

The Effect of Intelligent Physical Exercise Training on Sickness Presenteeism and Absenteeism Among Office Workers

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Objective: The aim of this study was to investigate the effect of individually tailored intelligent physical exercise training (IPET) on presenteeism and absenteeism among office workers. **Methods:** In a 1-year randomized controlled trial (RCT), employees were allocated to a training group TG ($N=193$) or control group CG ($N=194$). TG received 1-hour high-intensity IPET once a week within working hours, and was recommended to perform 30 minutes of moderate-intensity physical activity (PA) 6 days a week during leisure-time. **Results:** An intention-to-treat analysis showed no effect on absenteeism, but a significant 4% increase in workability and 9% increase in general health in TG compared with CG. A per-protocol analysis [adherence of $\geq 70\%$ ($N=89$)] in addition showed a significant 6% increase in productivity and a 29% reduction in absenteeism compared with CG. **Conclusion:** IPET combined with recommendations of leisure-time PA significantly improved presenteeism and decreased absenteeism if following the protocol.

BACKGROUND

The importance and benefits of leisure time physical activity (PA) have for many years been well established in relation to the cardiovascular system,^{1,2} all-cause mortality,^{3–5} and recently also emphasized for maintaining musculoskeletal health.^{6,7} In the Western world today, sedentary work is the most common working condition for people between the age of 16 and 64.² Furthermore, the majority of people in the Western world are not sufficiently active (not meeting national recommendations for PA) and are therefore not achieving the related health benefits.^{8–10}

Physical inactivity has been reported as the fourth leading risk factor for mortality worldwide, and the workplace has thus been recommended as an ideal setting for health promotion.¹¹ Research has documented that exercise is more than medicine¹² and that physically inactive employees are less productive, have more sickness absence (SA), and a decreased workability when they are at work.^{13,14} Furthermore, studies by Jans et al¹⁵ show that office workers do not compensate for prolonged sitting at work by spending less time on sedentary leisure activities. Sickness-related time away from work—SA—obviously influences productivity and workability. However, being present at work in spite of bad health, sickness presenteeism (SP) may also impact an employee's productivity and workability, thereby hindering a 100%

performance on the job.^{16–19} SP includes time not spent on job tasks, a slower working pace, and decreased quality of work, meaning a decrease in the employee's productivity, which often is a hidden cost for employers.^{20,21} It is not uncommon that SP precedes or follows SA, but such a connection may not always be the case.²²

Only few high-quality physical exercise training studies have shown preliminary positive effects on SP^{19,23,24} and SA at the workplace.^{14,25–27} To our knowledge, it is not known whether a high-intensity tailored training intervention at the workplace can improve health-related measures to the extent of also resulting in improved SA and SP.

The aim of the present paper is to present a secondary data analysis of a randomized controlled trial (RCT), investigating the effect of individually tailored intelligent physical exercise training (IPET)²⁸ on SP and SA among office workers over a 1-year period.

The theoretical framework of IPET has been described in a previous paper²⁸ and will be described in short in the following Methods section. The primary outcome of the study was published previously and documented cardiorespiratory fitness benefits of IPET.²⁹

METHODS

Study Design

A Supplemental Data file, <http://links.lww.com/JOM/A351>, has been made for the Methods section.

A randomized, single-blinded, parallel controlled trial was conducted from May 2011 to March 2014 with details of study design as well as primary outcome previously presented.^{28,29} The project was approved by the local Ethics Committee of Southern Denmark (S-20110051) and was registered in ClinicalTrials.gov, number: NCT01366950.

Workplace Recruitment

In May 2010, 103 companies across Denmark were contacted by e-mail to determine their interest in the study. Seventeen companies expressed their interest and six of these agreed to be involved in the study.²⁸ Two were private companies (a telecommunications company and a food company), two public municipalities, and two national boards (department of social services).

Office Worker Recruitment and Study Flow

Participants were employed as office workers for at least 25 hours a week in order to be eligible and participation in the project was voluntary, as requested by the ethics committee.

Exclusion criteria were pregnancy and severe musculoskeletal disorders or other severe health issues such as cardiovascular diseases (eg, chest pain during physical exercise, myocardial infarction, and stroke), a symptomatic herniated disc or a severe disorder of the spine, a postoperative condition, or a history of severe trauma.

Employee's at all six companies were informed about the project via intranets and a date for an information meeting was announced 2 months in advance. Information meetings addressed the overall aim of the study as well as practicalities such as type of

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physical exercise programs, site of training, health checks, and instructors. Everyone was offered information about the project in a paper copy, and could ask questions. The information was subsequently placed on the intranet of each company and could be accessed by everyone at the company. Written informed consent was obtained from all office workers at the start of the study. Eligible participants answered a questionnaire before a health check.

Randomization

Employees were assigned an arbitrary ID number that was concealed by an authorized technical staff person. After all the employees had completed their questionnaires and the baseline health check measures at each company were completed, the employees were individually randomized to a training group (TG) or a control group (CG) using the ID number and a random number computer algorithm, for further details see Sjøgaard et al.²⁸

Blinding

The examiners performing the health checks were blinded to participants' group assignment and in follow-up testing, participants were informed not to tell the examiners the group to which they were allocated to. All test personnel and investigators involved in data treatment were blinded to the randomization. However, due to the content of the physical exercise training intervention, the participants and the instructors supervising the IPET intervention could not be blinded to group allocation.

Outcome Measures

The 1-year effect on primary outcome in terms of cardiorespiratory fitness was presented in a previous paper.²⁹

The present paper presents 1-year effects on secondary outcomes: SA, general workability and productivity (in combination assessing SP),³⁰ mental workability, and general health.

Data From Company Registration

SA data were collected from all six companies by the Human Resources managers. Data collection covered 1 year before the intervention started and the first year of completed intervention. Absence data were accrued by years and months, and care days, weekends, and child first and second day of illness were removed. The focus of this study is short-term SA (periods of 1 to 10 days' absence); thus, long-term SA (≥ 11 days, which is the official cutoff point in Denmark) and part-time leave were discarded before analysis.³¹

Data From Questionnaire

All variables in the questionnaire are from validated and frequently applied questionnaires. In the present study, we report the effects on SP, here represented as mental workability, general workability, and productivity.^{32,33} The two items on general workability and mental work ability belong to the Work ability Index questionnaire developed about 40 years ago.³⁴ The index consists of 41 items, but it has been validated that the question on general work ability can be used as a single item question. General work ability is based on both mental and physical factor. As physical factors in this paper are covered by other tests, we added the question specifically on mental work ability. Productivity was rated on a 10-step ordinal scale: How do you perceive your overall productivity for the last 3 months? The rating ranged from one (the worst anyone could do) to 10 (the absolute best an employee in your job could do). General workability as a single item is well validated.³² General workability was rated on a 10-step ordinal scale: Imagine that your workability is worth 10 points when it is best. How many points would you give your present workability? The rating ranged from one (not capable of working) to 10 (best workability).

Mental workability, assumed to represent a subpart of general work ability, was rated on a five-step ordinal scale: How would you rate your present workability regarding the mental demands of your job? The rating ranged from 1) very bad, 2) bad, 3) OK, 4) good, to 5) very good. In addition, self-reported general health was rated on a five-step nominal scale: How do you rate your health, all in all? The rating ranged from 1) poor, 2) below average, 3) good, 4) very good, and 5) excellent.

Intervention

The training intervention and the theoretical framework of the concept of "intelligent physical exercise training" have been described in detail previously.²⁸ In short, the training program was performed during working hours and lasted 1 hour a week for 2 years, except during holidays. In the first year, the training was fully supervised, and in the second year, monthly supervision of one weekly training session was provided. Each participant in TG received an individually tailored training program based on outcome measures of the baseline health check. For each measure, cutoff points were identified to allocate individual training duration and intensity within cardio, strength, and/or functional training,²⁸ following the guidelines of the American College of Sports Medicine,³⁵ as well as specific strength training exercises for the neck and shoulder region.³⁶

For each training session of 60 minutes, 10 minutes were allowed for getting to and from the training area, and 20 minutes were allocated to cardiorespiratory fitness training to counteract office workers' sedentary working conditions. Hereafter, each participant was trained for 30 minutes, doing his or her specific exercises according to the individual training program provided. An example of a training program for an employee with good baseline health check, that is, no test results indicating health risks, would be 25 minutes of cardio training and 25 minutes of major muscle strength training with large muscle groups. Correspondingly, and for an employee with a poor baseline health check, that is, test results within all categories indicated health risks, the training would include 20 minutes of cardio training, 10 minutes of neck and shoulder training, 10 minutes of strength training with large muscles, 5 minutes of balance training, and 5 minutes of core stability training.

In total, 32 individual training programs were developed. However, nine of these covered more than 85% of the participants' needs, most of which included neck/shoulder strength training and cardio training. The types of exercises for cardiorespiratory training were chosen by the employee after receiving guidance from their instructor. These exercises were at vigorous intensity and could be running, rowing, ball games, etc. The selected strength training exercises were for the major muscle groups: one for the shoulders, three for the abdomen-back, and one for the chest muscles. The targeted intensity for strength training was 60% to 80% of 1RM (repetition maximum), with three sets of eight repetitions. For specific neck and shoulder training, the exercises shrugs, lateral raise, and reverse flies were allocated. Participants were asked to lift as much weight as possible for eight repetitions in three sets using proper technical execution but not above pain limit. The functional training exercises were selected from nine different exercises: five for balance training and four for body core training. Throughout the training session, training intensity was kept high, targeting 77% to 95% of heart rate maximum (HR max), corresponding to a rate of perceived exertion (RPE) of 14 to 17 on the Borg scale 6 to 20.³⁷ The instructors supervising the training sessions were instructed to record RPE values after each training session and to measure 1RM when the training intervention started, as well as to make progress in training and keep the participants motivated throughout intervention. One hour of vigorous activity was chosen as an intervention because it is recommended by the National Board of

Health in Denmark and because a previous workplace intervention study showed that cardiorespiratory fitness increased after 1 year with all-round high intensity exercise training performed for 1 hour a week.³⁸

In addition to the workplace intervention, participants in the TG were recommended to perform moderate PA 6 days a week during leisure or a minimum of 3 hours per week. Health ambassadors assisted in guiding and motivating the participants.

The CG received no workplace training or other information regarding recommended leisure time PA but were encouraged to maintain their lifestyle as usual.

Adherence

Attendance at the weekly training sessions at the workplace for the TG was recorded by the instructors and applied to calculate adherence, defined as the number of training sessions attended out of possible training sessions within the 1-year intervention. The number of possible training sessions varied across companies (34 to 37) because there were days when training was not possible for some of the companies, and public holidays also affected the number of possible training sessions. For a per-protocol analysis, we defined an inclusion criterion for the TG as adherence of at least 70% to the training sessions performed at the workplace.³³ All participants in the CG were included in the per-protocol analysis.

Leisure time PA was self-assessed by a representative subsample of 133 participants in the TG and 134 participants in the CG using two questions: (1) "How many days a week within the last month have you spent 30 minutes or more on physical activity?" Possible answers were categories from 0 to 7 days a week; and (2) "How much time on average have you spent on the following activities in the past year?" Possible answers were within three activity categories of light intensity, moderate intensity, and vigorous intensity: more than 4 hours per week, 2 to 4 hours per week, less than 2 hours per week, or no such activity. In a previous paper,²⁹ we reported that there was no baseline difference between TG and CG regarding leisure time PA. However, at follow-up, the TG compared with the CG significantly increased the number of participants who increased their leisure time PA.

Statistical Analysis

The statistical analyses were based on an intention-to-treat approach using SPSS version 22 (IBM Corp, Armonk, NY). Missing values in either baseline or follow-up measurements were substituted with data carried forward or backward. When measurements had missing values in both baseline and follow-up measurements, these were replaced by the mean of all existing values for the particular variable. Differences in baseline characteristics between TG and CG were examined by either a Chi-square test or independent *t* test depending on the type of data.

Per-protocol analysis was performed for those participants in the TG who met the criterion of at least 70% adherence (TG $\geq 70\%$), and all participants in the CG.

Baseline characteristics and absolute change from pre to post-intervention are presented as group mean and SD. For the analysis of covariance, group mean change is presented as adjusted means and SE with a 95% confidence interval. For all analyses, a two-tailed significance level of 0.05 was considered statistically significant.

RESULTS

Study Population

Of 1341 eligible office workers, 395 accepted to participate. Of these, we collected data from a total of 387, as eight were excluded because of pregnancy.

TABLE 1. Baseline Characteristics

	TG N=193		CG N=194		P
	Mean	SD	Mean	SD	
Age, years	44	11	45	10	0.220
Height, cm	171.0	8.9	170.3	8.5	0.473
Weight, kg	74.1	16.1	74.2	17.1	0.951
BMI, kg/m ²	25.3	5.0	25.5	5.2	0.796
Fat%	28.9	8.9	29.3	8.8	0.637
Sickness absence, days	4.4	6.3	3.6	4.7	0.142
Productivity (1–10)	8.3	1.1	8.2	1.3	0.575
General workability (1–10)	8.7	1.2	8.8	1.1	0.661
Mental workability (1–5)	4.3	0.7	4.3	0.6	0.814
Self-rated health (1–5)	3.6	0.7	3.7	0.8	0.215

Data are mean \pm SD for TG (Training group) and CG (Control group).

Baseline

There were no baseline differences between TG and CG with regard to demographics or outcome variables investigated (Table 1). Females accounted for 74% of the participants, who were (mean \pm SD) 44 \pm 10 years old, had a height of 1.71 \pm 0.09 m, a weight of 74.2 \pm 16.6 kg, a body mass index (BMI) of 25.4 \pm 5.1 kg/m², and a fat percentage of 31.9 \pm 7.9% for females and 21.2 \pm 6.0% for males.

For the per-protocol analysis, 89 participants had an adherence of minimum 70% (TG $\geq 70\%$). They did not differ at baseline from CG or those in TG with an adherence below 70%.

Intervention

Of the 387 randomized participants, a total of 105 (approx. 30%) were lost to 12 months follow-up, with similar percentages for TG and CG. The overall average adherence for TG was 56 \pm 29.2%, corresponding to 29.2 training sessions. There was no difference across companies with a range of 36% to 63% adherence, nor was there a significant difference between the sexes with an adherence of 54 \pm 29.7% for females and 61 \pm 27.3% for males.

The intention-to-treat analysis showed statistically significant differences in the changes between TG and CG (Table 2). TG showed a significant increase compared with CG in general workability with a mean percentage increase of 4.0 \pm 14.1 versus 0.3 \pm 11.8%, and in general health with a mean percentage increase of 8.9 \pm 22.5 versus 1.9 \pm 21.0%. There was no difference between TG and CG with regard to changes in productivity, mental workability, or SA.

The per-protocol analysis, comparing TG at least 70% with CG, showed significant additional differences (Table 3). In addition to the intention-to-treat analysis, TG at least 70% significantly increased productivity, with a mean percentage increase of 6.4 \pm 18.1 versus 2.6 \pm 13.2%, and significantly reduced SA, with a mean percentage of 28.9 \pm 61.7 compared with an increase of 8.1 \pm 131.1% in CG.

The within-group analysis showed a significant improvement for the TG at least 70% on all outcomes except mental workability when compared with those participants in the TG with an adherence below 70%. In particular, SA showed an increase in days of SA of 23.6 \pm 107.2% for participants with an adherence below 70%. For the other outcomes, a difference in percentage increase was on average 5.9 \pm 7.0%, all favoring TG at least 70%.

In addition, there were no significant changes from baseline to follow-up for the CG. Mental workability was not statistically significant in TG at least 70%. There were no differences between the sexes with regard to the presented outcomes (Fig. 1).

TABLE 2. Delta (Post - Pre Intervention) Mean Values for TG and CG, and Adjusted Mean Difference (ANCOVA) for Intervention Effects

	TG N=193		CG N=194		Difference TG - CG				P
	Delta Mean	SD (±)	Delta Mean	SD (±)	Adjusted Mean	SE	95% CI		
Sickness absence, days	-1.2	5.3*	-0.1	4.4	-0.55	0.38	-1.29	0.20	0.148
Productivity (1-10)	0.3	1.1*	0.1	1.0	0.16	0.10	-0.04	0.35	0.110
General workability (1-10)	0.3	1.1*	0.0	0.9	0.26	0.09	0.08	0.43	0.005†
Mental workability (1-5)	0.1	0.6*	0.0	0.6	0.05	0.06	-0.06	0.15	0.417
Self-rated health (1-5)	0.2	0.7*	0.0	0.6	0.20	0.06	0.08	0.33	0.001†

Data are mean ± SD for TG and CG and adjusted mean ± SE with 95% CI.

95% CI, 95% confidence interval; CG, Control group; TG, Training group.

*Significant within-group changes.

†Significant difference between TG and CG.

DISCUSSION

The major findings of the present study implementing IPET during working hours for 1 year among office workers was the significant increase in productivity and general workability (in combination assessing SP) as well as the decrease in short-term SA in a per-protocol analysis, that is, among the TG with an adherence of at least 70% compared with the CG. In addition, the intention-to-treat analysis showed significant increases in general workability and self-reported general health in the TG compared with the CG. This implies that IPET has the potential to increase SP and decrease SA.

When compared with CG, participants with an adherence of 70% or more demonstrated significant positive effects in SP and SA. These effects between groups were also significant for self-reported general health, showing that the present intervention positively affected health in the TG, and hereby indicates that the positive effect in SP may be due to improved health rather than concerns about losing their jobs. Interestingly, we find that the health improvements (SP and SA) are in line with the positive effects on primary outcome: 5% increase in VO₂ max in TG compared with CG and more than 10% increase among those with an adherence of at least 70%. Therefore, the improved primary outcome may underlie the positive effects on SP and SA.²⁹

The negative economic impact of SP has been reported to be up to seven times greater than that of SA.³⁹ Therefore, investigation of SP may be even more important than SA. Of note is that SP has been reported to be inversely related to SA. For example, a societal crisis where workers lose their jobs may be a factor that reduces SA but at the same time increases SP.⁴⁰ The underlying mechanism is quite likely that workers afraid of losing their jobs will be at work

even though they are sick, which may impair their job workability and productivity.

Studies of workplace PA interventions have only found limited evidence for reducing SA and productivity.^{16,41} Recently, a meta-analysis of workplace PA interventions found low levels of benefit for SA,^{42,43} and a review of workplace PA interventions found moderate evidence for no effect on reduction of SA.⁴⁴ Furthermore, a large Dutch study showed a positive effect on SA with the PA intervention at vigorous intensity.¹³ A review from 2014 with a total of 37 studies (both intervention and observational) published between 1981 and 2012 suggests that PA is effective in reducing SA, but PA is self-reported in the studies and description of the PA program lack in all studies.⁴⁵ Thus, there appears to be inconsistent evidence of the impact of PA interventions on SP and SA, which may in part be explained by study design, term definition, implementation, and content of the intervention.^{16,19,46} The present WHP intervention was in particular distinct from previous interventions regarding the content of the intervention. 1) The IPET was individually tailored, based on health-check screening for all three major life style diseases: cardiovascular, metabolic, and musculoskeletal disorders; 2) evidence-based physical exercises specifically counteracting each of these lifestyle diseases were implemented by expert trainees, relying on sports science training principles using high intensities; and 3) supervision of on-the-job exercise training 1 hour per week combined with health ambassadors' support of leisure time moderate PA for 30 minutes 6 days a week.²⁸ The concept developed in this project—which proved effective among office workers—is documented in detail and is therefore available free of charge for future studies. Expenses for health checks may be minimized and supervision may be minimized by the use of

TABLE 3. Delta (Post - Pre Intervention) Mean Values for TG ≥70% and CG, and Adjusted Mean Difference (ANCOVA) for Intervention Effects

	TG ≥70% N=89		CG N=194		Difference TG ≥70% - CG				P
	Delta Mean	SD	Delta Mean	SD	Adjusted Mean	SE	95% CI		
Sickness absence, days	-2.2	5.5*	-0.1	4.4	-1.54	0.46	-2.44	-0.64	<0.001†
Productivity (1-10)	0.4	1.2*	0.1	1.0	0.35	0.13	0.10	0.61	0.006†
General workability (1-10)	0.4	1.2*	0.0	0.9	0.46	0.11	0.24	0.69	<0.001†
Mental workability (1-5)	0.1	0.7	0.0	0.6	-0.08	0.07	-0.06	0.22	0.247
Self-rated health (1-5)	0.4	0.8*	0.0	0.6	0.32	0.08	0.16	0.48	<0.001†

Data are mean ± SD for TG ≥70% (adherence ≥70%) and CG and adjusted mean ± SE with 95% CI.

95% CI, 95% confidence interval; CG, Control group; TG, Training group.

*Significant within-group changes.

†Significant difference between TG ≥70% and CG.

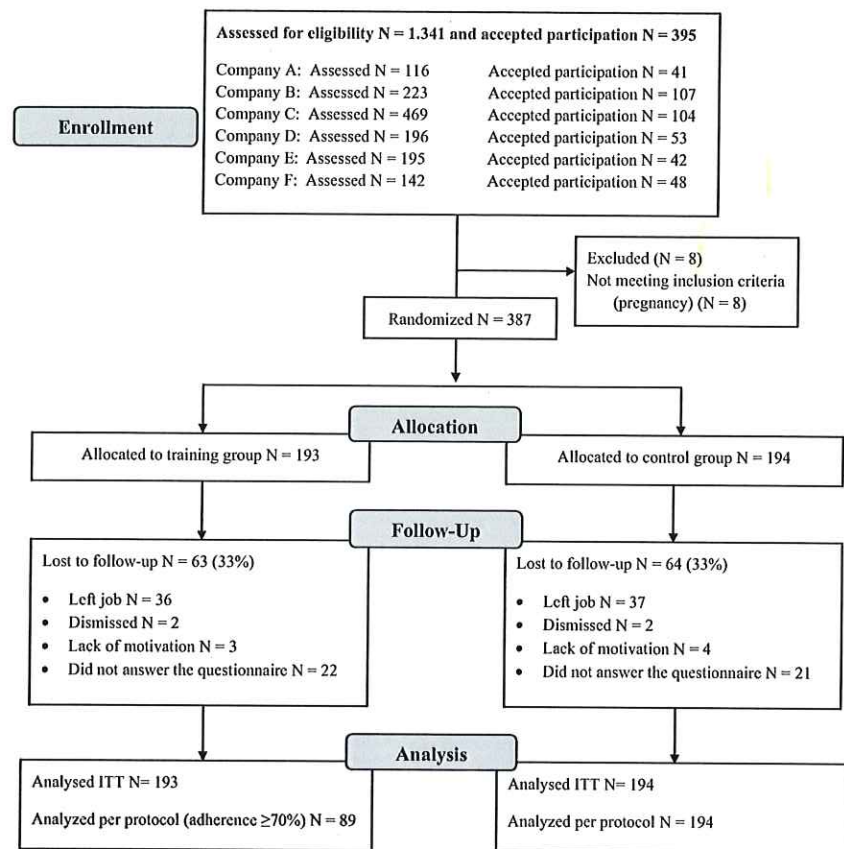


FIGURE 1. Flow of participants.

motivating gadgets, simple exercises, and well-explained training diaries.⁴⁷ Such efforts may in the future result in cost-effective benefits for companies and improved health for workers and society.

The baseline levels of SA, workability, productivity, and general health in the present study were similar to those in a previous study of Danish office workers conducted in 2005 to 2006.³⁸ In the latter study, exercises were focused on musculoskeletal health and not individualized to the same extent as in the present study. Interestingly, the study did not have the same effect on SP as the present study, and this could further corroborate the importance of individually tailoring the training with a broader health perspective, as in the present study.

Strengths and Limitations

A major strength of this study was the rigid RCT design considered to be the gold standard in health research. This study also had a high external validity, due to mean age and gender distribution of the participants being similar to office workers in the Danish workforce and the companies being located in different parts of Denmark with both private and public sectors being represented.

A limitation of this study was that the presenteeism variables were based on self-reported questionnaires and there is likely to be a significant amount of social desirability in reporting this outcome. Further, limitations of our study were the low acceptance rate of roughly 30% among the invited employees and a prior study has documented that employees who participate voluntarily in PA at the workplace are healthier than employees who do not elect PA at the workplace.⁴⁸ In contrast, other studies revealed that those who elected to participate in workplace exercise training were those with the highest need.^{49–52} Unfortunately, we do not know the characteristics of those who did not agree to participate in this study. Also, the adherence of 56% must be considered as a limitation,

although other studies among white-collar workers report adherence as low as 35%⁴⁸ and 39%,³⁸ the latter for only a 12-week intervention period. This calls for an increased attention to the recruitment procedures for workplace health promotion programs and implementation strategies to make programs and participation sustainable.⁵³ Finally, the lack of any psychometric properties for the SP questions is critical, as the focus is on increasing SP at the workplace.

Implications of This Study

This study documented that vigorous activity during working hours in combination with moderate PA in leisure time has the potential for preventing SA and increasing SP in terms of productivity and workability for office workers. Vigorous activity during working hours in combination with moderate PA in leisure time is therefore a possible intervention in a company's Human Resource strategy. Furthermore, vigorous activity at the workplace should be a part of national guidelines for health promotion.

Future studies will show if similar results can be documented for other workgroups and what consequences this will have for different industries' competitiveness and improved productivity. Furthermore, future studies should work with adherence in work health promotion activities, with the focus on participation of employees with the greatest need, with subsequent gains for both business and society.

CONCLUSION

This study demonstrated that 1 hour of supervised IPET during working hours every week and recommendations of 30 minutes of exercise at moderate intensity for 6 days a week had several effects. Participants with an adherence of at least 70% showed a significant improvement in SP and general health and

additionally decreased SA by 29%. Furthermore, the intervention significantly improved general workability and general health for the TG compared with CG, providing that the intervention protocol was followed. Overall, these results underline the effectiveness and corporate incentives of implementing IPET at the workplace.

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