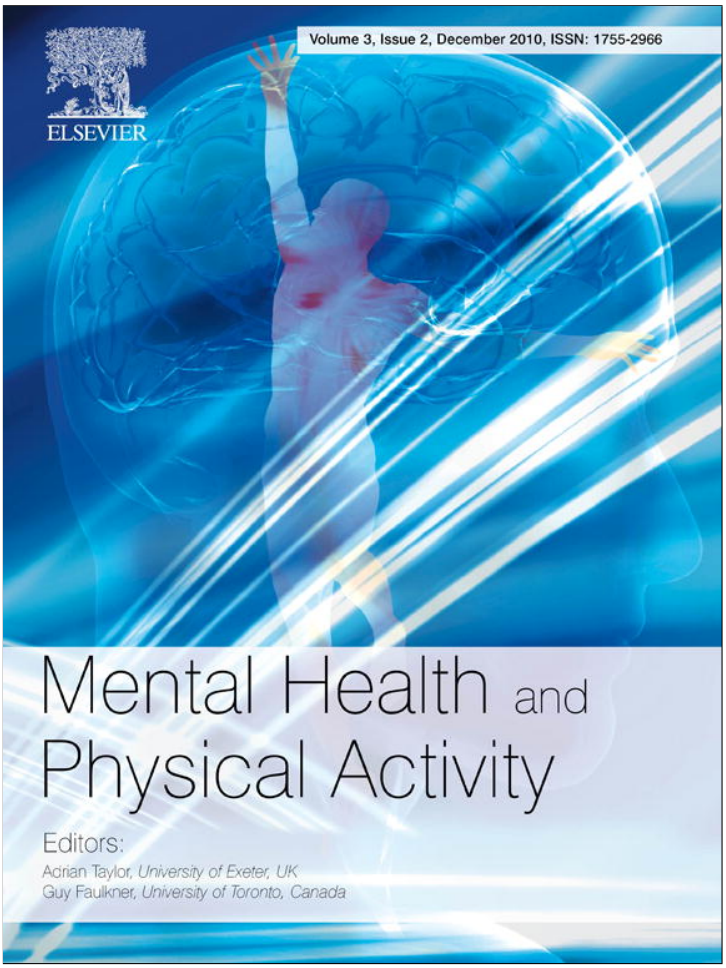

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Workplace exercise intervention to prevent depression: A pilot randomized controlled trial☆

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ABSTRACT

Objective: This study evaluates whether it is feasible to deliver an exercise program to inactive employees with minimal symptoms of depression, and the size of effects on the mental and physical health of employees.
Method: In the fall of 2008, 30 white-collar employees with minimal symptoms of depression ($5 \leq$ PHQ-9 ≤ 9) were randomly assigned to a 10-week in-company fitness program with two supervised training sessions per week or to a control group. Demographics, depression scores, and exercise behavior were determined by questionnaire, physical health variables were measured and company records were checked to calculate sickness absence data. Participants were measured at baseline and 10 weeks after (post-test).
Results: ANCOVA showed that the difference between the groups on the average change in depression from baseline to post-test approached significance. Eighty-six percent of the participants in the exercise group were below the cut-off point for experiencing minimal symptoms of depression, compared with 31% of the control participants. Most physical measures improved significantly from baseline to post-test in the exercise group compared to the control group. The difference between the groups on average change in sickness absence was not significant.
Conclusions: This intervention was feasible and shows that exercise can reduce the risk of depression in employees with sedentary jobs, an inactive lifestyle, and a high-risk of depression. A large randomized controlled trial with a long-term follow-up is needed to establish the effectiveness and cost-effectiveness of exercise in the prevention of depression in a workplace setting.

1. Introduction

The World Health Organization has estimated that depression affects nearly 121 million people worldwide (WHO, 2001). In the Netherlands, approximately 685,000 people between 18 and 65 years of age (6.6% of the population) suffer from depression annually, and the lifetime prevalence is 19% (Bijl, van Zessen, Ravelli, de Rijk, & Langendoen, 1998). A depressive disorder affects a person's wellbeing and impairs daily and professional functioning. Depression is common among employees: the prevalence of subclinical depressive symptoms in Dutch employees is 7.1% in men and 6.2% in women (Andrea et al., 2004), with an incidence of 3.3% (Andrea, Bültmann, van Amelsvoort, & Kant, 2009).

Depression leads not only to considerable direct costs (i.e., healthcare use) but also to substantial indirect costs such as reduced productivity, absenteeism, work disability, and early retirement (Ettner, Frank, & Kessler, 1997; Kessler et al., 2008; Lerner & Henke, 2008). In the Netherlands, the estimated total costs of depression in employees are between 1.3 and 2 billion euros (Koningsveld et al., 2003; Netherlands Institute of Mental Health and Addiction, 2007). Health promotion, including counseling, stress management, and improving the work environment, prevents depression among employees but reported effects are small (Martin, Sanderson, & Cocker, 2009). Physical activity interventions are another option, and studies have shown that exercise reduces depressive symptoms, at least in clinical populations (Brosse, Sheets, Lett, & Blumenthal, 2002; Craft, 2005; Lawlor & Hopker, 2001; Martinsen, 1994; Paluska & Schwenk, 2000). The calculated average effect size (d) is −0.8 (Rethorst, Wipfli, & Landers, 2009), although this effect is halved when only high-quality studies are included (Mead et al., 2009). An additional benefit of exercise is that it can improve fitness and work-related outcomes such as work

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attendance and job stress (Conn, Hafdahl, Cooper, Brown, & Lusk, 2009). However, few studies have investigated whether exercise has a preventive role in depression. A recent report from the Physical Activity Guidelines Advisory Committee (2008) concluded that evidence from prospective cohort studies shows that physical activity can protect against the onset of depression, with the odds of depression being on average 25–45% lower in physically active individuals than in inactive individuals. However, longitudinal studies have failed to find consistent effects of exercise on psychological symptoms in the general population (Brosse et al., 2002; Paluska & Schwenk, 2000). In order to assess whether exercise can prevent the development of depression in employees high-quality intervention studies are needed.

The purpose of this pilot study was to determine whether it is feasible to deliver an exercise program to inactive employees with minimal symptoms of depression, and the size of effects on the mental and physical health of employees. The results of this study will be used to design a larger trial to evaluate the effectiveness and cost-effectiveness of workplace exercise to prevent depression and related outcomes.

2. Method

2.1. Design

This pilot study was designed as a randomized controlled trial (RCT) and took place in the fall of 2008. After completing an online screening for subclinical depression, eligible employees gave their written informed consent. They completed a questionnaire and participated in a physical fitness test at the company's fitness center, where body mass index (BMI), waist circumference, fat percentage, and blood pressure were measured. Thereafter, they were randomly assigned (by drawing sealed envelopes) to the exercise group or the control group. Participants in the exercise group attended a 10-week exercise program that was free of charge and took place during working hours in the company's fitness center. Participants in the control group were asked not to change their exercise behavior and lifestyle during the study period. Ten weeks after the baseline measurement, a post-test assessment was carried out. Afterwards, all participants received exercise and lifestyle advice, and the participants in the control group were offered the opportunity to participate in the fitness program.

2.2. Participants

All employees of a large department of a major insurance company in the Netherlands were contacted via their work e-mail and asked to fill out an online screening questionnaire on 'exercise and mental health'. Inclusion criteria were willingness to participate in the exercise program, having minimal symptoms of depression (sub-threshold depression) based on a score of minimally 5 and maximally 9 on the Patient Health Questionnaire (PHQ-9), no history of psychological treatment, not being physically active according to current physical activity guidelines (Haskell et al., 2007), no intention to start with exercise during the study period, and no medical contraindications to exercise according to the Physical Activity Readiness Questionnaire (PARQ; Thomas, Reading, & Shephard, 1992).

2.3. Assessment tools

2.3.1. Depression

Depressive symptoms were evaluated with the PHQ-9 (depression scale of the PHQ; Spitzer, Kroenke, & Williams, 1999), which is a self-report questionnaire of nine questions for diagnosing depression, assessing its severity, and monitoring treatment response. The PHQ-9 has a high internal consistency ($\alpha = 0.84$) (Cameron, Crawford, Lawton, & Reid, 2008) and is very sensitive to changes in the severity of a depression (Löwe, Kroenke, Herzog, & Gräfe, 2004). Answers are given on a Likert scale ranging from 0 to 3 (not at all, several days, more than half the days, nearly every day) and summed into an overall score ranging from 0 to 27. Higher scores indicate more severe depression. The PHQ-9 manual distinguishes five categories of scores: no depression (0–4), minimal symptoms of depression (5–9), mild depression (10–14), moderately severe depression (15–19), and severe depression (20–27). In this study, a recently validated Dutch version of the Patient Health Questionnaire depression scale was used (Wittkampf et al., 2009).

2.3.2. Physical measures, exercise behavior and sick leave

Weight, height, waist circumference, and body fat percentage were measured using standardized protocols. Waist circumference was measured twice with a tape measure (Gulick, Creative Health Products, USA) at the midpoint between the lower border of the ribs and the upper border of the pelvis. The percentage of body fat was calculated from the sum of the thickness of four skinfolds (biceps, triceps, suprailiac, and subscapular) measured twice on the right side of the body using a caliper (Harpenden, HSK-BI, Baty International, UK). The body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

Systolic and diastolic blood pressure was measured twice at rest, according to protocol, using a manual blood pressure meter (Omron M-6, Omron Healthcare Europe BV, The Netherlands). The resting heart rate was measured after approximately 5 min of sitting at rest, using a heart rate monitor (Polar, Electro Oy, Finland). The submaximal Åstrand test (Åstrand, 1960) was used to predict maximum oxygen uptake (VO_2max). The test was performed on a stationary bicycle (Monark 818E, Monark Exercise AB, Sweden), and the mean heart rate (bpm) of the last 2 min of the test was used to estimate the VO_2max (Åstrand & Rhyming, 1954).

Physical activity was determined using a validated Dutch questionnaire on the current physical activity guidelines (Douwes & Hildebrandt, 2000). Participants were asked 'When looking back at the last month and thinking of a normal week: 1) on how many days of the week were you physically active at a moderate intensity for at least 30 min? (0–7 days a week), 2) How many times were you physically active at a high intensity for at least a continuous 20 min? (0–10 times a week)?'. A participant was classified as physically active if he/she met the criteria for moderate-intensity physical activity (exercise at a moderate intensity at least five times a week for at least 30 min) or vigorous-intensity physical activity (exercise at a high intensity at least three times a week for at least 20 min) (Haskell et al., 2007).

Sickness absence was calculated by checking company records for the number of days a participant was absent from work during the 10-week study period and during the same period the previous year.

2.4. Exercise program

Participants in the exercise group attended two supervised exercise sessions per week for 10 consecutive weeks. An individual training program was designed for each participant based on the results of the baseline physical fitness test. For each participant, a training session began with a 10-min warming-up, including cardiovascular and stretching exercises, followed by 10 min of power training. Subsequently, the training included 10–20 min (duration increased with time) of cycling on a bicycle ergometer, jogging on a treadmill, walking on a cross-trainer, or climbing stairs on a pedal stepper. The exercise program ended with 10 min

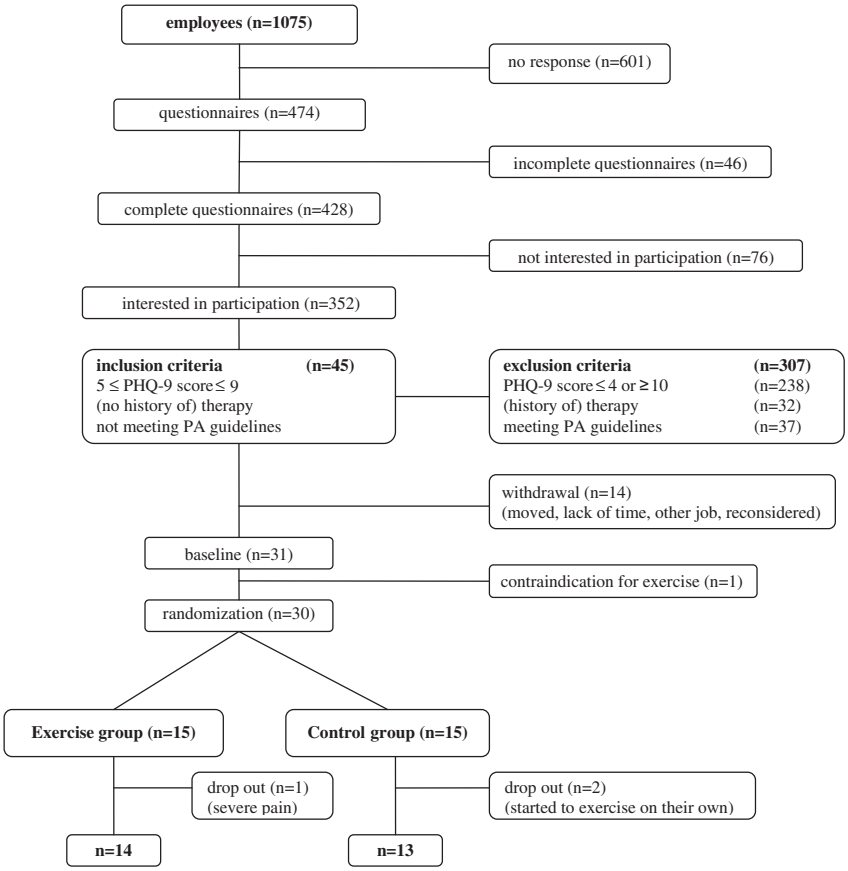

Fig. 1. Flowchart of the participants. PHQ-9, Patient Health Questionnaire; PA, physical activity.

cooling down, including sit-ups and relaxation exercises. Exercises were done in groups of approximately eight people and under the guidance of a professional instructor. Heart rate was continuously monitored during the exercise program using a heart rate monitor (Polar, Electro Oy, Finland). Participants exercised at 60% of their maximum heart rate during warming-up and at 80% of their maximum heart rate during cardiovascular training. Compliance was recorded and participants were contacted by phone or e-mail if they missed a session to prevent drop-out from the intervention. To encourage lifestyle daily physical activity, the instructor talked about the beneficial aspects of having a physically active lifestyle outside the exercise sessions, without giving direct advice on types and frequency of activities.

2.5. Analyses

Descriptive data were determined for the baseline characteristics, and differences between the control and the exercise groups were tested using a *t*-test for the continuous variables and a χ^2 test for the categorical variables. Variables with significant differences between the exercise group and the control group were treated as covariates in all further ANCOVAs. Change scores were computed for all outcome variables by subtracting the baseline score from the post-test score. For the primary outcome variable (depression), also an imputed change score was computed using baseline value carried forward to follow-up. Differences between the groups in average change score were tested using ANCOVAs, with the change score as dependent variable, the group-variable as independent, and variables showing significant baseline differences as covariates. Assumptions of the ANCOVA analyses, i.e., normally distributed residuals and homogeneity of regression slopes, were checked. A χ^2 test was used to determine the effect of the exercise program on physical activity and the presence of minimal symptoms of depression. Effect sizes were calculated by taking the square root of the division of the difference between the mean change score between the exercise group and the control group by the pooled standard deviation of the change scores.[1] Standard errors of the effect sizes were calculated using the effect size and the number of participants in both the control and the exercise group.[2] An effect size of 0.2 is considered a small effect, an effect size of 0.5 a medium effect, and an effect size of 0.8 or more is considered a large effect (Cohen, 1988). All data were checked and analyzed using the Statistical Package for the Social Sciences (SPSS 16.0). For all analyses, two-tailed *p*-values of <0.05 indicated statistical significance.

[1] Formula of computation of standardized mean change score difference between experimental group (=group 1) and control group (=group 2):

$$ES_{change} = \frac{\overline{x}_{change,group1} - \overline{x}_{change,group2}}{s_{change,pooled}}, \quad \text{where } s_{change,pooled} = \sqrt{\frac{(n_1 - 1) \times SD^2_{change,group1} + (n_2 - 1) \times SD^2_{change,group2}}{n_1 + n_2 - 2}}$$

[2] Formula of computation of the standard error of the effect size:

$$SE_{ES_{change}} = \sqrt{\frac{1}{n_1} + \frac{1}{n_2} + \frac{ES^2_{change}}{2(n_1 + n_2)}}$$

Table 1
Baseline characteristics of the exercise and control group.

Variable	Exercise group ($n = 15$)	Control group ($n = 15$)
	n (%) or mean (SD)	n (%) or mean (SD)
Demographics		
Sex (male) (n)	9 (60)	7 (47)
Age (years)	41.3 (6.5)	41.0 (8.3)
Working hours (hours/wk)	33.7 (4.9)	31.8 (7.5)
Depression		
No symptoms (n)	12 (80)	14 (93)
No history of symptoms (n)	11 (73)	13 (87)
PHQ-9 (score)	6.2 (1.5)	6.8 (1.5)
Physical measures		
Height (cm)	174.9 (6.5)	173.8 (12.3)
Weight (kg)	93.5 (20.5)	84.3 (18.7)
BMI ($kg \cdot m^{-2}$)	30.5 (6.1)	27.9 (5.7)
Waist circumference (cm)	101.8 (15.6)	93.3 (11.5)
Fat percentage (%)	29.4 (10.5)	29.6 (7.2)
Systolic blood pressure (mmHg)	132.7 (12.9)	126.1 (14.6)
Diastolic blood pressure (mmHg)	86.3 (9.7)	82.5 (7.0)
Resting heart rate (bpm)	72.5 (12.9)	69.1 (11.1)
VO_2max ($ml \cdot O_2^{-1} \cdot kg^{-1}$)	29.7 (8.4)	32.3 (10.6)
Exercise behavior		
Moderate-intensity PA (days/wk)[a]	1.9 (1.0)	2.0 (1.3)
Vigorous-intensity PA (times/wk)[b]	0.7 (0.8)	1.3 (0.6)*
Sickness absence		
Sickness absence (days/10 wks)	1.8 (3.6)	2.0 (2.7)

SD = standard deviation; difference between exercise group and control group: *$p < 0.05$.
[a] Physical activity (PA) of at least moderate intensity for at least 30 min.
[b] Intensive physical activity (PA) of at least 20 min.

3. Results

3.1. Participants

In total, 474 of the 1075 contacted employees (44.1%) returned the online screening questionnaire, and 428 of these questionnaires were complete (Fig. 1). Forty-five individuals who met the inclusion criteria were invited to participate in the study, of whom 31 agreed to participate and completed the baseline measurements. The baseline measurements (sex, age, working hours, psychological complaints, PHQ-9 score, moderate-intensity physical activity, vigorous-intensity physical activity) of the employees who did not agree to participate in the study ($n = 14$) did not differ significantly from those of the study participants. The baseline characteristics of the exercise group and the control group (Table 1) only differed significantly with respect to vigorous-intensity physical activity: on the basis of the self-report information, the participants in the control group exercised more often at a high intensity than did the participants in the exercise group. This variable was therefore treated as a covariate in further analysis. One participant was excluded from the study before randomization on advice from his physician. After randomization, two participants in the control group were excluded because of their intention to start exercising on their own during the study period (Fig. 1). During the exercise program, one participant experienced severe pain from a previous back injury and could not continue exercising. Results of those participants randomized into either the exercise or the control group who had participated in both the pre- and post-test measurement were analyzed ($n = 27$). In addition, an intention-to-treat analysis was performed for the primary outcome variable.

3.2. Depression

At the end of the 10-week exercise program, depression scores were lower in the participants of the exercise group than in the participants of the control group (Fig. 2). ANCOVA showed that the difference between the groups in average decrease in PHQ-9 depression scores approached significance ($p = 0.07$ and $p = 0.06$, for the completers and intention-to-treat analysis, respectively), with an effect size of −0.90, indicating a large effect (Table 2). Items of the PHQ-9 that improved significantly over time in the exercise group were 'depressed or hopeless' ($p = 0.019$), 'sleeping problems' ($p = 0.003$), 'feeling bad about self' ($p = 0.003$), and 'concentration problems' ($p = 0.009$). After completion of the exercise program, 2 out of 14 participants (14%) in the exercise group experienced symptoms of depression (PHQ-9 score of 5 or higher) compared with 9 out of 13 participants (69%) in the control group ($\chi^2 = 8.43$, $df = 1$, $p = 0.004$). The intention-to-treat analysis revealed that 3 out of 15 participants (20%) in the exercise group experienced symptoms of depression (PHQ-9 score of 5 or higher), compared with 11 out of 15 participants (73%) in the control group ($\chi^2 = 8.57$, $df = 1$, $p = 0.003$).

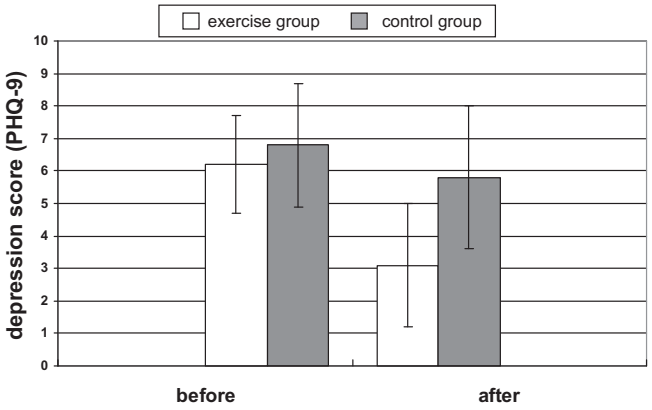

Fig. 2. Mean depression scores on the Patient Health Questionnaire (PHQ-9) in the exercise and control group before and after the intervention period. Higher scores indicate more severe depression. A score of 5–9 is indicative of having minimal symptoms of depression.

3.3. Physical measures, exercise behavior and sickness absence

There was a significant difference in the change scores of most of the physical measures between both groups in favor of the exercise group (Table 2). Besides, the participants in the exercise group showed an increase in their time spent on exercising at moderate- (days/wk) and vigorous-intensity (times/wk). During the exercise program, 8 out of 14 participants (57%) in the exercise group were physically active according to the criteria for moderate- or vigorous-intensity physical activity compared to 1 out of 13 (8%) in the control group ($\chi^2 = 7.42$, $df = 1$, $p = 0.006$). On average, participants in the exercise group were present at 16 out of 19 supervised sessions (range 9–19), resulting in a mean compliance of 84.6% (SD 13.6).

22 out of 27 participants gave permission to use their company sickness absence records for this study (Table 2). The average change in sickness absence in the exercise group did not differ significantly from the average change in the control group.

4. Discussion

This pilot study showed that it is feasible to screen and recruit employees with a high-risk of depression in a workplace setting using an online questionnaire. About ten percent of the employees returning the screening questionnaire met all inclusion criteria and were eligible for participation.

Table 2
Observed means for depression, physical measures, exercise behavior questions, and sickness absence; ANCOVA results (change score was used as dependent variable and baseline vigorous-intensity PA was used as covariate) and effect sizes of the differences between the groups on the change scores.

Variable	Observed mean (SD)				Observed change score (SD)		Effect size (SE)
	Exercise group		Control group		Exercise group ($n = 14$)	Control group ($n = 13$)[a]	
	Before ($n = 15$)	After ($n = 14$)	Before ($n = 15$)	After ($n = 13$)[a]			
Depression (score)	6.2 (1.5)	3.1 (1.9)	6.8 (1.5)	5.8 (2.2)	−3.1 (2.1)	−1.0 (2.5)^	−0.90 (0.40)
BMI ($kg \cdot m^{-2}$)	30.5 (6.1)	29.1 (5.8)	27.9 (5.7)	27.8 (6.3)	−1.5 (1.3)	0.0 (0.5)**	−1.52 (0.45)
Waist circumference (cm)	101.8 (15.6)	96.9 (14.1)	93.3 (11.5)	93.8 (13.5)	−4.6 (3.2)	0.4 (2.1)**	−1.80 (0.47)
Fat percentage (%)	29.4 (10.5)	25.8 (9.9)	29.6 (7.1)	29.9 (7.6)	−3.6 (2.6)	0.3 (1.7)**	−1.74 (0.46)
Systolic blood pressure (mmHg)	132.7 (12.9)	127.1 (10.1)	126.1 (14.6)	125.4 (10.5)	−6.4 (7.4)	−1.7 (9.8)	−0.55 (0.40)
Diastolic blood pressure (mmHg)	86.3 (9.7)	83.6 (12.0)	82.5 (7.0)	84.6 (8.4)	−3.2 (8.7)	2.1 (5.0)^	−0.73 (0.41)
Resting heart rate (bpm)	72.5 (12.9)	64.6 (8.3)	69.1 (11.1)	69.2 (13.7)	−8.9 (7.4)	2.3 (8.3)**	−1.44 (0.44)
VO_2max ($ml \cdot O_2^{-1} \cdot kg^{-1}$)	29.7 (8.4)	36.8 (10.3)	32.3 (10.6)	32.4 (9.6)	7.4 (4.7)	−0.6 (5.7)**	1.55 (0.45)
Moderate-intensity PA (days/wk)[b]	1.9 (1.0)	3.6 (1.5)	2.0 (1.3)	2.5 (1.6)	1.6 (1.7)	0.3 (1.5)*	0.82 (0.40)
Vigorous-intensity PA (times/wk)[c]	0.7 (0.8)	2.7 (1.5)	1.3 (0.6)	1.2 (1.0)	2.1 (1.4)	−0.2 (0.9)**	1.89 (0.46)
Sickness absence (days/10 wks)[d]	1.8 (3.6)	0.8 (1.1)	2.0 (2.7)	1.9 (2.2)	−1.1 (3.8)	−0.1 (2.6)	−0.30 (0.43)

SD = standard deviation; SE = standard error. Difference between exercise group and control group: $^{\wedge}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$.

[a] One control group participant could not attend the post-test physical measurements; therefore 12 participants were included in the ANCOVA analysis for BMI, waist circumference, fat percentage, blood pressure, resting heart rate and VO_2max.

[b] Physical activity (PA) of at least moderate intensity for at least 30 min.

[c] Intensive physical activity (PA) of at least 20 min.

[d] Sickness absence was based on comparison with the same 10-week period in the previous year. Due to refusal to release sickness absence records, 12 exercise group participants and 10 control group participants were analyzed.

Participation in the exercise program resulted in a larger average decrease in depression scores compared to the control group that approached significance. More importantly, 86% of the participants in the exercise group no longer experienced minimal symptoms of depression, compared to 31% of the participants in the control group. This result indicates a reduced risk of developing depression in the near future (Fergusson, Horwood, Ridder, & Beautrais, 2005; Judd et al., 1998). These results add to current knowledge about the relation between physical activity and mental health. Recent reviews conclude that there are strong indications that exercise reduces the severity of a depression in clinical populations (Brosse et al., 2002; Craft, 2005; Lawlor & Hopker, 2001; Paluska & Schwenk, 2000). To date, there have been no studies focusing on the effect of exercise on the mental health of people at high-risk of depression and its role in preventing depression, as also concluded by Physical Activity Guidelines Advisory Committee (2008).

To our knowledge, the current study is the first RCT involving employees with sedentary jobs and an inactive lifestyle, and who are at high-risk (presence of minimal symptoms) of developing depression. Other studies have reported exercise to have a beneficial effect on psychological complaints such as depression. One of these studies selected employees with minimal stress levels and compared a physical exercise and relaxation intervention with a cognitive intervention (van Rhenen, Blonk, van der Klink, van Dijk, & Schaufeli, 2005). It was concluded that both interventions were equally effective on psychological complaints (including depression), burnout and stress levels. Our results can help improve the effectiveness of current workplace interventions focusing on mental health, which nowadays mainly use counseling and management techniques (Conn et al., 2009; Martin et al., 2009).

The exercise program did not influence sickness absence. However, a significant effect could not be expected because of the small sample size, the short period studied, and the fact that sickness absence is a complicated outcome measure influenced by several factors. In comparison, another Dutch study focusing on workplace interventions to improve mental health reported minimal effects on sickness absence (van Rhenen, Blonk, Schaufeli, & van Dijk, 2007).

Although little is known about the level of exercise needed to influence depressive symptoms (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005), we estimated that a fitness program of two sessions/week for 10 weeks would be enough and, most importantly, feasible. The high level of compliance with the exercise program can probably be explained by the opportunity to exercise free of charge and during working hours at the company's fitness center.

There were some limitations to this study. First, more than half of the contacted employees (56%) did not respond to our screening questionnaire. It is not known how many participants with minimal symptoms of depression were missed, or whether a selection effect was present. A second limitation is the lack of a long-term follow-up. The results found at the post-test assessment might not be sustained in the long term if participants do not remain physically active. Although all participants were given an individual lifestyle advice at the end of the study, the effect of this advice on their physical activity in the long term has not been measured. Even so, getting an inactive group of employees physically active according to current guidelines is an important first step in achieving a healthier lifestyle. Further research is needed to study the long-term maintenance of physical activity.

The results of this small-scale study warrant replication in a large-scale RCT with a long follow-up and with a less controlled intervention that better reflects current practice.

5. Conclusion

The results of this study show that this intervention was feasible and that regular exercise can reduce the risk of depression in employees with sedentary jobs, an inactive lifestyle, and a high-risk of depression. A large RCT with a long-term follow-up is needed to confirm these positive findings, to determine the (cost-) effectiveness of this approach to preventing depression, and to determine the mechanisms involved in reducing the risk of depression.

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Conflict of interest statement

The authors declare that there are no conflicts of interest.

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