,

TABLE 4. Intervention Costs, Benefits, Net Benefits, Benefit Cost Ratio, and Return-On-Investment Per Worker (Employer's Perspective)

	Costs, €	Mean Difference Benefit Costs, € (95% CI)			Financial Return			
	Inter-vention	Sickness Absenteeism Costs from Paid Work	Presenteeism Costs	Total Benefit Costs	NB, € (95% CI)	BCR, € (95% CI)	ROI % (95% CI)	Prob. FR
Main analysis	284	218 (−507; 952)	703 (264; 1,361)	922 (−79; 2,092)	637 (−394; 1,770)	3.24 (−0.39; 7.22)	224 (−139; 622)	0.86
SA1	284	224 (−505; 971)	726 (289; 1,398)	950 (−105; 2,105)	666 (−410; 1,786)	3.34 (−0.44; 7.28)	234 (−144; 628)	0.87
SA2	284	334 (−190; 920)	703 (264; 1,361)	1,037 (212; 1955)	752 (−93; 1,646)	3.65 (0.67; 6.79)	265 (−33; 579)	0.95
SA3	284	−646 (−2,700; 774)	703 (264; 1,361)	57 (−2,038; 1,847)	−227 (−2,220; 1,659)	0.20 (−6.81; 6.83)	−80 (−781; 583)	0.43
SA4	284	474 (−527; 1,719)	726 (289; 1,398)	1200 (−141; 2,694)	916 (−457; 2,376)	4.22 (−0.61; 9.36)	322 (−161; 836)	0.89
SA5	284	320 (−381; 1,188)	442 (−11; 1,438)	762 (−320; 2,228)	478 (−660; 1,832)	2.68 (−1.32; 7.44)	168 (−232; 644)	0.77

Main analysis: sickness absenteeism costs from paid based on company records using the FCA.
SA1 = sensitivity analysis 1: main analysis leaving out the four respondents on sick leave at the start of the intervention (intervention $n = 120$; control $n = 120$).
SA2 = sensitivity analysis 2: sickness absenteeism costs from paid work based on self-reported data using FCA.
SA3 = sensitivity analysis 3: sickness absenteeism costs from paid work based on company records using the HCA.
SA4 = sensitivity analysis 4: sickness absenteeism costs from paid work based on company records using the HCA leaving out the four workers on sick leave at the start of the intervention (intervention $n = 120$; control $n = 120$).
SA5 = sensitivity analysis 5: main analysis including only workers with complete absenteeism and presenteeism data (intervention $n = 82$; control $n = 83$).
NB: Net Benefit = Benefits – Costs (Net loss/Net savings).
BCR: Benefit-Cost Ratio = Benefits/Costs (amount of money returned per monetary unit invested).
ROI: Return-On-Investment = (Benefits – Costs)/Costs [×100%] (percentage of profit per monetary unit invested).
FCA, friction cost approach; HCA, Human Capital Approach; Prob. FR, probability of financial return.

which was mainly driven by lower presenteeism costs. These results were confirmed in the sensitivity analyses.

It is remarkable that our findings show that the intervention is less costly than control as a result of significantly lower presenteeism costs, whereas there are no relevant differences in effects. It is unclear how this finding can be explained. It is possible that employees value the investment their employer makes in making their working environment healthier (ie, Hawthorne effect), and that this results in higher efficiency while at work. It can also not be ruled out that the relevant improvement in daily step counts, which was statistically significant at baseline, 4- and 8-months follow-up,[35] might have contributed to lower lost productivity costs. However, this is purely speculative and should be tested in future research including qualitative evaluation of similar interventions.

Comparison with Other Studies

Only one previous study evaluated the cost-effectiveness of a similar multi-component intervention. Gao et al[13] showed that the Stand-Up Victoria intervention was more costly and significantly more effective compared with no intervention for decreasing overall sitting time. This is in contrast with our study that showed no significant differences in costs and effects of the DW intervention group compared with control group. Three potential explanations for the different findings may be drawn. First, the Stand-Up Victoria intervention was more intensive (ie, providing all participants with sit-stand desks and extensive one-on-one coaching sessions) compared with the less intensive DW intervention (ie, consisting of partial replacement of sitting desks with sit-stand desks and group coaching sessions). Second, the Stand-Up Victoria intervention was compared with no intervention, whereas the DW intervention was compared with usual practice (ie, consisting of prompts to use the stairs, walking routes and telephone routes with footsteps on the floor, and lunch bags to take along on a lunch walk). Third, we included both presenteeism as well as absenteeism costs, while Gao et al[13] only included absenteeism costs making it difficult to compare cost outcomes.

Strengths and Limitations

This study has a number of strengths. First, it was performed alongside a pragmatic cluster randomized controlled trial,[35] which is considered the best vehicle for economic evaluations because it reflects real life conditions and allows the prospective collection of cost and effect data. Second, the CEA was conducted from a societal perspective meaning that all relevant costs categories (ie, costs related to intervention, healthcare utilization, informal care, and productivity losses) were included in the analysis.[16] Third, a ROI analysis was performed from the employer's perspective, which included both costs related to work absenteeism and presenteeism due to sickness. For employers, an intervention's effect on their company's bottom line is highly important and presenteeism is particularly important because in chronic health conditions presenteeism costs may exceed sickness absenteeism costs. Fourth, we used company record data to assess sickness absenteeism, which we could use to verify self-reported sickness absenteeism data.

This study also has some limitations. First, the intervention delivery was delayed. As a result, four participants were absent from paid work due to sickness at the start of the intervention. However, the friction cost approach assumed that these employees were replaced at the time the intervention started, so that there were no productivity losses anymore. Second, as with many preventive interventions, one may argue that a follow-up period of 8 months may be too short to assess potential effects. However, as the intervention's effects at 8-month follow-up were relatively small and not statistically significant, we do not expect larger intervention effects at longer follow-up durations. Moreover, the uptake of the intervention was relatively low, with preliminary process evaluation results showing that almost half of the participants in the intervention group never made use of the workstations and in general adherence rates to these types of interventions decline over time.[12] Third, the cost questionnaires included retrospective questions about a 4-month period, which may have caused recall bias. However, we assume that this bias is equally distributed across the two groups and will, therefore, not impact the difference between groups. In addition, comparison of sickness absenteeism costs from paid work between company records and self-reported data showed little differences between the two methods suggesting that recall bias was limited. Fourth, we needed to rely on self-reported presenteeism data since there is no golden standard for measuring it objectively.[37] Nevertheless, we used a standardized instrument that has been applied in several economic evaluations.[22]

Fifth, it is unknown whether the results may be generalized to other companies, as the DW intervention was developed and implemented in only one company. By using Dutch average mean wages instead of company-specific wages to calculate lost productivity costs, we tried to partly overcome this limitation. However, to calculate intervention costs we did use company-specific wages. Sixth, it is unknown whether the current findings are generalizability to the complete target population, because self-selection bias may have resulted from up front differences between the 304 workers who agreed to participate and the 303 workers (ie, out of the total 607) who chose not to participate. Unfortunately, we do not have information about the workers who decided not to participate. Amongst others, it might be possible that the included participants represented a population that was already active at baseline (ie, almost 10,000 steps/d), leaving little room for improvement.

CONCLUSION

The multi-component DW Intervention is likely to be cost-effective from a societal perspective and it might provide a financial return from an employer perspective compared with usual practice. Considering the non-significant effect of the DW intervention on main effect outcomes, the intervention in its current form should probably not be widely implemented, despite the positive effects on lost productivity costs. However, a more intensive version of the intervention that would replace all sitting desks with sit-stand desks, such as two recently published multi-component workplace interventions did,[11,13] is more likely to be effective as well as cost-effective. Also, more research is needed to understand the underlying mechanism behind the impact of the intervention on presenteeism and whether these results are generalizable to other companies.

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