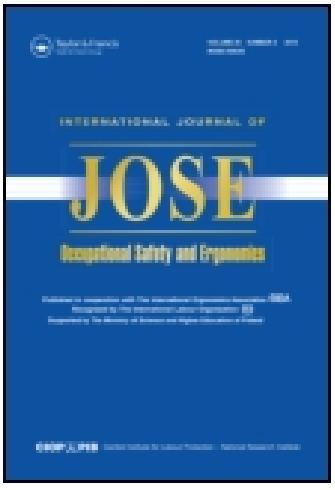

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The Effect of a Physical Activity Program on Decreasing Physical Disability Indicated by Musculoskeletal Pain and Related Symptoms Among Workers: A Pilot Study

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The aim of this study was to verify the effect of a physical activity (PA) program on musculoskeletal pain and related symptoms in different body regions among workers. ***Methods.*** *The intervention study lasted 6 months. The training sessions were given during work time. The intervention group (TOI) (*n = *39) participated in 10–15 min of physical exercise training 3 times a week and focused on stretching exercises and general strength. The reference group (TOR) (*n = *31) were asked to continue their daily activities. Musculoskeletal pain was assessed with the standardized Nordic questionnaires for analyzing musculoskeletal symptoms. Evaluations were performed at baseline and at the end of the intervention.* ***Results.*** *After the intervention, the TOI obtained some significant results regarding a decrease in the intensity of pain in some of the body regions evaluated, such as elbow (*p = *.03) and dorsal region (*p = *.015). In comparing the TOR and TOI after the 6 months of the PA program, we can verify that in the elbow and in the thigh/hip regions, the pain intensity decreased significantly; additionally, there is some evidence to suggest statistically significant results in the neck region (*p = *.063).* ***Conclusion.*** *Our intervention seems to have reduced musculoskeletal pain and related symptoms in factory workers.*

physical activity musculoskeletal pain workers intervention study

1. INTRODUCTION

The hazards of a sedentary lifestyle are widely acknowledged. Occupational health promotion focuses on factors that influence workers' health and productivity [1]. Physical activity (PA) in all settings (e.g., occupational and leisure time) has been considered to provide similar health-promoting benefits [2] and, therefore, international recommendations for health-promoting PA do not distinguish between occupational and leisure-time PA [3].

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Occupational health programs have demonstrated improvements in the leading global risk factors for chronic disease, which has led to their increasing role in chronic disease prevention [4]. Indeed, in the past 20 years, the number of health promotion programs in workplace settings has continued to grow [5]. This growth can be attributed to the increased awareness of the advantages of having quality health promotion programs available for employees [5]. Companies believe that these programs can reduce employee health care and disability costs, reduce staff renewal rate, aid in recruiting new workers, enhance the company image, and improve employee productivity [6]. Skilled employees who are well compensated, have pleasant work environments, and enjoy their work can still have low productivity when they are absent from work because of poor health [6].

Musculoskeletal symptoms rates are high among employed adults and have shown a consistent increase over the past few decades [7, 8]. Osteoarticular disorders have also been shown to increase the risk of sick leave and early retirement, causing high socioeconomic costs [9]. Work-related musculoskeletal disorders are a major cause of disability in working age individuals [10, 11]. Several studies have shown that repetitive work can contribute significantly to an increase in musculoskeletal disorders in workers and to absenteeism [7, 10, 12].

In 2003, a comprehensive study focusing on the economic return of occupational health promotion concluded that workplace programs resulted in a 25%–30% reduction in medical and absenteeism costs in an average period of ~3.6 years [6].

In this context, effective, well-documented initiatives for reducing weight, improving physical capacity, and reducing musculoskeletal pain among workers are, therefore, necessary [7, 10, 12]. PA interventions to improve muscle strength, stretch, and postural control, e.g., co-ordination training, may be particularly relevant for preventing osteoarticular deterioration in workers [13].

The aim of this study was to verify the effect of a workplace PA intervention program on musculoskeletal pain and related symptoms in different body regions in Portuguese workers.

2. MATERIALS AND METHODS

2.1. Study Design and Sampling

This study derives from a research project on PA at the workplace, which aims to decrease physical disability, indicated by musculoskeletal pain and related symptoms, increase work ability, and decrease sickness absence among workers with high physical work demands.

The intervention study was conducted between November 2010 and September 2011, in a multinational manufacturing company with offices in Portugal. The 11 months of the study included preliminary evaluation, selection of the intervention (TOI) and the reference (TOR) groups, and executing the intervention program that lasted 6 months. Evaluations took place at baseline and at the end of the intervention.

This study began with several introductory meetings on the project with the administration board, the medical department, the production department, the human resources department, and the workers. The total number of employees in the company was ~1000; however, only 220 were allowed by the administration board to participate in this study for the production flow not to be adversely affected. These employees were characterized by having repetitive work with moderate force demanding tasks, and a large amount of standing. Moreover, all the participants were full-time workers (40 h/week) and had been employed in the company for at least 6 months.

Thus, at the beginning of this intervention, 220 employees were invited (93 men, 128 women) to participate. From those, 212 agreed to participate (88 men, 124 women) in baseline evaluations. Seventy-four of those (33%) agreed to be randomly assigned to the TOI or TOR. There were 42 participants in the TOI and 31 participants in the TOR. Because 3 participants left the company before the beginning of the programme, the final number of participants in the TOI was 39 (Figure 1).

Groups were created based on the management of working teams, and day and evening/night shifts. This approach was chosen to avoid contamination between the TOI and TOR. The aim was to increase compliance and to facilitate the

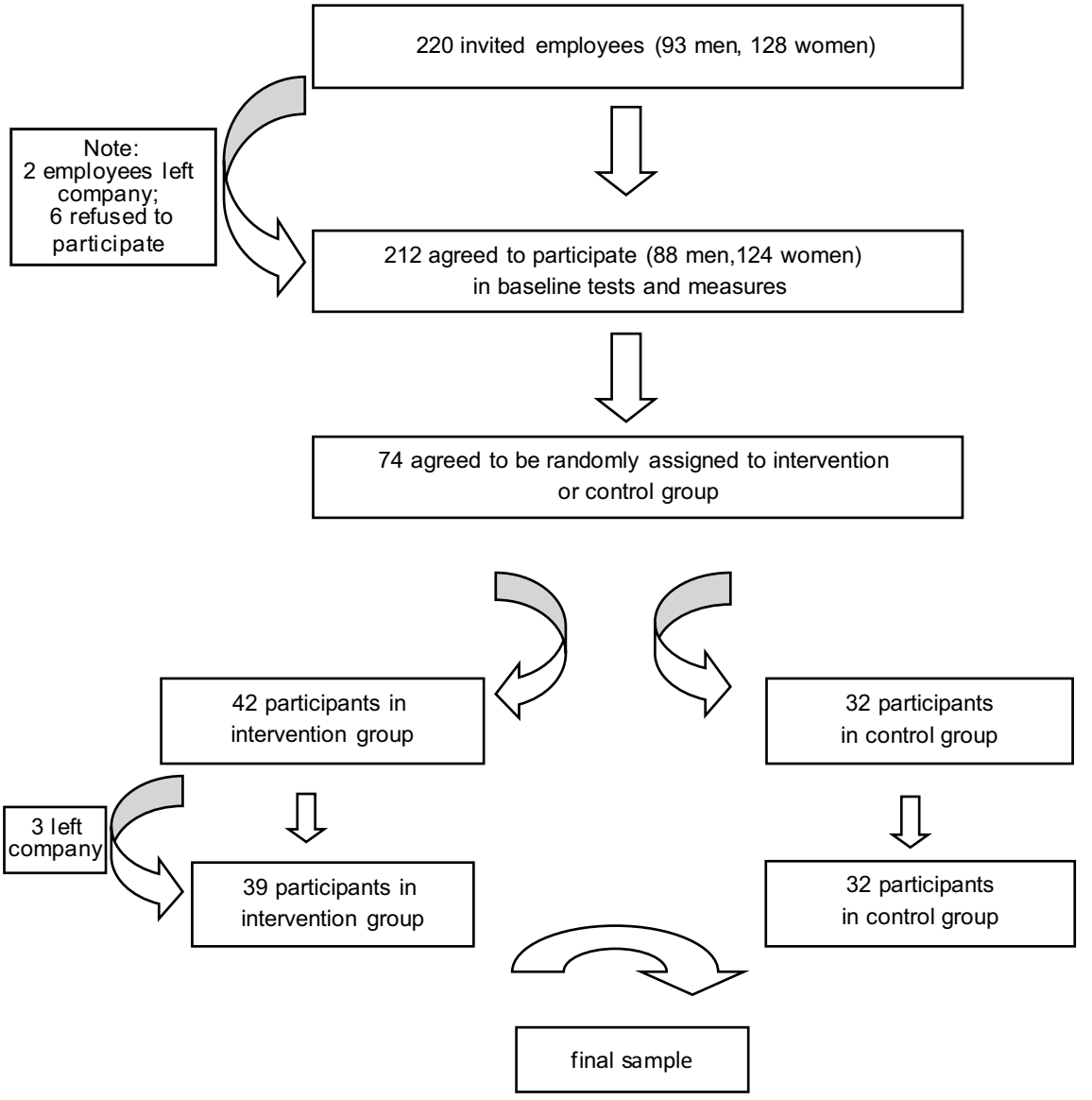

Figure 1. Flowchart of the participants

necessary practical arrangement at the workplace. It was, therefore, decided to integrate the intervention into work time.

A cluster formation of the groups was performed to assure equal allocation in the intervention. The randomization was done by an external research group, which had no knowledge of the workplace or the participants.

All participants were informed of the goals of the program and provided written informed consent to participate. The study was approved by the Faculty of Sport, University of Porto Ethics Committee; it was conducted in accordance with the Declaration of Helsinki [14].

2.2. Intervention Program

The intervention lasted 6 months. The training sessions were given during work time. The TOR consisted of one training group with their own instructor. The aim was to create a close-knit team spirit, which would hopefully help prevent dropouts. The same instructor gave all training sessions during the 6 months.

The physical training consisted of 10–15 min of physical exercise training three times a week and focused on stretching exercises to decrease some muscular tension in some body regions, specifically the hands, wrists, elbows, shoulders,

neck, and dorsal and lumbar regions to maintain physical capacity. Other exercises of general strength were also included and consisted of exercises for lower extremities (i.e., thigh, hip, knees, ankle, and feet). Participants took home a strength and stretching training program, illustrating these exercises, and were encouraged to perform them at home. In addition to the brief training sessions, participants were orally encouraged in all training sessions to initiate aerobic leisure time exercises such as biking, walking, running, or attending different sports in the local area.

2.3. Anthropometric Measures

Body height was measured to the nearest millimeter in bare or stocking feet with the participant standing upright against a stadiometer (Holtain, UK). Weight was measured to the nearest 0.10 kg, lightly dressed with a portable electronic weight scale (Tanita Inner Scan BC 532, Japan). Body mass index was calculated from the ratio between body weight (in kilograms) and body height (in squared meters). Participants were categorized as nonoverweight, overweight, and obese, applying the cut-off points suggested by the World Health Organization [15].

Percentage of body fat (%BF) was measured with a bioelectric impedance scale (Tanita Inner Scan BC 532, Japan), which was set to "standard" while body frame and the participant's age, height, and gender were entered.

Waist circumference was measured twice, with a nonelastic metal anthropometric tape, midway between the lower rib margin and the iliac crest at the end of normal expiration [16]. The average of the two measures was used for analysis. If the two measurements differed by over one centimeter, a third measurement was taken and the two closest measurements were averaged.

2.4. Blood Pressure

Blood pressure was measured in a seated position after 10 min of rest with an electronic blood pressure monitoring device (OSZ 5 Easy Welch Allyn, UK) on the left arm. Three measurements were done one minute apart and an average was calculated.

2.5. Sociodemographic Variables

Participants answered a questionnaire that assessed several sociodemographic variables (age, marital status, etc.).

2.6. PA

PA was assessed using the short version of the international PA questionnaire (IPAQ) [17]. Validity and reliability data from 12 countries (including Portugal) show IPAQ has comparable validity and reliability to a computer sciences and applications (CSA) monitor, which assesses physical activity, and to other self-reported measures of PA [18]. According to the Guidelines for Data Processing and Analysis of the IPAQ, total PA was expressed as metabolic equivalent (MET) by weighting the reported minutes per week in each activity category by the MET specific to each activity (total PA = 3.3 MET × walking minutes × walking days + 4.0 MET × moderate-intensity activity minutes × moderate days + 8.0 MET × vigorous-intensity activity minutes × vigorous-intensity days) [18]. PA was expressed as minutes per week by summing the time spent in moderate and vigorous PA (MVPA).

2.7. Musculoskeletal Disorders and Related Symptoms

Musculoskeletal pain and related symptoms was assessed a standardized Nordic questionnaire for the analysis of musculoskeletal symptoms (NMQ) [19], supplemented with questions about localized pain intensity. This questionnaire has been validated to the Portuguese population [20]. The NMQ consists of 27 binary choice questions (yes or no). The questionnaire has three questions on nine body regions (neck, shoulders, elbows, wrists/hands, dorsal region, lumbar region, hips/thighs, knees, and ankles/feet). The first question covers troubles or pain in the past 12 months, the second one addresses limitation caused by work in the daily activities in the past 12 months, and the third one deals with troubles or pain in the past 7 days. In the sense of facilitating the identification of body regions, the questionnaire also includes a body diagram depicting all of the involved body

regions [19]. The pain intensity in the past 7 days, includes a numeric pain scale of 0–10.

2.8. Statistical Analysis

Descriptive characteristics of the participants were presented as means, standard deviation, and percentages.

The Shapiro–Wilk test was used to assess the assumption of normality. The two-tailed *t* test was performed to compare groups for continuous variables and the χ^2 test for categorical variables. When the continuous variables were found not to be normally distributed, the Mann–Whitney test was used to determine differences between groups. For repeated measures, the paired-sample *t* test was used or the Wilcoxon signed-rank test when appropriate. In addition, McNemar's test was used to compare paired proportions.

The data was analyzed for statistical significance with SPSS 20.0 for Mac OXS; $p < .05$ was denoted as significant.

3. RESULTS

Table 1 shows descriptive characteristics of the TOR and TOI. A higher proportion of overweight and obese can be seen in the TOR before and after the intervention ($p < .05$, for all). No significant differences were seen in age, weight, height, blood pressure, body fat, and waist circumference across groups.

Concerning PA, in the TOR, MVPA decreased after the intervention ($p = .002$) and there was not a significant difference in the TOI after the intervention ($p = .966$). When we compare the differences in MVPA between groups, we can verify that the TOI group was more active than the TOR ($p = .010$). No differences were observed between groups before the intervention.

Table 2 verifies musculoskeletal pain in different body regions of the TOR and TOI before and after the PA program. No differences were seen between groups in musculoskeletal pain and related symptoms in baseline.

TABLE 1. Descriptive Characteristics of the Participants

	Reference (TOR) (*n* = 31)			Intervention (TOI) (*n* = 39)			*p* (T0C × T0I)	*p* (T1C × T1I)
Characteristic	**T0**	**T1**	***p***	**T0**	**T1**	***p***		
Age (years)[a]	38.8 (8.6)	–	–	38.0 (6.9)	–	–	.687[e]	–
Weight (kg)[b]	68.7 (17.6)	70.5 (20.4)	.165[d]	57.2 (15.2)	67.3 (18.4)	.194[d]	.298[f]	.104[f]
Height (m)[a]	1.62 (0.09)	–	–	1.62 (0.09)	–	–	.945[e]	–
BMI (kg/m^2)[b]	26.4 (3.5)	27.0 (3.8)	.179[d]	26.0 (6.8)	25.0 (7.4)	.194[d]	.202[f]	.057[f]
Weight status (%)			.102			.739	.043	.003
nonoverweight	25.8	19.4		46.2	51.3			
overweight	54.8	54.8		25.6	17.9			
obese	19.4	25.8		28.2	30.8			
Body fat (%)[a]	30.17 (9.61)	29.3 (9.8)	.183[c]	28.24 (10.97)	27.5 (11.5)	.514[c]	.441[e]	.502[e]
Waist circumference (cm)	91.1 (11.8)	92.7 (11.3)	.212[c]	90.3 (13.7)	89.5 (12.3)	.512[c]	.602[e]	.269[e]
Blood pressure (mmHg)[a]								
systolic	123.7 (14.3)	127.0 (17.1)	.290[c]	124.1 (12.5)	122.7 (17.7)	.477[c]	.909[e]	.305[e]
diastolic	75.5 (8.8)	75.9 (10.7)	.755[c]	75.2 (10.3)	74.7 (11.7)	.756[c]	.885[e]	.679[e]
MVPA (min/week)[b]	180 (390)	90 (135)	.002[d]	180 (390)	150 (345)	.966[d]	.798[f]	.010[f]

Notes. BMI = body mass index; MVPA = moderate and vigorous physical activity; T0 = before intervention; T1 = after the intervention; T0C = before intervention for the control group; T0I = before intervention for the intervention group; T1C = after intervention for the control group; T1I = after intervention for the intervention group; a = *M* (*SD*); b = *Mdn* (interquartile range); c = Student's *t* test for paired variables; d = Wilcoxon's test; e = Student's *t* test for independent variables; f = Mann–Whitney's test.

TABLE 2. Musculoskeletal Pain in Different Body Regions Before and After Physical Activity Program

Pain in Body Regions	Reference (TOR) ($n = 31$)			Intervention (TOI) ($n = 39$)				
	T0	T1	p [b,c]	T0	T1	p [b,c]	p (T0C × T0I) [d,e]	p (T1C × T1I) [d,e]
Neck								
12 m (% yes)	19 (61.3)	20 (64.5)	1	33 (56.4)	20 (51.3)	.774	.681	.266
limit (% yes)	7 (22.6)	6 (19.4)	1	11 (28.2)	2 (5.1)	.004*	.593	.063
7 days (% yes)	9 (29.0)	9 (29.0)	1	11 (28.2)	9 (23.1)	.774	.939	.571
pain intensity [a]	2 (5)	3 (5)	.727	3 (6)	(5)	.059	.494	.128
Shoulders								
12 m (% yes)	18 (58.1)	23 (74.2)	.267	26 (66.7)	28 (71.8)	.774	.459	.823
limit (% yes)	6 (19.4)	5 (16.1)	1	7 (17.9)	8 (20.5)	1	.881	.639
7 days (% yes)	9 (29.0)	12 (38.7)	.508	11 (28.2)	12 (30.8)	1	.939	.487
pain intensity [a]	3 (6)	3 (6)	.827	4 (7)	4 (5)	.269	.382	.918
Elbows								
12 m (% yes)	9 (29.0)	10 (32.3)	1	10 (25.6)	4 (10.3)	.109	.751	.022
limit (% yes)	5 (16.1)	4 (12.9)	1	3 (7.7)	3 (7.7)	1	.270	.470
7 days (% yes)	6 (19.4)	5 (16.1)	1	5 (12.8)	1 (2.6)	.125	.456	.044
pain intensity [a]	0 (5)	0 (3)	.752	0 (1)	0 (0)	.003*	.402	.015*
Wrists/hands								
12 m (% yes)	21 (67.1)	24 (77.4)	.508	26 (66.7)	25 (64.1)	1	.924	.227
limit (% yes)	7 (22.6)	8 (25.8)	1	15 (38.5)	9 (23.1)	.070	.155	.791
7 days (% yes)	11 (35.5)	10 (32.3)	1	12 (30.8)	10 (25.5)	.774	.677	.543
pain intensity [a]	3 (5)	4 (6)	.646	4 (7)	3 (6)	.083	.340	.537
Dorsal region								
12 m (% yes)	6 (19.4)	4 (12.9)	.625	8 (20.5)	4 (10.3)	.344	.904	.730
limit (% yes)	2 (6.5)	2 (6.5)	1	3 (7.7)	1 (2.6)	.625	.841	.425
7 days (% yes)	2 (6.5)	1 (3.2)	1	2 (5.1)	3 (7.7)	1	.813	.424
pain intensity [a]	0 (0)	0 (0)	.244	0 (2)	0 (0)	.015*	.064	.976
Lumbar region								
12 m (% yes)	22 (71.0)	23 (74.2)	1	24 (52.2)	23 (59.0)	1	.409	.183
limit (% yes)	9 (29.0)	5 (16.1)	.453	11 (28.2)	9 (23.7)	.727	.939	.438
7 days (% yes)	8 (25.8)	8 (25.8)	1	12 (30.8)	13 (33.3)	1	.648	.495
pain intensity [a]	3 (5)	4 (4)	.214	6 (7)	4 (6)	.083	.109	.440
Hips/thighs								
12 m (% yes)	6 (19.4)	9 (29.0)	.375	7 (17.9)	8 (20.5)	1	.881	.409
limit (% yes)	3 (9.7)	4 (12.9)	1	3 (7.7)	1 (2.6)	.625	.768	.095
7 days (% yes)	3 (9.7)	5 (16.1)	.625	1 (2.6)	1 (2.6)	1	.203	.044*
pain intensity [a]	0 (0)	0 (4)	.646	0 (1)	0 (0)	.408	.172	.455

Notes. *$p < .05$. T0 = before intervention; T1 = after the intervention; T0C = before intervention for the control group; T0I = before intervention for the intervention group; T1C = after intervention for the control group; T1I = after intervention for the intervention group; a = *Mdn* (interquartile range); b = McNemar's test for categorical variables; c = Wilcoxon's test for continuous variables; d = χ^2 test for categorical variables; e = Mann–Whitney's test; 12 m = troubles or pain in the past 12 months; limit = limitation caused by work in the daily activities in the past 12 months; 7 days = troubles or pain in the past 7 days.

TABLE 2. (*continued*)

Pain in Body Regions	Reference (TOR) (n = 31)			Intervention (TOI) (n = 39)				
	T0	T1	p [b,c]	T0	T1	p [b,c]	p (T0C × T0I) [d,e]	p (T1C × T1I) [d,e]
Knees								
12 m (% yes)	9 (29.0)	11 (35.5)	.727	11 (28.2)	17 (43.6)	.146	.939	.492
limit (% yes)	6 (19.4)	2 (6.5)	.125	3 (7.7)	2 (5.1)	1	.148	.813
7 days (% yes)	4 (12.9)	4 (12.9)	1	6 (15.4)	8 (20.5)	.754	.768	.401
pain intensity [a]	0 (3)	0 (3)	.478	0 (3)	0 (3)	.985	.821	.920
Ankles/feet								
12 m (% yes)	14 (45.2)	16 (51.6)	.774	18 (46.2)	16 (41.0)	.754	.934	.377
limit (% yes)	4 (12.9)	3 (9.7)	1	5 (12.8)	4 (10.3)	1	.992	.936
7 days (% yes)	5 (16.1)	10 (32.3)	.180	6 (15.4)	10 (25.6)	.219	.932	.543
pain intensity [a]	0 (3)	3 (7)	.012	1 (5)	0 (6)	.351	.314	.299

Notes. *$p < .05$. T0 = before intervention; T1 = after the intervention; T0C = before intervention for the control group; T0I = before intervention for the intervention group; T1C = after intervention for the control group; T1I = after intervention for the intervention group; a = *Mdn* (interquartile range); b = McNemar's test for categorical variables; c = Wilcoxon's test for continuous variables; d = χ^2 test for categorical variables; e = Mann–Whitney's test; 12 m = troubles or pain in the past 12 months; limit = limitation caused by work in the daily activities in the past 12 months; 7 days = troubles or pain in the past 7 days.

The results showed that the TOI participants after the PA intervention felt less limitation caused by work in daily activities in the past 12 months in the neck (p = .004) and the pain intensity decreased after the PA intervention (p = .059). If we compare the differences between the two groups, we can verify that the TOI felt less limitation caused by work in daily activities in the past 12 months in the neck (p = .063).

After the intervention, the TOI showed some significant results regarding a decrease in the intensity of pain in some body regions evaluated: the elbow (p = .03) and dorsal region (p = .015).

Although not statistically significant in this study, there were some results that should be examined, because there is a tendency toward a decrease in the intensity of pain in the neck (p = .059), in the wrist/hand (p = .083), and in the lumbar region (p = .083).

If we compare the TOR and TOI after the 6 months of the PA program, we can demonstrate that in the elbow and thigh/hip regions, the pain intensity decreased significantly, and there is some trend to show statistically significant results in the neck region (p = .063).

4. DISCUSSION

This study assessed the effects of a workplace PA intervention program on musculoskeletal pain in different body regions in Portuguese workers.

When the physical work demands exceed the safety margin of the individual physical capacities, this environment is generally considered to enhance the risk for physical deterioration, musculoskeletal disorders, poor work ability, and sickness absence [2]. However, effective interventions for preventing physical deterioration in job groups at high risk still need to be established.

This feature of the program enhances the probability for enabling evidence-based information for public health policy and health promotion strategies among employees in job groups with high risk for physical deterioration. Another strength of the program is that the interventions take place at the workplace, providing a high external validity of the findings.

A significant proportion of the participants of this study reported musculoskeletal pain in some parts of the body. This study also verified musculoskeletal pain with significant intensity in some

body regions, particularly in the neck, elbow, dorsal region, thigh/hip, and ankle/feet, decreased after this intervention program.

The PA program was based on stretching exercises. These types of exercises are not appropriate for health gains in terms of weight, blood pressure, body fat, and waist circumference [10, 21, 22]. As expected, there were no significant differences in weight, blood pressure, body fat, and waist circumference across groups.

These results are in line with other studies that observed significant health impact of PA worksite interventions. Indeed, several studies observed a high prevalence of musculoskeletal disorders, sickness absence, and work disability [7, 23]. Improving workers' daily PA may prevent weight gain and subsequently improve workers' health, increase productivity, and reduce absenteeism [11]. In this vein, a randomized, controlled trial included 16 school worksites (eight of intervention and eight of control). Intervention schools formed committees to develop and implement health promotion activities for employees. Anthropometric measures and PA self-report data were collected at baseline and at the end of the intervention (2 years later). The primary outcome measure was PA. This participatory intervention resulted in a modest improvement in health status and possible unmeasured secondary gains, such as improved morale and increased productivity [24].

Work which included plenty of twisting movements of the trunk, working with the trunk forward flexed, or the hands above shoulder level were important work-related risk factors. Musculoskeletal pain of a working-age population has many risk factors of which age, stress, and work-related physical loading seem to play an important role. By affecting the latter factors, it may be possible to decrease the prevalence of musculoskeletal symptoms and maintain a good ability to work. Due to high morbidity rates, the importance of preventive measures must be emphasized. When studying the associations between physical exercise and musculoskeletal pain among the working-age population, researchers should pay attention to the factors which are strongly related to pain, such as stress and work-related physical loading. More research with prospective design is necessary to achieve more reliable information of the true effects of physical exercise on musculoskeletal health. The risk factors for musculoskeletal pain form a complex mesh, many factors of which (e.g., the amount of exercise practiced) are difficult to measure in epidemiological research [4, 7].

The results presented here are also in agreement with those reported by Sethi, Sandhu, and Imbanathan, conducted among 301 workers with different jobs and shifts in an engineering plant, in which they found a significant association between high PA and a decrease in scores of musculoskeletal discomfort and occupational stress [25].

In addition, the quality (i.e., different modes) and quantity of exercise should be specified. This program of PA was based on programs of several studies. What differentiates this program (10–15 min three times/week) from other programs in others studies is the blend of stretching exercises to decrease some muscular tension in some regions to maintain physical capacity along with exercises of general strength. Participants also took home the strength and stretching training program, illustrating these exercises, and were encouraged to perform them at home. In addition to the brief training sessions, participants were encouraged orally in all training sessions to initiate aerobic leisure time exercises, e.g., biking, walking, running, or attending different sports in the local area.

5. LIMITATIONS OF THE STUDY

A limitation of the program is that only simple measures of process evaluation such as the proportion of workers in uptake, the actual start of the program, and the actual completion of the intervention program were collected. Moreover, no economical cost-effectiveness evaluations were included. Another limitation is that the intervention among factory workers was an exploratory study that was not well controlled.

6. CONCLUSION

The study population of the program (i.e., employees in job groups with high physical demands) is well documented to have a high risk for physical deterioration. If proven effective, the specific tailored interventions to the different job groups can provide meaningful scientifically-based information for public health policy and health promotion strategies for employees in these job groups at high risk for physical deterioration. This knowledge can be beneficial for occupational health professionals, supervisors, companies, and employees in these job groups. Because the interventions were carried out during ordinary circumstances at a wide range of workplaces, it is expected that the findings can be transferred and that the interventions implemented in other workplaces with high physical demands will have similar results. In conclusion, our intervention (our dose–response) was cost effective because the program had a low dose of PA but had a high response (i.e., a benefit for health). Despite the difficulties, an epidemiological perspective is necessary since both musculoskeletal disorders and physical exercise concern vast populations.

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