J Occup Health 2017; 59: 122-130

Journal of Occupational Health

Original

The practice of active rest by workplace units improves personal relationships, mental health, and physical activity among workers

Ryoma Michishita[1], Ying Jiang[1], Daisuke Ariyoshi[2], Marie Yoshida[3], Hideko Moriyama[3] and Hiroshi Yamato[1]

[1] Department of Health Development, Institute of Industrial Ecological Sciences, University of Occupational and Environmental Health, Kitakyushu, Japan, [2]The Seiko Electric Co., Ltd, Fukuoka, Japan and [3]The Society of 10 Minutes Lunch Fitness, Fukuoka, Japan

Abstract: Aim: This study was designed to clarify the effects of active rest, with a focus on the practice of short-time group exercise by workplace units, on personal relationships, mental health, physical activity, and work ability among workers. **Methods:** Fifty-nine white-collar workers (40 males and 19 females) performed our active rest (short-time exercise) program, which consists of warm-up, cognitive functional training, aerobic exercise, resistance training and cool-down for 10 minutes per day, 3 times per week during their lunch breaks for 10 weeks. Participants from a workplace unit were randomly allocated to the intervention (five workplaces, n=29) or control groups (six workplaces, n=30). The participants' anthropometric measurements, and their Profile of Mood States (POMS) 2, Brief Job Stress Questionnaire (BJSQ), physical activity levels and Work Ability Index were examined at the baseline and after the 10-week intervention. **Results:** After 10 weeks, physical activity levels, especially the time spent in moderate and vigorous intensity, increased in the intervention group ($p<0.05$). The items of "vigor-activity" and "friendliness" improved in POMS 2, while "vigor," "interpersonal stress," "support from superiors, colleagues, and family/friends," and "job satisfaction" improved in BJSQ in the intervention group ($p<0.05$). In the intervention group, the number of exercise participation was positively correlated with the change in "vigor-activity" in POMS 2 ($r=0.467$, $p=0.011$). **Conclusions:** These results suggest that the practice of active rest by workplace units is important for improving personal relationships, mental health, and physical activity among workers.
(J Occup Health 2017; 59: 122-130)
doi: 10.1539/joh.16-0182-OA

Key words: Active rest, Mental health, Personal relationships, Physical activity

Received July 22, 2016; Accepted November 11, 2016
Published online in J-STAGE December 15, 2016
Correspondence to: R. Michishita, Department of Health Development, Institute of Industrial Ecological Sciences, University of Occupational and Environmental Health, 1-1 Iseigaoka, Yahatanishi-ku, Kitakyushu, 807-8555, Japan (e-mail: rmichishita@med.uoeh-u.ac.jp)

Introduction

The concept of "active rest" has been proposed in recent times[1,2]. This concept is based on the hypothesis that moderate exercise allows individuals to recover from fatigue more effectively than lying down[1,2]. It is well shown that many workers spend their lunch breaks playing games or spending e-mails[3]. It is hypothesized that if workers perform exercise during their lunch breaks instead of playing games or spending e-mails, then they will be able to reduce their fatigue and increase their work efficiency. Furthermore, the introduction of active rest in the workplace may elevate health awareness, increase physical activity during work or leisure-time, and will be expected to have a health promotion effect among workers. In addition to improving physical health such as decreasing body weight and blood pressure, exercise training has been shown to improve mental health[4-6]. The performance of group exercise in the same workplace is expected to improve workplace communication[7,8]. Namely, the performance of group exercise in the same workplace may make it easier for workers to obtain support from supervisors and colleagues. We hypothesized that improved communication within the workplace would have beneficial effects on personal relationships, mental health and work ability because the performance of group exercise in the same workplace is expected to improve workplace

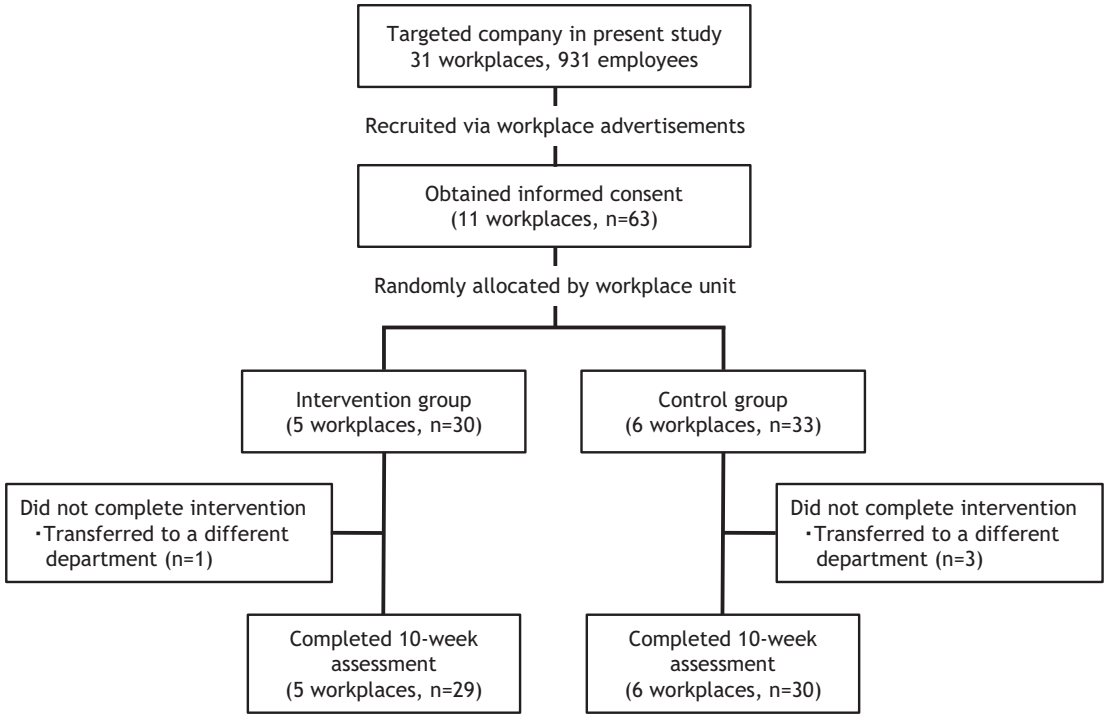

Fig. 1. Flow chart of participants included in the study

communication[7,8]. However, at present, the effects of the practice of active rest by workplace units on personal relationships, mental health, physical activity, physical health and work ability among workers have not been investigated.

We recently produced a short-time exercise program consisting of warm-up, cognitive functional training, aerobic exercise, resistance training and cool-down periods, which can be completed within 10 minutes with the aim of preventing metabolic and locomotive syndromes, creating an opportunity for individuals to develop exercise habit. If the effects of the practice of active rest by workplace units can be clarified, it may show that the performance of group exercise within the same workplace during lunch breaks can help to improve personal relationships, mental health, physical activity, physical health, and work ability. We therefore hypothesized that the practice of active rest by workplace units may help to maintain or improve these factors. This study was designed to clarify the effects of the practice of active rest by workplace units on personal relationships, mental health, physical activity, physical health, and work ability among workers.

Participants and Methods

Participants and study design

The targeted company in this study is composed of 31 workplaces and 931 employees. Participants were recruited via workplace advertisements and from 11 workplaces and 63 white-collar workers who voluntarily participated in our active rest program. Participants with a history of severe complications such as cardiovascular or cerebrovascular diseases, were excluded from this study. The information about medical history, taking medications, smoking and alcohol intakes were confirmed using self-administered questionnaires before intervention. In the present randomized controlled trial, participants were randomly allocated in workplace units to the intervention (n=30) and control groups (n=33). One participant in the intervention group and three participants in the control group did not complete the program because they were transferred to another department. Thus, 59 participants (male, n=40; female, n=19; age, 40.9 ± 9.2 years; body mass index [BMI], 22.8 ± 2.9 kg/m^2) completed the intervention. The intervention group included 29 participants (5 workplaces, male, n=19; female, n=10; age, 40.8 ± 9.8 years; BMI, 23.1 ± 3.2 kg/m^2), while the control group included 30 participants (6 workplaces, male, n=21; female, n=9; age, 41.1 ± 8.6 years; BMI, 22.5 ± 2.5 kg/m^2). A diagram of participants included in this study is shown in Fig. 1.

After the baseline assessments, the intervention group started the 10-week active rest program and the control group continued their normal daily life and served as controls. Participants' anthropometric indices, blood pressure levels, physical activity levels, mood states, job-related stress levels, and work ability were evaluated before the intervention and after the 10-week intervention (Fig. 2).

All participants gave their informed consent for partici-

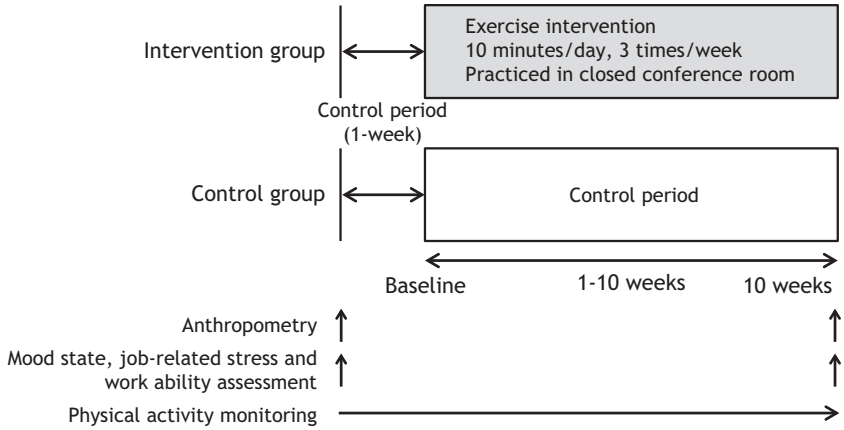

Fig. 2. Protocol of our active rest intervention study
In this randomized controlled trial, participants within a workplace unit were randomly allocated to the intervention and control groups.
Anthropometry indices, blood pressure, physical activity levels, mood states, job-related stress and work ability were evaluated before intervention and after the 10-week intervention.

pation in this study after agreeing with its purpose, methods, and significance. This study conformed to the Declaration of Helsinki and was approved by the Ethics Committee of the University of Occupational and Environmental Health, Japan (No. H27-068).

Active rest program (10 minutes lunch fitness®)

Participants performed the 10 minutes lunch fitness® program 3 times per week for 10 weeks (a total of 29 times). The program takes 10 minutes and was performed during a lunch break. This short-time exercise program consisted of warm-up (stretching), cognitive functional training, aerobic exercise, body weight resistance training and cool-down components. The program could be completed within 10 minutes. The 10 minutes lunch fitness® program was created by the Society of 10 Minutes Lunch Fitness (http://10mlf.com) with the aim of preventing metabolic and locomotive syndromes, and promoting an opportunity for individuals to develop exercise habit[9]. This exercise program is the exercise to feel moderately for degree to sweat. The exercise training was practiced under the supervision of a fitness instructor in a closed conference room so that the control group would not be able to observe it.

Anthropometry and physical activity level measurements

Anthropometry and blood pressure measurements were performed after at least two hours of fasting (at ten or fifteen o'clock). Subjects' height and body weight were measured and their BMI was calculated as the ratio of the body weight (kg) to height squared (m^2). The waist circumference was measured at the level of the umbilicus. The body fat mass and lean body mas were measured using the bioelectrical impedance method (DC-320, TANITA Inc., Tokyo, Japan). Blood pressure (HEM-7080IT, OMRON Inc., Kyoto, Japan) was measured in the right arm with the subject sitting in a chair, after more than 5 minutes of rest, and expressed as the average of triplicate measurements.

Physical activity levels were assessed using a single-axis accelerometer (Life-Corder GS, Kenz, Nagoya, Japan), which is shown to be a valid method of determining the energy expenditure associated with a respiratory chamber and doubly labeled water[10,11]. The use of an accelerometer and the procedure for wearing an accelerometer are same as that in previous publications[10-12]. Each participant wore an accelerometer on a belt at the waist level during the intervention period, except while sleeping or bathing. After the measurements were taken, the device was retrieved and data were downloaded to a personal computer. To minimize any potential influence of the device on the participants' physical activity levels and to assess the typical physical activity levels, data from the first and last days were discarded. In addition, only data from the days on which the accelerometer was worn for ≥8 hours per day in the last seven days before the completion of the intervention period were analyzed. Based on the frequency and magnitude of acceleration, the total inactivity time (<1.1 METs: acceleration intensity, <1), or the time spent in light (1.1-2.9 METs: acceleration intensity, 1-3), moderate (3.0-5.9 METs: acceleration intensity, 4-6), or vigorous intensity (≥6.0 METs: acceleration intensity, 7-9) was evaluated.

Assessment of mood states and job-related stress

The mood states of participants were assessed using the Japanese translation of the Profile of Mood States second edition (POMS 2®, KANEKOSHOBO Inc., Tokyo, Ja-

Table 1. The participants' baseline characteristics in the intervention and control groups

	Intervention group (5 workplaces, n=29)	Control group (6 workplaces, n=30)	p value
Age (years)	40.8±9.8	41.1±8.6	0.910
Sex (males/females; n, %)	19 (65.5)/10 (34.5)	21 (70.0)/9 (30.0)	0.713
Taking medications (n, %)	3 (10.3)	4 (13.3)	0.723
Smoking (n, %)	8 (27.6)	7 (23.3)	0.708
Alcohol (n, %)	22 (75.8)	17 (56.7)	0.119

The data are expressed as the mean ± standard deviation and the number of participants.

pan)[13-15]. POMS 2 is a mood inventory, which contains 65 items (adjectives) that describe seven different moods as follows: "Anger-hostility", "confusion-bewilderment", "depression-dejection", "fatigue-inertia", "tension-anxiety", "vigor-activity" and "friendliness". Participants were asked to indicate their mood states on a five-point scale ranging from "not-at-all" to "extremely" during the previous 1-week period. The sum of scores was calculated for each subscale. The Total Mood Disturbance (TMD) score was calculated as follows: (["anger-hostility" + "confusion-bewilderment" + "depression-dejection" + "fatigue-inertia" + "tension-anxiety"] − "vigor-activity"). It is well known that the POMS 2 allows for detailed evaluation of mood changes[12-14].

The participants' job-related stress was evaluated using the Brief Job Stress Questionnaire (BJSQ), which was developed and validated by the Ministry of Health, Labour and Welfare of Japan[16]. BJSQ was created to identify employees who experience mental problems at an early stage. BJSQ has been widely used in research and practice in the field of workplace mental health in Japan[17]. BJSQ is composed of 57 items and based on a four-point Likert scale that ranges from "strongly disagree" to "strongly agree". This questionnaire consists of the following subscales: Job stressors (17 items: E.g., quantitative job workload, qualitative job workload, interpersonal stress, and job control), job stress reaction (29 items: E.g., psychological and physical stress response), social support (9 items: E.g., support from superiors, colleagues, and family/friends), and the participants' satisfaction with their job and daily life (2 items).

Assessment of work ability

The participants' work ability was assessed using the Work Ability Index (WAI) Japanese edition[18]. WAI, which was developed by the Finnish Institute of Occupational Health, is often used to estimate work ability. It is well known that good work ability is associated with high-quality work and job satisfaction[19]. AT present, WAI is considered to be related to several cardiovascular risk factors[20-23]. WAI consists of the following seven dimensions: Perceived work ability in comparison to lifetime best, assessment of physical and mental demands of work colleagues, diagnosed diseases, limitations in work due to disease, sick leave, work ability prognosis, and psychological resources. WAI is calculated as the sum of ratings of each dimension (range: 7-49 points).

Statistical analyses

Data were expressed as the mean and standard deviations (SD). The StatView J-5.0 software program (SAS Institute, Cary, NC, USA) was used for all statistical analyses. Intergroup comparisons were performed using the Mann-Whitney's U-test for continuous variables and the chi-squared test for categorical variables. Comparisons of data at the baseline and after the 10-week intervention were performed using a Wilcoxon signed-ranks test for continuous variables. Differences in the changes in anthropometric values, as well as physical activity levels, mood states, job-related stress levels, and work ability of the intervention and control groups were included in the two-way repeated measure analysis of variance for the intervention and groups × time interactions. A simple linear regression analysis was performed to determine the associations between continuous variables. Probability values were determined using two-sided testing and the probability values of <0.05 were considered to indicate statistical significance.

Results

Table 1 shows the participants' baseline characteristics in both the intervention and control groups. There were no significant differences in the baseline characteristics of the two groups. The mean number of exercise participation performed by participants in the intervention group was 18.2 ± 8.4 times (range: 2-29 times) (a total of 29 times). Fig. 3 shows physical activity levels at the baseline and after the 10-week intervention in both the intervention and control groups. The time spent in moderate and vigorous intensity increased in the intervention group ($p<0.05$, respectively). A significant interaction effect for group × time was seen in tmoderate and vigorous intensity between the two groups ($p<0.05$).

Table 2 shows anthropometric indices, mood states, job-related stress, and work ability at the baseline and af-

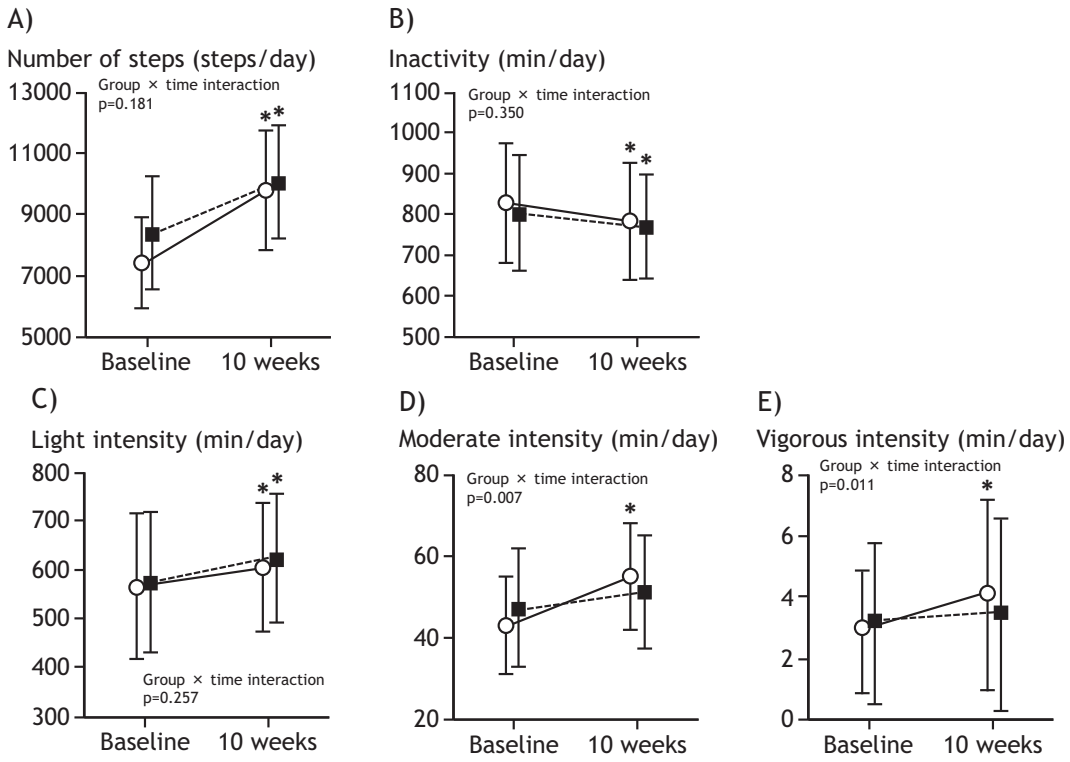

Fig. 3. Comparisons of physical activity levels in the intervention and control groups at the baseline and after the 10-week intervention

Data are expressed as the mean ± standard deviation.

A) number of steps, B) inactive time, C) time spent in light intensity, D) time spent in moderate intensity, and E) time spent in vigorous intensity

Open circle; intervention group, filled square; control group

*; p for Wilcoxon signed-ranks test, <0.05, in comparison to values before intervention in each group.

ter the 10-week intervention in the intervention and control groups. After 10 weeks, the items of "fatigue-inertia" decreased and "vigor-activity" and "friendliness" in POMS 2 increased in the intervention group ($p<0.05$). A significant interaction effect for group × time was seen in the items of "fatigue-inertia", "vigor-activity" and "friendliness" in POMS 2 between the two groups ($p<0.05$). The BJSQ items of "interpersonal stress" decreased and "vigor," "support from superiors, colleagues and family/friends," and "satisfaction with job/daily life" increased in the intervention group ($p<0.05$). A significant interaction effect for group × time was seen in the BJSQ items of "interpersonal stress," "vigor," "support from superiors, colleagues and family/friends," and "satisfaction with job/daily life" between the two groups ($p<0.05$).

Fig. 4 shows the association between the number of exercise participation and change in the item of "vigor-activity" in POMS 2, as determined by a simple regression analysis in the intervention group. In this analysis, the change in the item of "vigor-activity" in POMS 2 was a dependent variable and the number of exercise participation during the intervention period was an independent variable. The number of exercise participation was positively correlated with the change in the item of "vigor-activity" ($r=0.467$, $p=0.011$).

Discussion

The major finding of this study was that the items of "friendliness" in POMS 2 while "interpersonal stress" and "support from superiors, colleagues and family/friends" in BJSQ improved in the intervention group. Moreover, a significant interaction effect for group × time was seen in these mood states and job-related stress levels between the intervention and control groups.

Several studies have reported the effects of group exercise on physical and mental health states[7,8,24]. Erime et al.[7] revealed that participation in club and team sports resulted in greater improvements in psychosocial health outcomes than that in individual exercise. In an intervention study[24] that compared the psychological effects of group and individual exercise programs on middle-aged and older adults, subjects who participated in a program that involved group exercise had a higher self-assessment of activity, enjoyment, achievement, satisfaction and self-

Table 2. The anthropometric indices, mood states and job-related stress at baseline and after the 10 weeks in the intervention and control groups

	Intervention group (5 workplaces, n=29)			Control group (6 workplaces, n=30)			Group×time interaction (p value)
	Baseline	10 weeks	p value	Baseline	10 weeks	p value	
Anthropometric indices and blood pressure							
BMI (kg/m^2)	23.1±3.2	23.2±3.2	0.466	22.5±2.5	22.6±2.3	0.179	0.595
Body fat mass (kg)	15.7±4.8	15.6±4.8	0.829	14.9±3.9	15.0±4.0	0.706	0.649
Lean body mass (kg)	48.0±9.8	48.3±9.8	0.210	48.4±8.7	48.6±8.6	0.139	0.607
Waist circumference (cm)	82.9±10.8	82.0±9.8	0.375	81.2±7.4	81.4±8.0	0.502	0.281
Systolic blood pressure (mmHg)	119.9±16.3	122.4±17.1	0.127	124.1±23.1	121.7±18.1	0.389	0.187
Diastolic blood pressure (mmHg)	76.1±15.2	78.0±13.2	0.090	77.7±13.5	77.5±10.6	0.830	0.343
POMS 2 score							
Anger-hostility (points)	7.1±5.4	7.1±5.4	0.972	6.5±5.1	5.8±5.7	0.323	0.324
Confusion-bewilderment (points)	14.2±6.5	13.2±6.7	0.081	12.1±6.7	11.1±6.7	0.090	0.913
Depression-dejection (points)	8.4±7.7	8.5±8.3	0.605	7.8±8.2	7.5±7.2	0.761	0.840
Fatigue-inertia (points)	7.8±4.5	6.0±3.6	0.007	6.6±5.6	6.7±5.5	0.648	0.042
Tension-anxiety (points)	12.9±6.6	11.8±6.3	0.113	12.1±6.5	11.5±7.7	0.247	0.866
Vigor-activity (points)	11.5±6.4	13.4±6.2	0.008	12.9±8.4	13.0±7.8	0.920	0.046
Friendliness (points)	10.5±3.4	11.6±3.9	0.010	10.8±4.2	10.3±3.6	0.131	0.001
TMD score (points)	39.0±31.3	33.4±30.9	0.018	31.6±26.9	29.5±28.2	0.096	0.279
BJSQ score							
Job stressor							
Quantitative job workload (points)	3.1±0.8	3.0±0.7	0.272	3.1±1.1	3.3±1.1	0.236	0.358
Qualitative job workload (points)	2.9±0.8	2.9±0.9	0.799	3.1±1.0	3.3±0.8	0.256	0.219
Physical demands (points)	3.6±0.6	3.4±0.6	0.098	3.7±0.5	3.7±0.5	0.990	0.294
Interpersonal stress (points)	3.2±0.8	2.9±0.5	0.008	3.2±0.8	3.2±0.8	0.686	0.019
Poor workplace environment (points)	2.6±1.0	2.8±0.9	0.196	2.8±1.0	3.1±0.9	0.272	0.634
Job control (points)	3.3±0.6	3.4±0.7	0.445	3.7±0.7	3.7±0.9	0.767	0.545
Skill utilization (points)	3.0±0.7	2.9±0.7	0.161	3.0±0.8	2.9±0.7	0.917	0.436
Job aptitude (points)	2.8±0.9	2.9±0.9	0.715	3.2±1.0	3.0±0.8	0.239	0.328
Worthwhileness of working life (points)	2.9±0.9	3.0±0.9	0.361	3.1±1.2	3.0±1.0	0.248	0.144
Job stress reaction							
Vigor (points)	3.0±1.1	3.5±1.3	0.002	3.2±1.2	3.2±0.8	0.610	0.021
Irritability (points)	3.4±1.1	3.4±1.1	0.991	3.2±1.0	3.4±1.0	0.301	0.204
Fatigue (points)	3.0±0.8	3.1±0.8	0.554	3.4±1.1	3.2±1.1	0.374	0.382
Anxiety (points)	3.0±0.8	3.2±1.0	0.142	3.3±1.1	3.3±1.0	0.861	0.703
Depression (points)	3.2±1.3	3.3±1.3	0.477	3.5±1.3	3.3±1.1	0.285	0.324
Physical complaint (points)	2.9±0.8	2.8±1.0	0.310	3.2±0.7	3.4±1.0	0.164	0.152
Social support							
Support from superiors (points)	3.4±1.0	3.9±0.7	0.019	3.2±1.0	3.0±1.1	0.263	0.021
Support from colleagues (points)	3.1±0.8	3.4±0.7	0.018	2.8±1.0	2.7±0.9	0.594	0.012
Support from family/friends (points)	3.4±1.4	3.9±1.0	0.005	3.4±1.3	3.4±1.5	0.875	0.008
Satisfaction for job/daily life (points)	3.2±0.8	3.4±0.8	0.027	3.4±1.0	3.2±0.8	0.388	0.034
Work Ability Index (points)	42.3±5.0	41.6±5.1	0.414	42.7±5.1	41.8±4.3	0.242	0.906

The data are expressed as the mean ± standard deviation.
BMI, body mass index; POMS, Profile of Mood States; TMD, total mood disturbance; BJSQ, Brief Job Stress Questionnaire.

recognition scores than those who only participated in an individual exercise program. However, the effects of the practice of active rest by workplace units on personal relationships have not previously been studied. Regrettably,

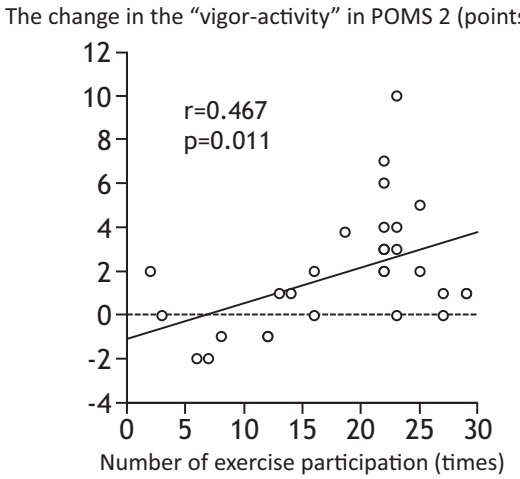

Fig. 4. Association between the number of exercise participation and the change in item of "vigor-activity" in POMS 2, as determined by a simple regression analysis in the intervention group.
In this simple regression analysis, the change in the item of "vigor-activity" in POMS 2 was a dependent variable and the number of exercise participation during the intervention period was an independent variable. The number of exercise participation was positively correlated with the change in the item of "vigor-activity" in POMS 2 (r=0.467, p=0.011).

the participants' position and personal relationships in each of the workplace were unclear to secure anonymity of the individual. Therefore, we were not able to elucidate the mechanisms underlying the effect of active rest by workplace units on personal relationships. In this study, participants were randomly allocated within a workplace unit to both the former and latter intervention groups, and members of the workplace unit participated in exercise training during their lunch breaks. Thus, the effects of active rest on personal relationships in workplace may have results from the performance of group exercise in the same workplace during the participants' lunch breaks. If we recommended the 10 minutes of exercise from the viewpoint of occupational injury and compelling force, then companies may be addressed within the working time. Based on our results, we believe that it is important to perform exercise during lunch breaks from the viewpoint of occupational health. The current findings suggest that the performance of group exercise within a workplace during lunch breaks may be useful for improving personal relationships of workers, especially those related to "interpersonal stress," and "support from superiors, colleagues, and family/friends".

It is well known that in addition to improving physical health, exercise training also improves mental health[4-6]. Our previous community-based lifestyle modification studies reported that leisure-time exercise and walking or cycling to work were associated with improved mental health states, as evaluated by Genera Health Questionnaire (GHQ)[4]. Furthermore, it has been previously demonstrated that job satisfaction can be effectively improved by lifestyle modification intervention[5]. Watanabe et al.[25] investigated the associations between exercise habit and job resource and vigor scales, and showed that job resource and vigor scales were positively correlated with exercise habit in 4,543 employees. In this study, the items of "vigor-activity" in POMS 2, "vigor" and "job satisfaction" in BJSQ also improved in the intervention group. This finding is consistent with the results of previous studies. Moreover, in this study, participants performed our short-time exercise program for 10 minutes per day, 3 times per week. However, at present, it is still unknown whether the performance of short-time exercise training by workplace units during lunch breaks is effective for improving the mental health of workers. Interestingly, our results revealed that the number of exercise participation was positively correlated with the change in the item of "vigor-activity" in POMS 2. Thus, the results of this study were considered to support the possibility that the performance of active rest by workplace units during lunch breaks had a cumulative effect despite the short time of the exercise training, and that this intervention may be effective for improving workers' vigor and job satisfaction.

On the other hand, physical activity levels, especially the time spent in moderate and vigorous intensity, increased in the intervention group. Moreover, in the control group, the inactive time decreased and the number of steps and time spent in light intensity increased. The use of stairs during work and leisure-time has been reported to increase due to behavioral changes in subjects who wear a pedometer[26,27]. Thus, in the control group, the decrease in inactive time, and the increase in the number of steps and time spent in light intensity may have been influenced by the use of a pedometer. However, we showed that physical activity levels, especially the time spent in moderate and vigorous intensity increased in the intervention group. Firestone et al.[28] observed that encouragement of group exercise is an effective strategy for increasing leisure-time physical activity among adults. Therefore, the results of this study demonstrate that the performance of group exercise within a same workplace during workers' lunch breaks may also be important for increasing the physical activity of moderate-to-vigorous intensity, and confirm the hypothesis that the introduction of active rest within the workplace elevates health awareness, increases physical activity during work, and leisure-time among workers.

Study limitations and implications for occupational health

This study is associated with several limitations. First, the study population and workplace were small, and was predominantly composed of white-collar workers with no

any health complications. It therefore remains unclear whether our findings are applicable to workers in other occupations or those with health complications. Moreover, we would not have to perform a comparison of each parameter in the workplace units because the study population in each of the workplace was small. In addition, even though there is an interactive effect in some of many variables, the difference between intervention and control groups at 10 weeks was small. Second, we assessed the mood states and job-related stress using POMS 2 and BJSQ. However, we were unable to clarify from our results whether these were involved in the mechanisms underlying the improvement in personal relationships and mental health that were observed in workers who practiced active rest. Third, although the anthropometry and blood pressure were measured at ten or fifteen o'clock, we were not able to unify the timing of these measurements. Fourth, this study could not be considered to remove the physical activity data during exercise training to clarify the increase in work and leisure-time physical activity. Therefore, we could not clarify the direct influence of an increase in physical activity only by work and leisure-time. Fifth, adherence to exercise was insufficient in the intervention group (18.2 ± 8.4 times). Finally, our study period was only 10 weeks, which was insufficient follow-up for evaluating the effects of active rest on parameters that reflect physical health, such as body weight and blood pressure.

However, despite these limitations, this was the first study to evaluate the effects of active rest by workplace units on personal relationships, mental health and physical activity among workers. The 10 minutes lunch fitness® program was created with the aim of disease prevention and promoting an opportunity for individuals to develop exercise habit, and its safety has been confirmed[9]. In this study, adverse events during the intervention period were not observed. Therefore, the possibility of contamination of intervention is considered to be extremely low. In several recent studies, it has been clearly demonstrated that group exercise can effectively improve mental health through an increase in physical activity, as well as improvement in psychological factors and social relationships[7,8,24,28]. Thus, the results of this study demonstrate the effects of the practice of active rest by workplace units, and may confirm the hypothesis that the performance of group exercise within the same workplace during the workers' lunch breaks helps to improve their personal relationships, mental health, and physical activity. Given our present findings, we believe that it is necessary to promote the practice of active rest by workplace units to promote the workers' health. Further investigation in a larger population, including population of workers in other occupations or with health complications, will be necessary to more precisely clarify the mechanisms underlying this association and the implications for occupational health.

Conclusions

This study was designed to clarify the effects of the practice of active rest by workplace units on personal relationships, mental health, physical activity, and work ability among workers. After 10 weeks, physical activity levels, especially the time spent in moderate and vigorous intensity increased in the intervention group. The items of "vigor," "interpersonal stress," and "support from superiors, colleagues, and family/friends" improved in the intervention group. These results suggest that the practice of active rest by workplace units is useful for improving personal relationships, mental health, and physical activity among workers.

Acknowledgments: We would like to thank Mr. Katsutoshi Arie, Naonori Tsuchiya and the staff members of the Seiko Electric Co., Ltd., as well as the fitness instructors of the Society of 10 Minutes Lunch Fitness® for their assistance with data evaluation. We are grateful to the participants of this study. This work was supported by a grant from the Meiji Yasuda Life Foundation of Health and Welfare.

Conflict of interest statement: In this study, two authors (Moriyama H and Yoshida M) who are officials of the Society of 10 Minutes Lunch Fitness are included as the coauthors. Hideko Moriyama is the director of the Society of 10 Minutes Lunch Fitness and she created and offered this exercise program. Marie Yoshida is an official employee of the Society of 10 Minutes Lunch Fitness and she contributed to recruitment of subjects. There was no cost burden for subjects because it was conducted by our research funding to clarify the effects of active rest on personal relationships, mental health, physical activity, and work ability among workers. The salary of such fitness instructors were paid by the Society of 10 Minutes Lunch Fitness. None of the above two coauthors (Moriyama H and Yoshida M) had a role in data collection, data management, or analysis in this study. None of the other authors have any conflicts of interest to declare in association with this study.

References

1) Koizumi K, Fujita Y, Muramatsu S, Manabe M, Ito M, Nomura J. Active recovery effects on local oxygenation level during intensive cycling bouts. J Sports Sci 2011; 29: 919-926.
2) Greco CC, Barbosa LF, Caritá RA, Denadai BS. Is maximal lactate steady state during intermittent cycling different for active compared with passive recovery? Appl Physiol Nutr Metab 2012; 37: 1147-1152.
3) Ministry of Internal Affairs and Communications. 2015

WHITE PAPER Information and Communications in Japan. [Online]. [cited 2016 Aug. 18]; Available from: URL: http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2015/2015-index.html
4) Ohta M, Mizoue T, Mishima N, Ikeda M. Effect of the physical activities in leisure time and commuting to work on mental health. J Occup Health 2007; 49: 46-52.
5) Ohta M, Takigami C, Ikeda M. Effect of lifestyle modification program implemented in the community on workers' job satisfaction. Ind Health 2007; 45: 49-55.
6) Mammen G, Faulkner G. Physical activity and the prevention of depression: a systematic review of prospective studies. Am J Prev Med 2013; 45: 649-657.
7) Eime RM, Young JA, Harvey JT, Charity MJ, Payne WR. A systematic review of the psychological and social benefits of participation in sport for adults: informing development of a conceptual model of health through sport. Int J Behav Nutr Phys Act 2013; 10: 135.
8) Kanamori S, Takamiya T, Inoue S. Group exercise for adults and elderly: Determinants of participation in group and its associations with health outcome. J Phys Fitness Sports Med 2015; 4: 315-320.
9) The Society of 10 Minutes Lunch Fitness. [Online]. Available from: URL: http://10mlf.com
10) Kumahara H, Schutz Y, Ayabe M, et al. The use of uniaxial accelerometry for the assessment of physical-activity-related energy expenditure: a validation study against whole-body indirect calorimetry. Br J Nutr 2004; 91: 235-243.
11) Rafamantanantsoa HH, Ebine N, Yoshioka M, et al. Validation of three alternative methods to measure total energy expenditure against the doubly labeled water method for older Japanese men. J Nutr Sci Vitaminol 2002; 48: 517-523.
12) Yoshioka M, Ayabe M, Yahiro T, et al. Long-period accelerometer monitoring shows the role of physical activity in overweight and obesity. Int J Obes 2005; 29: 502-508.
13) McNair DM, Lorr M, Droppleman LF. Profile of Mood States. San Diego: Educational and Industrial Testing Service; 1971.
14) Yokoyama K, Araki S, Kawakami N. Production of the Japanese edition of Profile of Mood States (POMS): Assessment of reliability and validity. Jap J Public Health 1990; 37: 913-918 (in Japanese with English abstract).
15) Heuchert JP, McNair DM. POMS 2®: Profile of Mood States Second Edition. Tonawanda: Multi-Health Systems; 2012.
16) Shimomitsu T, Haratani T, Nakamura K, et al. Final development of the Brief Job Stress Questionnaire mainly used for assessment of the individuals. In: Kato M, editor. The Ministry of Labor sponsored grant for the prevention of work-related illness, FY 1999 report. Tokyo: Tokyo Medical University; 2000. p. 126-164 (in Japanese).
17) Kobayashi Y, Kaneyoshi A, Yokota A, Kawakami N. Effects of a worker participatory program for improving work environments on job stressors and mental health among workers: a controlled trial. J Occup Health 2008; 50: 455-470.
18) Suzuki H, Kumashiro M, Kusanoi K, Shazuki S, Fuji A, Eto R. Comparison of work ability index and cognitive function tests. Sangyo Eiseigaku Zasshi 2004; 46: 71-77 (in Japanese with English abstract).
19) Tuomi K, Huuhtanen P, Nykyri E, Ilmarinen J. Promotion of work ability, the quality of work and retirement. Occup Med 2001; 51: 318-324.
20) Tuomi K, Ilmarinen J, Eskelinen L, Järvinen E, Toikkanen J, Klockars M. Prevalence and incidence rates of diseases and work ability in different work categories of municipal occupations. Scand J Work Environ Health 1991; 17(Suppl 1): 67-74.
21) van den Berg TI, Elders LA, de Zwart BC, Burdorf A. The effects of work-related and individual factors on the Work Ability Index: a systematic review. Occup Environ Med 2009; 66: 211-220.
22) Bridger RS, Bennett AI. Age and BMI interact to determine work ability in seafarers. Occup Med 2011; 61: 157-162.
23) Ohta M, Kumashiro M, Eguchi Y, Morita Y, Konno Y, Yamato H. The relationship between work ability and oxidative stress in Japanese workers. Ergonomics 2014; 57: 1265-1273.
24) Yokoyama N, Nishijima T, Maeda S, Kuno S, Ajisaka R, Matsuda M. Effect of exercise program participation on personal factors of exercise adherence promotion in middle-aged and elderly subjects ―comparison of group and individual exercise program―. Jpn J Phys Fitness Sports Med 2003; 52 (Suppl): 249-258 (in Japanese with English abstract).
25) Watanabe K, Otsuka Y, Inoue A, Sakurai K, Ui A, Nakata A. Interrelationships between job resources, vigor, exercise habit, and serum lipids in Japanese employees: a multiple group path analysis using medical checkup data. Int J Behav Med 2016; 23: 410-417.
26) Bravata DM, Smith-Spangler C, Sundaram V, et al. Using pedometers to increase physical activity and improve health: a systematic review. JAMA 2007; 298: 2296-2304.
27) Tudor-Locke C, Craig CL, Aoyagi Y, et al. How many steps/day are enough? For older adults and special populations. Int J Behav Nutr Phys Act 2011; 8: 80.
28) Firestone MJ, Yi SS, Bartley KF, Eisenhower DL. Perceptions and the role of group exercise among New York City adults, 2010-2011: an examination of interpersonal factors and leisure-time physical activity. Prev Med 2015; 72: 50-55.