



**Impact of workplace exercise program in the musculoskeletal
symptomatology of warehouse workers: randomized control trial**

**Impacto do programa de exercício no local de trabalho na sintomatologia
músculo-esquelética dos trabalhadores de armazém: ensaio de controle
aleatório**

**Impacto del programa de ejercicios en el lugar de trabajo en la
sintomatología musculoesquelética de los trabajadores de almacén: ensayo
aleatorizado de control**

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Abstract

In industrialization sector, musculoskeletal disorders are very frequent and can be considered as one of the main problems. They are associated with pain, discomfort, and functional limitations. Exercise programs can improve the symptomatology and daily life activities. Aims: Evaluate the impact of a 21-month exercise program on musculoskeletal symptoms reports of warehouse workers. Methods and Materials: This study was a randomized controlled trial based on CONSORT guidelines. Sample was 249 male workers, randomized in two groups (96 intervention and 124 control group). The Portuguese version of Nordic Musculoskeletal Questionnaire was used to evaluate the musculoskeletal symptomatology at baseline (M0), after 11 months (M1) and after 21 months (M2). The flexibility, mobility and strengthening exercises were executed at the beginning of the working time, once a day,

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lasting eight minutes. The data were analyzed in SPSS® 25.0 for Windows® ($p < 0.05$). Results: We verify a higher prevalence of problems in different body regions at both groups. The most common symptom, with higher proportion across all variables, was the low back region, followed by the neck, in both groups. Most symptomatology was low back region in both groups before intervention. In the intervention group, was verified decrease of symptoms, “problems in the last 12 months”, at M0/M1 ($p = 0.005$) and M0/M2 ($p = 0.021$); “limitations in the last 12 months”, at M0/M1 ($p = 0.004$) and M0/M2 ($p < 0.001$); and “problems in the last 7 days”, at M0/M1 ($p = 0.017$) and M0/M2 ($p = 0.02$). In the control group was verified an increased symptoms at M0/M2 ($p = 0.038$) in “problems in the last 12 months”. Conclusions: It can be concluded that the implementation of a 21-month workplace exercise program contributes to decrease the report of low back symptoms of warehouse workers.

Keywords: Musculoskeletal Disorders. Musculoskeletal Symptoms. Nordic Musculoskeletal Questionnaire. Occupational Health.

Resumo

No setor da industrialização, as perturbações músculo-esqueléticas são muito frequentes e podem ser consideradas como um dos principais problemas. Eles estão associados com dor, desconforto e limitações funcionais. Os programas de exercícios podem melhorar a sintomatologia e as atividades da vida diária. Objetivos: Avaliar o impacto de um programa de exercício de 21 meses nos relatórios de sintomas musculoesqueléticos dos trabalhadores do armazém. Métodos e Materiais: Este estudo foi um ensaio controlado aleatório baseado nas diretrizes CONSORT. A amostra foi de 249 trabalhadores do sexo masculino, randomizados em dois grupos (96 de intervenção e 124 de controle). A versão portuguesa do Questionário Musculoesquelético Nórdico foi utilizada para avaliar a sintomatologia musculoesquelética no início do estudo (M0), após 11 meses (M1) e após 21 meses (M2). Os exercícios de flexibilidade, mobilidade e fortalecimento foram realizados no início do horário de trabalho, uma vez por dia, com duração de oito minutos. Os dados foram analisados no SPSS® 25.0 para Windows® ($p < 0,05$). Resultados: Verificamos uma maior prevalência de problemas em diferentes regiões do corpo em ambos os grupos. O sintoma mais comum, com maior proporção em todas as variáveis, foi a região lombar, seguida pelo pescoço, em ambos os grupos. A maior parte da sintomatologia foi região lombar baixa em ambos os grupos antes da intervenção. No grupo de intervenção, foi verificada diminuição dos sintomas, "problemas nos últimos 12 meses", em M0/M1 ($p = 0,005$) e M0/M2 ($p = 0,021$); "limitações nos últimos





12 meses", em M0/M1 ($p=0,004$) e M0/M2 ($p<0,001$); e "problemas nos últimos 7 dias", em M0/M1 ($p=0,017$) e M0/M2 ($p=0,002$) 02). No grupo controle foi verificado um aumento dos sintomas em M0/M2 ($p=0,038$) em "problemas nos últimos 12 meses". Conclusões: Pode-se concluir que a implementação de um programa de exercício no local de trabalho de 21 meses contribui para diminuir o relato de sintomas de lombada baixa dos trabalhadores do armazém.

Keywords: Transtornos Musculoesqueléticos. Sintomas Musculoesqueléticos. Questionário Musculoesquelético Nórdico. Saúde do Trabalho.

Resumen

En el sector de la industrialización, los trastornos musculoesqueléticos son muy frecuentes y pueden considerarse uno de los principales problemas. Se asocian con dolor, molestias y limitaciones funcionales. Los programas de ejercicios pueden mejorar la sintomatología y las actividades de la vida diaria. Objetivos: Evaluar el impacto de un programa de ejercicios de 21 meses en los informes de síntomas musculoesqueléticos de los trabajadores de almacén. Métodos y materiales: Este estudio fue un ensayo controlado aleatorizado basado en las directrices de CONSORT. La muestra fue de 249 trabajadores varones, aleatorizados en dos grupos (96 de intervención y 124 de control). Se utilizó la versión portuguesa del cuestionario musculoesquelético nórdico para evaluar la sintomatología musculoesquelética al inicio (M0), después de 11 meses (M1) y después de 21 meses (M2). Los ejercicios de flexibilidad, movilidad y fortalecimiento se ejecutaron al inicio del tiempo de trabajo, una vez al día, con una duración de ocho minutos. Los datos fueron analizados en SPSS® 25.0 para Windows® ($p<0.05$). Resultados: Se constata una mayor prevalencia de problemas en diferentes regiones del cuerpo en ambos grupos. El síntoma más común, con mayor proporción en todas las variables, fue la región lumbar, seguida del cuello, en ambos grupos. La mayoría de los síntomas fueron región lumbar en ambos grupos antes de la intervención. En el grupo de intervención se verificó disminución de síntomas, "problemas en los últimos 12 meses", en M0/M1 ($p=0,005$) y M0/M2 ($p=0,021$); "limitaciones en los últimos 12 meses", en M0/M1 ($p=0,004$) y M0/M2 ($p<0,001$); y "problemas en los últimos 7 días", en M0/M1 ($p=0,017$) y M0/M2 ($p=0,02$). En el grupo control se verificó un aumento de los síntomas en M0/M2 ($p=0,038$) en "problemas en los últimos 12 meses". Conclusiones: Se puede concluir que la implementación de un programa de ejercicios en el lugar de trabajo de 21 meses contribuye a disminuir el reporte de síntomas lumbares de los trabajadores de almacén.





Palabras clave: Trastornos Musculoesqueléticos. Síntomas Musculoesqueléticos. Cuestionario Musculoesquelético Nórdico. Salud Laboral.

Introduction

Nowadays, due to technological advances and industrialization, musculoskeletal disorders are very frequent and can be considered as one of the main problems in this sector at industrialized countries (EU-OSHA, 2019). These disorders have been associated with individual and biomechanical risk factors of tasks and occupational environment (physical, social, psychological, and ergonomic conditions), developed slowly and gradually, and sometimes remains untreated, being one of the main causes of absenteeism from work (Andersen et al., 2018).

Other risk factors that can influence the development of musculoskeletal injuries are the repetitive motion patterns, the heavy lifting, and forceful manual exertions, segmental or whole-body vibrations, local or whole-body exposure to cold, and insufficient recovery time (Bevan, 2015; EU-OSHA, 2019). Three to five worker reports the presence of an injury, with the most predominant body regions being the neck and low back regions (Korhan & Ahmed Memon, 2019; World Health Organization, 2022) followed by upper and lower limbs (Abareshi et al., 2015; Shaw et al., 2017).

Low back pain is the most common symptom, being sporadic and self-limiting, being considered the condition with the most impact on average lifetime by the global burden disease (Shaw et al., 2017). In Portugal, almost 30% of the workers suffer with low back pain (EU-OSHA, 2019). Some cases of musculoskeletal disorders can be attributed to occupational exposures. Only in the United States of America, these disorders accounted almost 400.000 workers resulting, at least one workday lost (Shaw et al., 2017). Professional activities, such as those taking place in the warehouse or industrial context, with the need to carry hand loads and lifting are directly associated with pain or lumbar discomfort of the participants. The high shear forces in the lumbar region, which arise mainly from the transport or lift of the load, appear as one of the major risk factors (EU-OSHA, 2019; Kerr et al., 2001; Levangie & Norkin, 2005; Shaw et al., 2017).

Over the last few years, several therapeutic approaches have been used to resolve these conditions. Regarding prevention, labor gymnastics programs are the most frequent response





and with better results in the resolution and prevention of symptoms (Eurofound, 2019; Goetzel & Ozminkowski, 2008; Moreira-Silva et al., 2016). These programs have been demonstrating an increase in muscle strength, a reduction in pain level and a decrease in fatigue (Cunha Laux et al., 2018; Machado-Matos & Arezes, 2016; Moreira-Silva et al., 2016).

The aim of this study was to evaluate the effects of an exercise program in musculoskeletal symptomatology of warehouse workers with a follow up of 21 months.

Materials and Methods

2.1 Study Design

This study was a randomized controlled trial based on CONSORT guidelines.

2.2 Sample

The population used in this study was 557 warehouse male warehouse workers from a distribution company in Portugal. All workers were involved in a routine of overcharge tasks and/or repetitive movements and they worked under low temperatures during all seasons of the year. According to the company norms, all workers wore cold protective clothing, gloves, boots and lumbar support belts.

Warehouse workers were deemed eligible if they met the following criteria: a) they had a contract for three or more years; b) they performed the same task type (assembly and disassembly pallets). On the other hand, it excluded individuals who: a) were required to rotate work positions; b) were absent from work because of back pain; c) had severe back pain (Visual Analogue Scale – VAS \geq 5) in the last year; d) had undergone treatment (conservative or surgical) to low back pain for the last year; and e) had been diagnosed with any kind of pathology which could prevent them from participating in the program (Sculco et al., 2001).

After informing the clinical physician and human resources staff of the company about the criteria that would have to be considered for subject selection, the company has provided us with an alphabetically organized list of 249 eligible workers, corresponding to 44.70% of the population.

The subjects were asked to volunteer to participate in the study under written consent. The sample was randomized by Excel® RAND (Washington, USA) function in two groups





(125 in the intervention group and 124 in the control group), with blindness of participants. After the randomization, some participants refuse to participate in the study, remaining 96 in the intervention group and 124 in the control group.

At baseline the mean of the age in the intervention group was 34.55 ± 8.47 and in the control group was 32.31 ± 9.85 (Table 1).

Table 1

Sample characterization

Variables	Intervention group (n=96)			Control group (n=124)		
	Mean \pm SD	Min	Max	Mean \pm SD	Min	Max
Age	34.55 \pm 8.47	19	53	32.31 \pm 9.85	18	56
Height (cm)	173 \pm 0.07	160	188	178 \pm 0.09	159	188
Weight (kg)	76.54 \pm 10.44	55	95	81.07 \pm 16.84	60	110

SD (standard deviation); Min (minimum); Max (maximum); cm (centimeters); kg (kilograms);

2.3 Instruments

The Portuguese version of the Nordic Musculoskeletal Questionnaire (NMQ) was used to evaluate musculoskeletal symptomatology of subjects (Mesquita et al., 2010). This questionnaire has a Kuder-Richardson reliability of 0.855 and a test-retest reliability in the Cohen's kappa coefficient test between 0.677 and 1 (Mesquita et al., 2010). The Portuguese version of the NMQ consists of 27 binary choice questions (yes or no). The questionnaire has three questions correlating to nine anatomic regions (neck, shoulders, wrists/hands, upper back, low back, hips/thighs, knees, ankles/feet), addressing three variables: in the first, subjects are asked if they felt any problems in the last 12 months; the second variable subjects are asked if they felt any work-related limitation in their daily activities in the last 12 months; the third addresses problems felt in the last 7 days (Kuorinka et al., 1987). According to the original author of the questionnaire, for "problems" we must understand pain or discomfort (Kuorinka et al., 1987). For a clear identification of body regions, the questionnaire also includes a figure of the human with nine body regions shaded and defined (Kuorinka et al., 1987; Mesquita et al., 2010).

2.4 Procedures

Before the application of this study, it was realized a pilot study to understand if was necessary any modification. The exercise program was implemented in several stages. In a





first moment, visits to the facilities allowed to know the type of tasks executed by workers and the most common injuries. Upon evaluation of risks and most repeated gestures, an adequate exercise program was created. This program was executed daily, at the beginning of the working time, in the company facilities, included nine exercises, easy to perform and suitable for the workplace, consisted in exercises to promote mobility, flexibility and strength. Each exercise was performed in set of 10 repetitions with 10 seconds 'pause between each cycle of exercises, lasting approximately eight minutes. The exercises can be consulted at appendix 1.

To motivate workers to adhere to the program and follow it, there were several training sessions, and posters illustrating the exercise program to execute were distributed in the company facilities. Also included regular visits of physiotherapists each two weeks to correct possible execution errors or to answer doubts and questions from workers.

The evaluations were made at three moments – at baseline (M0), after 11 months (M1), and after 21 months (M2). It was offered to the control group participants, at the end of the study, the possibility of executing the exercise program.

The study was conducted between February 2009 and March 2011 with the company authorization, and according to a deal between the involved institutions, who doesn't allow us to share the raw data, only allowed us to share the statistical results.

2.5 Statistical

Exploratory data analysis and sample characterization were performed using descriptive statistics.

The Mann-Whitney U test was used to verify if it exists any difference between groups in the different variables (problems in the last 12 months; limitations in the last 12 months; problems in the last 7 days) on M0.

The Q Cochran's test was used to verify differences in musculoskeletal symptomatology between moments in intervention and control group. To verify in which assessments (M0-M1; M1-M2; M0-M2), the changes occurred with statistically significant differences it was used the McNemar test.

The level of significance was set at 0.05, with 95% confidence intervals. Statistical analysis was conducted using SPSS® 25.0 for Windows® (New York, USA).





2.6 Ethical Considerations

This project was carried out in accordance with the recommendations of the American Psychological Association's Code of Ethics and the Declaration of Helsinki. It was developed an institutional protocol approved by the Health School of Polytechnic of Porto.

All the participants were informed about the study aims and procedures and they provided consent for their participation. The participants could refuse to participate in the study at any point under Law 67/98 of 26 October 1998 (Law on the Protection of Personal Data transposing into the Portuguese legal system Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995) on the protection of individuals regarding the processing of personal data and on the free movement of such data.

Results

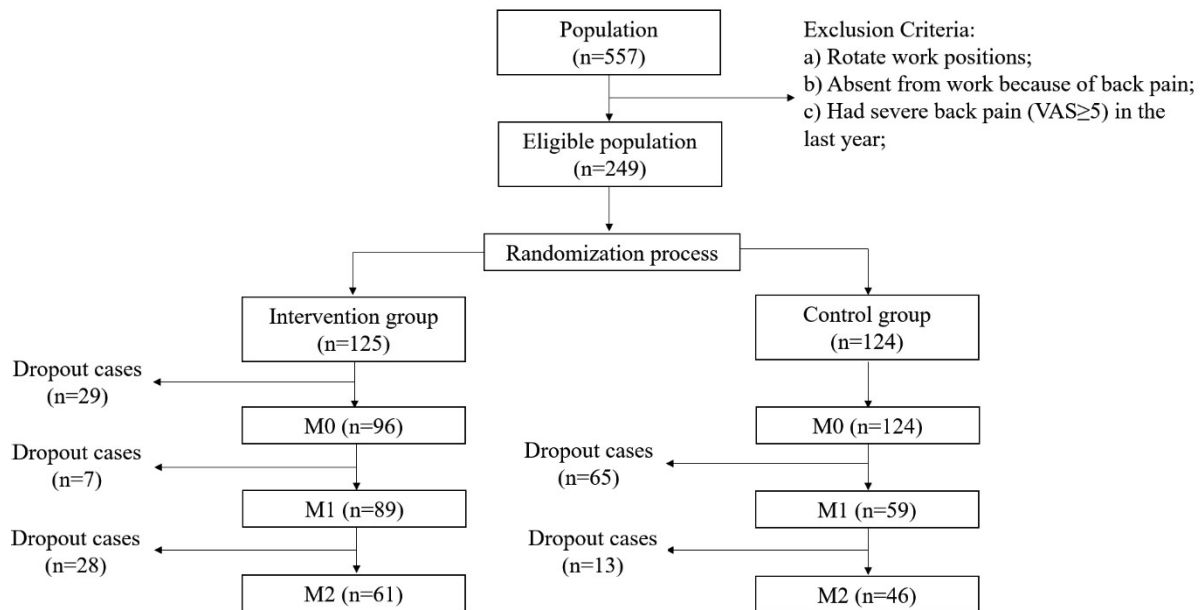
At the baseline, the sample included 96 participants for the intervention group and 124 for the control group. From the M0 to M1 in the intervention group was a total loss of 7.29% (n=7) and in the control group, of 52.42% (n=65). From the M1 to M2 in the intervention group was a total loss of 31.46% (n=28) and in the control group of 22.03% (n=13) (Figure 1).





Figure 1

Sample flow-chart



Before the exercise program begin, we had 29 workers that refused to be part of the program. After 21 months, the sample was reduced to approximately 57%. These losses resulted due workers leaving the company, changing workplace, or not answering the questionnaire.

At the baseline (M0) symptoms proportions were identical in both groups, except for low back region, in all the variables (problems in the last 12 months; limitation in the last 12 months; problems in the last 7 days).

The most common symptom, with higher proportion in all variables was the low back region, followed by the neck, in both groups (Table 2).





Table 2

Proportion of musculoskeletal symptomatology and differences in the intervention and control group, at baseline, after 11 and 21 months in different variables (problems in the last 12 months; limitation in the last 12 months; problems in the last 7 days)

Regions	Musculoskeletal Symptomatology																												
	Intervention group							Control group																					
	Problems in the last 12 months				Limitation in the last 12 months			Problems in the last 7 days				Limitation in the last 12 months			Problems in the last 7 days														
	M0	M1	M2	%	p ⁽¹⁾	M0	M1	M2	%	p ⁽¹⁾	M0	M1	M2	%	p ⁽¹⁾	M0	M1	M2	%	p ⁽¹⁾									
Neck	20.3	20.3	26.1		NS	4.2	8.5	4.3		NS	6.3	11.9	8.7		NS	10.5	9.0	23.0		NS	4.0	5.6	4.9		NS	8.1	5.7	3.3	NS
Shoulders	18.8	10.2	10.9		NS	6.5	8.5	2.2		NS	9.4	8.5	6.5		NS	11.3	14.8	13.1		NS	4.8	8.0	3.3		NS	6.5	5.7	3.3	NS
Elbows	2.1	1.7	2.2		NS	2.1	1.7	0.0		NS	18.8	10.3	8.7		NS	0.8	1.1	4.9		NS	0.0	0.0	0.0		NS	0.8	0.0	3.3	NS
Wrists/Hands	18.8	10.3	8.7		NS	10.4	10.2	0.0		NS	10.4	11.9	4.3		NS	21.0	6.7	23.0		NS	10.6	2.2	3.3		NS	13.0	4.5	13.1	NS
Upper Back	12.5	6.8	4.3		NS	9.4	5.1	0.0		NS	7.3	3.4	0.0		NS	8.9	9.0	11.5		NS	4.1	5.6	1.6		NS	7.3	6.7	6.6	NS
Low Back	58.3	40.7	39.1		0.022	38.9	21.7	8.7		<0.001	46.9	30.5	17.4		<0.001	35.5	33.7	52.5		0.048	18.5	21.3	21.3		NS	28.2	29.2	26.2	NS
Hips/Thighs	11.5	3.4	2.2		NS	7.3	3.4	0.0		NS	6.3	3.4	0.0		NS	11.5	9.0	4.9		NS	4.0	5.7	1.6		NS	6.5	5.7	3.3	NS
Knees	9.4	15.3	10.9		NS	4.2	6.8	2.2		NS	3.1	11.9	2.2		NS	17.7	12.8	8.2		NS	8.1	9.1	4.9		NS	8.9	2.3	1.6	NS
Ankles/Feet	9.4	13.6	8.7		NS	6.3	10.2	4.3		NS	8.3	11.9	6.5		NS	10.5	6.8	3.3		NS	5.6	5.7	0.0		NS	6.5	3.4	3.3	NS

M0 (baseline); M1 (after 11 months); M2 (after 21 months); % - relative frequency; ⁽¹⁾ significant value of Cochran's Q test to verify differences in musculoskeletal symptomatology between moments in intervention and control group; NS: not significant.





In the intervention group, from M0 to M2, most of the assessment regions (shoulders, elbows, wrists/hands, upper back, low back, hips/thighs, knees and ankle/feet) showed a decrease of the symptoms in all variables (problems in the last 12 months; limitations in the last 12 months; problems in the last 7 days), except the elbows and the knees in the variable “problems in the last 12 months” that were increased. The neck region showed a slight increase in all variables (problems in the last 12 months; limitations in the last 12 months; problems in the last 7 days).

In the control group, from M0 to M2, in the variable “problems in the last 12 months” the results indicated an increase of symptomatology on the neck, shoulders, elbows, wrists/hands, upper back and low back regions and a decreased on the hips/thighs, knees and ankles/feet regions.

To verify differences between moments in the intervention and control group, it was used the Cochran’s Q test. In the intervention group, it was observed statistically significant differences in the low back region in the three variables: “problems in the last 12 months” ($p=0.022$); “limitations in the last 12 months” ($p<0.001$) and “problems in the last 7 days” ($p<0.001$). In the control group, the results showed statistically significant differences in the low back region, for the variable “problems in the last 12 months” ($p=0.048$).

Since there were only statistically significant results for the low back region, it was performed the McNemar test to verify in which moment these differences occurred (Table 3). In the intervention group, the results have showed statistically significant differences to the decrease of the symptoms in the variable “problems in the last 12 months” at M0/M1 ($p=0.005$), and at M0/M2 ($p=0.021$). Regarding to the variable “limitations in the last 12 months” at M0/M1 ($p=0.004$) and at M0/M2 ($p<0.001$) was observed a decrease of the symptomatology, the same was observed in the variable “problems in the last 7 days” at M0/M1 ($p=0.017$) and at M0/M2 ($p=0.02$). In the control group, the results have showed statistically significant differences in the increase of the symptoms in the variable “problems in the last 12 months” at M0/M2 ($p=0.038$).

Table 3

Application of McNemar test to verify differences in the low back region between moments

Low back region	Intervention group			Control group		
	M0-M1	M1-M2	M0-M2	M0-M1	M1-M2	M0-M2
	P	P	P	P	P	P
Problems in the last 12 months	0.005	NS	0.021	NS	NS	0.038
Limitations in the last 12 months	0.004	NS	<0.001	NS	NS	NS





Problems in the last 7 days	0.017	NS	0.02	NS	NS	NS
M0(baseline); M1 (after 11 months); M2 (after 21 months); p –value; NS: not significant.						

Discussion

In general, in the study population was observed a higher prevalence of musculoskeletal symptomatology in the different evaluation moments. The low back region was the body region which represent the greatest proportion of problems reported as limitation to personal and work-related activities in the last 12 months in both groups. That finding shows that besides being the most frequent symptom, low back symptoms was also the most incapacitating. These results are consistent with several studies which refer that low back pain is the major cause of diminished work capabilities, limitation, resulting in work-absenteeism, substantial health-care related expenses and productivity losses (Chou et al., 2018; Hartvigsen et al., 2018; Michel et al., 2018). Despite the results are not statistically significant, it is important to point out that our study showed that the intervention group decreased its reported limitations of musculoskeletal symptomatology in all regions. Nevertheless, in control group, this symptomatology increase in most of the regions. It's also important to notice that individuals with low back symptoms showed an increased in functional capacity following the participation in the exercise program. These findings are similar to other studies which show that with the implementation of a exercise program could be a factor that lead to an improvement of a labor participation (Chou et al., 2018; Kelly & et al, 2014; Leite-Moreira et al., 2006; Miyamoto et al., 2018; Moreira-Silva et al., 2016; Shaw et al., 2017; Vasseljen et al., 2014).

Although the low back is the most affected region, symptoms have decreased in the intervention group during this study, being differences statistically significant between M0 and M1 and between M0 and M2. There were not statistically significant differences for the remaining regions of the body, the decrease in symptoms was notorious. These results were similar to the ones obtained in a meta-analysis, made by Moreira-Silva et al. (Moreira-Silva et al., 2016) that analyze the effectiveness of physical activity interventions in the workplace to reduce musculoskeletal symptoms and it proves that a specific program of physical activity in the workplace significantly reduces musculoskeletal symptomatology (Moreira-Silva et al., 2016).

The neck, shoulder and wrist/hands were the regions that also presents a higher symptomatology, however, with a low limitations of daily life activities. Despite weren't





statistically significant, the results showed a decreased of symptomatology in last 12-month in intervention group and a slight increase or maintenance in control group. This fact, were probably related to that the pain felt in the shoulder was a result of cervical radiating pain, which became centralized as a benefit of executing the exercise program, which included specific exercises for these body regions (Feyer et al., 2000). Among the musculoskeletal symptoms, radiation of the pain is common and it can become centralized with the implementation of a intervention program (Seeley et al., 2005; Steenstra et al., 2017; Visser & Van Dieën, 2006).

From M1 to M2 there was no statistically significant evidence of a decrease in musculoskeletal symptoms in any region. At that time, the company suffers major alterations regarding management and logistic, which imply several modification of environment and the workers are obligated to do some extra-hours of work. These modifications are also probably related to an increase of anxiety/stress levels, that could affect the general workers well-being. The presence of psychological factors as anxiety and insecurity in people with low back symptoms is associated with the risk of developing disability (Hartvigsen et al., 2018; Lardon et al., 2018). Anxiety, is also, associated with pain, growth of symptomatology and pain behaviors (Andersen et al., 2018; Belache et al., 2018).

In Kasai, a strengthening exercise program, designed to increase low back flexibility, has contributed to improve subjects functional ability (Kasai et al., 2006). In fact, exercise effects on functional ability only persist if they are executed for long periods (Kelly & et al, 2014; Moreira-Silva et al., 2016; Peate et al., 2007; Steenstra et al., 2017). Throughout the 21-months follow-up there were no statistically significant differences in almost the regions (neck, shoulders, elbows, wrists/hands, upper back, thighs/hips, knees and ankles/feet), the results showed a decrease of the musculoskeletal symptoms in the intervention group.

Besides of the musculoskeletal symptoms decrease in the intervention group, we cannot affirm that decreases resulted only from the exercise program. On a field study of occupational health, it is not possible control all the variables that can influence the results obtained, as like the effect of contamination caused by all the posters with the exercise program available in the workplace or by the fact of the workers from the control group saw the others executing the exercises.

A limitation of this study was the impossibility of controlling subjects' tasks, resting time, eating habits and leisure and sports activities executed by subjects in non-working time and the fact of the effect of contamination between groups was not considered. However, these





limitations are difficult to control in real life situations, although the whole team has been always interested and attentive to motivate individuals to participate and to understand the importance of this study. Another limitation was the loss of participants, and despite the randomization at baseline the percentage of symptoms between groups differs, with the intervention group having high symptoms in all regions compared to the control group, with may point to possible bias.

Conclusions

Despite the withdrawals and limitations found throughout the study, it seems that it can be concluded that the implementation of a 21-month workplace exercise program contributes to decrease the report of low back symptoms of warehouse workers.

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