Title: Effect of a Brief Progressive Resistance Training Program in Hospital Porters on Pain, Work ability, and Physical Function

ABSTRACT

Background: Hospital porters are possibly exposed to the greatest mechanical loads within the hospital environment. However, the evidence about preventive strategies in this population is scarce.

Objective: To investigate the effect of a workplace-based progressive resistance-training program on musculoskeletal pain among hospital porters.

Method: A total of 37 hospital porters (27 women, 10 men) participated. Participants allocated to the intervention group performed five brief resistance training sessions/week, for 9 weeks during working hours at the hospital. Intensity was progressively increased. Participants allocated to the control group maintained their usual physical activity. The primary outcome was pain assessed with the patient global impression of pain change scale. Secondary outcome measures were average pain intensity, work ability, use of analgesics, and physical function. Additionally, perceived general changes were evaluated at follow-up: wellness, satisfaction at work, desire to exercise, motivation to eat healthy, energy to be with family and friends, and socialization with colleagues.

Results: For the primary outcome, the intervention group showed lower general pain ($p<0.0001$) and greater wellbeing ($p<0.0001$), work satisfaction ($p=0.0048$), desire for practicing exercise ($p=0.0007$), and energy ($p=0.0474$) compared with the control group. Significant between-group interactions were found for work impairment due to diseases ($d=-1.2$), hips/thighs pain ($d=0.7$), ankles/feet pain ($d=0.4$), the Biering-Sorensen test ($d=-0.6$) and the push-ups test ($d=-2.3$) favoring the intervention group. All between-group differences were clinically important.

Conclusion: A progressive resistance training program performed at the workplace is feasible and effective in reducing musculoskeletal pain and improving work ability and physical function among hospital porters.

Keywords: absenteeism; exercise; musculoskeletal; strength

Effect of a Brief Progressive Resistance Training Program in Hospital Porters on Pain, Work ability, and Physical Function

INTRODUCTION

Musculoskeletal pain is a major cause of sickness absence (Andersen, Clausen, Persson, & Holtermann, 2012; Andersen, Fallentin, Thorsen, & Holtermann, 2016), disability pension (Andersen, Villadsen, & Clausen, 2019), poor work ability, and poor quality of life, with a huge socioeconomic impact (Bergström et al., 2007; Kamaleri et al., 2009; Morken et al., 2003; Natvig et al., 2002).

Musculoskeletal pain is particularly frequent in physically demanding occupations (Andersen, Mortensen, Hansen, & Burr, 2011; Holtermann et al., 2010). Hospital workers typically perform physically strenuous tasks when handling patients (Waters et al., 2006). Because of this, musculoskeletal pain is a major challenge in the healthcare industry, affecting job performance and increasing the risk for long-term absenteeism when workers experience severe pain (Andersen, Mortensen, et al., 2011).

Researchers have tested different strategies to manage and reduce musculoskeletal pain in healthcare workers. Traditionally, strategies have been focused on the inclusion of ergonomic equipment and interventions to minimize physical demands (Andersen et al., 2014), suggesting that lowering the physical demands of work could reduce the risk of developing musculoskeletal pain. Nonetheless, these traditional strategies do not appear to be adequately effective, since the incidence of musculoskeletal pain among hospital workers sector have remained high for decades (Driessen et al., 2010). Newer approaches suggest that increasing the physical capacity of workers through exercise programs could be an effective alternative (Andersen et al., 2010; Jakobsen et al., 2015b). However, the implementation of workplace-based interventions is often complicated due to the lack of time, equipment, and low adherence (Kwak et al., 2006). In addition, carrying out strenuous exercise programs without time for rest may hinder performance of work tasks. In this sense, brief exercise programs can be especially beneficial for the workplace setting. For instance, previous studies have shown greater results of workplace-based versus home-based brief exercise programs among healthcare workers in reducing musculoskeletal pain and use of analgesics (Jakobsen et al., 2015b), preventing deterioration work ability (Jakobsen et al., 2015a) and reducing perceived exertion during work (Jakobsen et al., 2015c). However, these studies were performed

among care workers (nurses) and there are no exercise interventions conducted among those with the most physically demanding work, i.e. hospital porters. Hospital porters are exposed to the greatest mechanical loads within the hospital environment, as they have to manually carry the patients on stretchers, transfer them from one site to another, pick them up in case of falls, etc. The existing evidence about the prevalence and the incidence of injuries or the effectiveness of prevention strategies in this population is scarce. Although some strategies like the introduction of breaks during working hours by activity-rest schedules (Beynon et al., 2000) or computer-based workforce scheduling (Lin, 1999) have been documented, a need exists for evaluating the effectiveness of exercise-based interventions in this group of hospital workers. Especially, interventions considering time availability and performed with cheap equipment are needed to favor the implementation and maintenance of physical conditioning at the workplace (Zebis et al., 2011).

The aim of this study was to investigate the effect of a workplace-based brief progressive resistance program on musculoskeletal pain among hospital porters. We hypothesized that a brief supervised progressive resistance training program during working hours would be feasible and effective in reducing pain symptoms and improve work ability and physical function.

MATERIALS AND METHODS

Trial Design

A single-blind, non-randomised controlled trial was conducted from January 2018 to June 2018. The non-randomised design was chosen due to the difficulty in obtaining a sample of participants who could carry out the program simultaneously. Therefore, a convenience sample was selected among the volunteers by those responsible for the work area (neither involved in assessments nor supervision of sessions) with the sole criterion of not altering the work-service. To avoid selection bias, none of the investigators participated in the allocation of the subjects. Those responsible for the allocation were unaware of the objectives of the study, only knowing that one of the two groups would require the participation of the workers in a work-placed brief session. The participants were allocated to a 9-week workplace-based physical exercise program (progressive resistance training) or to a control group. The study was approved

by the Ethics Committee on Experimental Research of the University of Valencia (H1518604158393) and registered in ClinicalTrials.gov (NCT03501147) prior to enrollment of participants. The study followed the CONSORT checklist to ensure transparent and standardized reporting of the trial.

The trial adhered to the principles of the Declaration of Helsinki. All participants were informed about the purpose and content of the investigation. Informed consent was obtained from all individual participants included in the study.

Participants

Participants were hospital porters working at a local hospital (University Clinic Hospital of Valencia). We included hospital porters with a fixed shift schedule, aged between 18 and 65 years, and with at least one episode of musculoskeletal pain (related to acute or chronic causes) during the last month. Exclusion criteria were: (a) acute, severe musculoskeletal injury, (b) medical history of severe cardiovascular diseases (e.g. heart failure, myocardial infarction, and stroke), (c) a medical history of life threatening disease, or (d) pregnancy.

Interventions

Intervention Group

Participants allocated to the intervention group performed five sessions per week, during 9 weeks, with a total of 45 planned sessions. All participants in the study joined and started the program at the same time. Two consecutive half-hour shifts were established each day to perform the training. In this way, each participant could organize their work in their service in order to be absent during the short time that the session lasts. Assuming that an effective post-intervention implementation at the worksite will only occur if the program is easily adopted and inexpensive to perform, a short-duration, cost-efficient program involving easy-to-use exercises performed with inexpensive and easy-to-transport training equipment was designed. The intervention group performed a brief resistance training with dynamic and isometric exercises during the working hours at the hospital. All exercises were performed in circuit, quickly changing from an exercise to the next without break. In this way, each session had an approximate duration of 15 minutes. To increase adherence sessions took place in groups and were performed at a site located closely to the worksite. Two physical therapists instructed and supervised the sessions with a

average ratio of approximately 9 participants per shift. The program consisted of 6 resistance exercises (Fig. 1): (1) squat, (2) back squeeze, (3) deadlifts, (4) torso-twist, (5) push-ups, (6) side bridge. The order of execution of the exercises was always the same, except for the first exercise which changed with each training progression. Thus, the stage 1 (weeks 1-2) started with the squat, the stage 2 (weeks 3-4) with the back squeeze, the stage 3 (weeks 5-6) with the deadlift, the stage 4 (weeks 7-8) with the torso-twist, and the stage 5 (week 9) with the push-up.

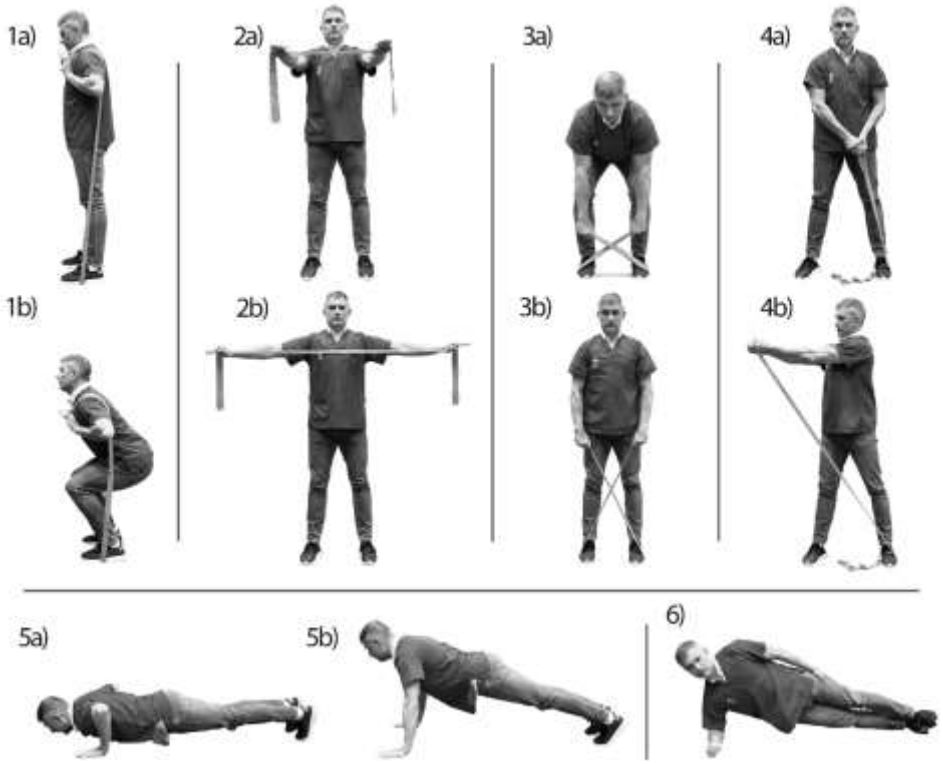

Fig. 1 Resistance exercises: (1a) squat starting position, (1b) squat ending position, (2a) back squeeze starting position, (2b) back squeeze ending position (3a) deadlifts starting position, (3b) deadlifts ending position (4a) torso-twist starting position, (4b) torso-twist ending position (5a) push-ups starting position, (5b) push-ups ending position (6) side bridge

Intensity progressively increased during the program according to the principle of progressive overload (Table 1). In exercises 1-4 (elastic-resisted), intensity progressed from 20 repetitions maximum (RM) at the beginning of the training period to 8 RM during the later phase. To achieve the desired intensity at these exercises, elastic bands (TheraBand CLX, The Hygenic Corporation, Akron, OH, USA) were pre-

stretched to approximately 50% of the initial length (initial length, 1.9 m) and then different bands were used/added when needed to reach the desirable intensity. For this purpose, red, blue, black, silver and gold elastic band colors were available, alone or combined in parallel. In exercise 5, progression was conducted by performing the exercise to failure (many repetitions as possible), with no other load than own body weight. In addition, participants with difficulty of performing this exercise with the support of the feet started with knee support and, if they were not able to do so, they performed the exercise leaning against the wall. All these 5 dynamic exercises were performed using consecutive concentric (2s) and eccentric (2s) muscle contractions in a controlled manner. Finally, exercise 6 was performed isometrically in both sides. The number of sets increased progressively. In addition, an intensity progression was established by modifying the complexity of the exercise, starting with knee support and progressing to feet support when participants were able to perform the basic version without difficulty and with the appropriate technique. When participants were not able to complete the session with the new progression, they returned to the previous exercise until they were ready to progress.

The instructors followed a 4-stage model for exercise adjustment in case of acute worsening of the pain or other contraindications during the exercises (Jakobsen et al., 2014). Dynamic exercises (1-5) followed the entire model of exercise adjustment while isometric exercise (6) only followed stages 1 and 4.

Table 1. Training progression

	Elastic-resisted exercises (1-4)	**Isometric exercise (6)**
Weeks 1-2	1x20 reps (20 RM)	1x10 reps (5" each repetition) resting 5" between repetitions.
Weeks 3-4	1x15 reps (15 RM)	1x15 reps (5" each repetition) resting 5" between repetitions.
Weeks 5-6	1x12 reps (12 RM)	1x20 reps (5" each repetition) without rest between repetitions.
Weeks 7-8	1x10 reps (10 RM)	1x25 reps (5" each repetition) without rest between repetitions.
Week 9	1x8 reps (8 RM)	1x30 reps (5" each repetition) without rest between repetitions.

RM = repetition maximum, reps = repetitions

Control Group

Participants allocated to the control group maintained their usual activity for the same 9 weeks and were instructed to report any incident or novelty that could be related to the outcome variables.

Outcome measures

Physical function was measured by a trained blinded examiner while the remaining outcomes were measured by questionnaire survey at baseline and after the 9-week intervention period. Additionally, some items about the level of physical activity and the experience in strength training were collected by filling out a questionnaire before the intervention. Once the intervention period was over, participants were asked to complete a questionnaire about general perceived changes.

Primary outcome measures

The main outcome was the Pain Overall Status, a standard 7-point patient global impression of pain change, where “pain has improved a lot” is scored with 1 point and “pain has gotten much worse” is scored with 7 points.

Secondary outcome measures

Average pain intensity: The Nordic questionnaire (Kuorinka et al., 1987) was used for the assessment of pain intensity during the previous month and week. The Nordic Musculoskeletal Questionnaire is a valid screening tool (Kuorinka et al., 1987), with sensitivity ranging from 66 to 92%, and specificity between 71 and 88% (Ohlsson et al., 1994). Using a test-retest methodology, this tool showed an acceptable reliability with a range of different answers from 0 to 23% (Kuorinka et al., 1987). Using a body diagram highlighted with specific body areas (neck/shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees, ankles/feet) , participants reported the presence and intensity of musculoskeletal pain at the time of the intervention, and during the last three months, according to an 11-point numerical rating scale (NRS), where 0 means “no pain” and 10 indicates “the worst possible pain”.

Work ability index (WAI): This instrument determines the work capacity of a subject on the basis of the responses to different items related to the demands of work, the health status of the subjects and resources (Ilmarinen, 2006). The items represent the following seven categories: 1) Current work ability compared with the lifetime best; 2) Work ability in relation to the demands of the job; 3) Number of current diseases diagnosed by a physician; 4) Estimated work impairment due to diseases; 5) Sick leave

during the past year (last 12 months); 6) Own prognosis of work ability 2 years from now; 7) Mental resources.

Perceived physical exertion: The subjective perception of effort during work was evaluated through the Borg CR-10 scale. The possible answers for the rating of perceived exertion (RPE) were: extremely light (RPE = 0.5); very light (RPE = 1); light (RPE = 2); moderate (RPE = 3); hard (RPE = 5); very hard (RPE = 7); extremely hard (RPE = 9).

Need for recovery: The need for recovery after work was assessed by a 5-point scale: 1) never; 2) hardly ever; 3) sometimes; 4) usually; 5) always.

Self-rated use of analgesics: The use of analgesics for musculoskeletal pain was evaluated by the number of days in which they had taken analgesics for this reason during the previous week (0-7).

Physical function: The upper body strength and endurance were assessed by the push-up and the Biering-Sorensen tests. In the push-up test, the starting position for male subjects was the "standard push-up" position (hands pointing forward located under the shoulders, back straight, head up, using the toes as support) while for female participants was the modified "knee push-up" position (using the knees as support). The score was determined by the maximal number of push-ups performed consecutively without rest. The test concluded when the subject was unable to maintain an appropriate technique during two consecutive repetitions. The Biering-Sorensen was used to assess the muscle endurance of the trunk extensor muscles. In the Biering-Sorensen test, the subjects lied prone on the examining table with the upper edge of the iliac crests in alignment with the edge of the table and the lower body fixed to the table. The subjects had to maintain isometrically the upper body in a horizontal position with the arms crossed in the chest. The test ended when the trunk lowered its position 5-10° with respect to the hip or when the subject touched the bench. Before and after the test, participants supported the upper body on a bench to avoid muscle fatigue. The score was determined by the time recorded in seconds.

Perceived general changes: The perceived general changes were evaluated after the intervention by questions with 3 possible answers ("has worsened", "no change", "has improved"). 7 items were assessed: 1) Wellness, 2) satisfaction at work, 3) desire to exercise, 4) motivation to eat healthy, 5) energy to be with family and friends, 6) socialization with colleagues.

Sample size

An a priori power analysis was conducted in G*Power (3.1.9.2 version) software to calculate the required sample size. With the present study design, accepting a 5% alpha risk (α=0.05), a 20% beta risk (β=0.2) and assuming at least a medium effect size, a total of 34 subjects were required.

Blinding

Due to the design of the study, participants and physiotherapists could not be blinded to group allocation. Nevertheless, the assessments and the statistical analysis was performed by blinded examiners.

Statistical analysis

Analyses were performed using SAS statistical software (Proc Mixed, SAS version 9.4) according to the intention-to-treat principle, including all participants regardless of loss to follow-up. *Group*, *time* and *group by time* interaction were entered as factors in the model. Analyses were adjusted for the baseline value of the outcome as well as gender. Subject was entered as a random factor. The estimation method was restricted maximum likelihood (REML) with degrees of freedom based on the Kenward-Roger approximation. P-levels < .05 were accepted as statistically significant. Outcomes are reported as within- and between-group least square mean differences with 95% confidence intervals.

Effect sizes (Cohen´s d) were calculated. The effect size was described as: <0.2= trivial effect; 0.2-0.5 = small effect; 0.5-0.8 = moderate effect; > 0.8= large effect. Minimal clinically important differences were calculated according to a previous study (Lemieux et al., 2007) by multiplying the pooled baseline standard deviation scores by 0.2.

RESULTS

A total of 37 hospital porters (27 women and 10 men) voluntarily participated in the study. Subjects' baseline characteristics are shown in Table 2. All subjects completed the intervention and were evaluated according to the group to which they had initially been allocated. The participant flow diagram is showed in Fig. 2.

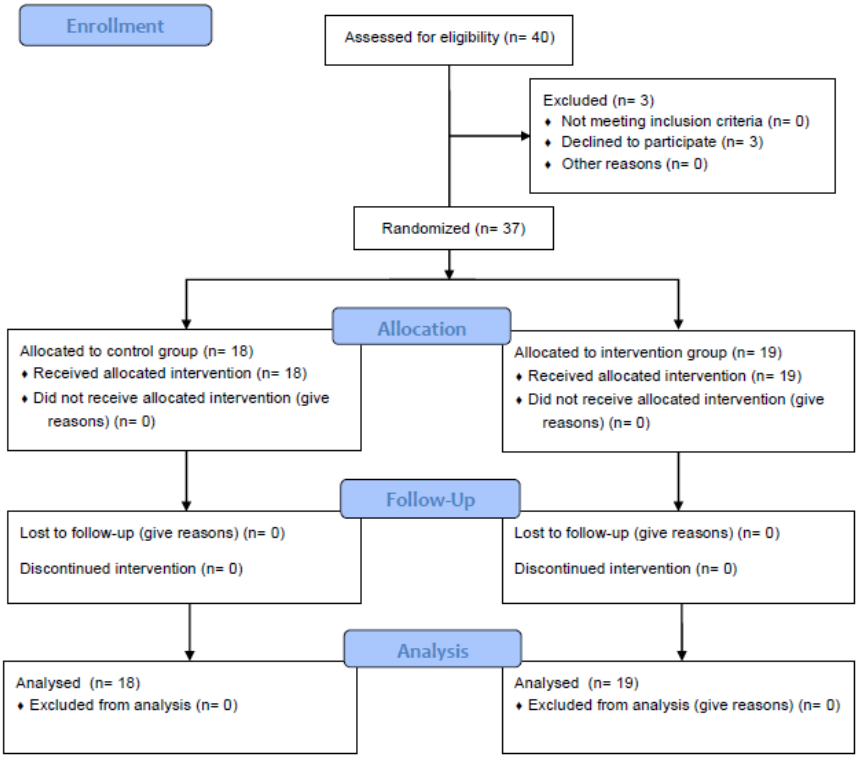

Fig. 2 Participant flow diagram

Table 2. Baseline Values

	Control (n=18)		Intervention (n=19)	
Female/Male	10/8		17/2	
	mean	SD	mean	SD
BMI	25.91	4.67	25.76	4.55
Age	48.83	10.61	52.63	8.55
*Weight	72.72	12.53	65.96	12.37
Height	167.72	8.4	159.95	6.66
Physical activity days	1.61	1.61	1.74	1.63
Physical activity duration	41.39	33.42	40.84	27.25

WAI_1	7.94	1.47	7.74	1.59
WAI_2	8.31	1.03	8.08	1.08
WAI_3	4.28	1.99	4.21	2.37
WAI_4	5.5	0.79	5.11	0.81
*WAI_5	3.44	1.65	4.42	0.96
WAI_6	6.5	1.15	6.37	1.26
WAI_7	3.44	0.86	3.68	0.48
WAI_total	39.42	5.1	39.87	5.33
Neck/Shoulders Pain	3.5	2.87	3.74	2.7
Upper back Pain	1.83	2.92	2.53	2.25
Elbows Pain	0.33	1.03	1	2.08
Wrist/Hands Pain	1.61	2.66	2.11	2.62
Low back Pain	2.72	2.85	3.47	2.74
Hips/thighs Pain	1.78	2.82	3.37	3.13
Knees Pain	3.06	3.46	3.21	3.24
*Ankles/Feet Pain	0.94	2.1	2.84	2.69
BORG	3.72	1.45	4.37	1.98
*NFR	2.28	0.57	3.11	0.81
Pain_medication	1.56	1.95	1.95	2.17
Biering_Sorensen Test	84.22	51.92	103.63	72.26
Push-ups Test	16.83	9.45	14.79	8.97

SD = standard deviation, WAI: Work ability index, NFR: need for resting, WAI_1: Current work ability compared with the lifetime best, WAI_2: Workability in relation to the demands of the job, WAI_3: Number of current diseases diagnosed by a physician, WAI_4: Estimated work impairment due to diseases, WAI_5: Sick leave during the past year (last 12 months), WAI_6: Own prognosis of work ability 2 years from now, WAI_7: Mental resources.

No damage or adverse effects were reported in either group. Table 3 shows percentages and between-group differences of perceived changes at follow-up. The intervention group showed lower general pain and greater wellbeing, work satisfaction, desire practicing exercise and energy than the control group. Table 4 shows complete within-group and between-group differences from baseline to follow-up. Significant between-group interactions were found for estimated work impairment due to diseases (WAI 4), hips/thighs pain, ankles/feet pain, the Biering-Sorensen test, and the push-ups test favoring the intervention group. All between-group differences were clinically important. Furthermore, all between-group differences reached moderate-large effect sizes, except for pain at the different sites, were small-moderate effect sizes were reported.

Table 3. Self-perceived changes reported as % patients (number of patients).

	Control (n=18)	Intervention (n=19)	Bet-group difference p value
General pain			**<.0001**
Very much improved	-	25.3% (5)	
Much improved	5.55% (1)	42.1% (8)	
Minimally improved	16.66% (3)	25.3% (5)	
No change	77.77% (14)	5.3% (1)	
Minimally worse	-	-	
Much worse	-	-	
Very much worse	-	-	
Wellbeing			**<.0001**
Improved	11.1% (2)	84.2% (16)	
No change	88.9% (16)	15.8% (3)	
Worsened	-	-	
Work satisfaction			**0.0048**
Improved	5.6% (1)	47.4% (9)	
No change	94.4% (17)	52.6% (10)	
Worsened	-	-	
Desire practicing exercise			**0.0007**
Improved	22.2% (4)	78.9% (15)	
No change	77.8% (14)	21.0% (4)	
Worsened	-	-	
Motivation eating healthy			0.2355
Improved	44.4% (8)	36.8% (7)	
No change	55.6% (10)	63.5% (12)	
Worsened	-	-	
Energy			**0.0474**
Improved	5.6% (1)	31.6% (6)	
No change	94.4% (17)	68.4% (13)	
Worsened	-	-	
Socialization			0.2641
Improved	5.6% (1)	15.8% (3)	
No change	94.4% (17)	84.2% (16)	
Worsened	-	-	

Table 4. Within-group difference from baseline to follow-up. Between-group difference at follow-up.

	Within-group difference from baseline to follow-up		Between-group difference at follow-up				
	Intervention	Control	Intervention vs Control	P	P (*group by time* interaction)	Effect size	Minimal important change
WAI_1	-0.42 (-0.97 to 0.13)	0.11 (-0.45 to 0.67)	-0.70 (-1.28 to -0.12)	**0.019**	0.181	-0.65	0.31
WAI_2	-0.05 (-0.55 to 0.45)	-0.11 (-0.63 to 0.40)	0.10 (-0.43 to 0.63)	0.698	0.871	0.00	0.21
WAI_3	0.16 (-0.47 to 0.78)	0.11 (-0.53 to 0.75)	-0.06 (-0.72 to 0.60)	0.855	0.917	0.00	0.44
WAI_4	-0.26 (-0.59 to 0.06)	0.28 (-0.06 to 0.61)	-0.52 (-0.86 to -0.17)	**0.004**	**0.023**	-1.25	0.16
WAI_5	0.21 (-0.23 to 0.65)	-0.33 (-0.78 to 0.12)	0.35 (-0.15 to 0.84)	0.165	0.089	0.00	0.27
WAI_6	0.16 (-0.59 to 0.91)	0.33 (-0.44 to 1.10)	-0.13 (-0.92 to 0.67)	0.750	0.746	0.00	0.24
WAI_7	0.05 (-0.33 to 0.43)	-0.06 (-0.45 to 0.33)	-0.01 (-0.41 to 0.40)	0.976	0.693	0.00	0.14
WAI_total	0.03 (-1.34 to 1.39)	0.33 (-1.05 to 1.71)	-0.50 (-1.95 to 0.95)	0.492	0.750	-0.19	1.04
Neck/Shoulder Pain	1.21 (0.18 to 2.24)	0.11 (-0.95 to 1.17)	1.03 (-0.04 to 2.10)	0.059	0.139	0.36	0.56
Upper back Pain	0.74 (-0.59 to 2.06)	-0.61 (-1.97 to 0.75)	1.36 (-0.06 to 2.77)	0.060	0.161	0.38	0.52
Elbow Pain	0.16 (-0.39 to 0.70)	-0.56 (-1.12 to 0.01)	0.52 (-0.06 to 1.10)	0.078	0.074	0.61	0.33
Wrist/Hand Pain	0.00 (-1.09 to 1.09)	-0.50 (-1.61 to 0.61)	-0.02 (-1.17 to 1.13)	0.976	0.524	0.00	0.53
Low back Pain	1.11 (-0.27 to 2.48)	0.06 (-1.36 to 1.47)	0.96 (-0.50 to 2.42)	0.194	0.292	0.36	0.56
Hip/thigh Pain	1.26 (-0.01 to 2.53)	-0.61 (-1.92 to 0.69)	1.53 (0.18 to 2.88)	**0.027**	**0.044**	0.67	0.60
Knee Pain	0.63 (-0.19 to 1.45)	0.56 (-0.29 to 1.40)	0.05 (-0.82 to 0.92)	0.913	0.898	0.00	0.67
Ankle/Feet Pain	1.21 (0.06 to 2.36)	-0.50 (-1.68 to 0.68)	1.06 (-0.18 to 2.31)	0.092	**0.042**	0.41	0.48
Rate of perceived exertion	0.25 (-0.59 to 1.10)	-0.06 (-0.90 to 0.79)	0.39 (-0.53 to 1.30)	0.399	0.607	0.00	0.35
Need for Recovery	-0.05 (-0.29 to 0.19)	-0.06 (-0.30 to 0.19)	0.01 (-0.26 to 0.28)	0.924	0.986	0.00	0.14
Pain_medication	0.95 (0.12 to 1.77)	-0.06 (-0.90 to 0.79)	1.03 (0.16 to 1.91)	**0.021**	0.095	0.48	0.41
Biering_Sorensen	-40 (-65 to -14)	-0.56 (-27.01 to 25.90)	-40 (-67 to -13)	**0.005**	**0.038**	-0.64	12.58
Push-up	-20 (-24 to -16)	1.06 (-3.17 to 5.28)	-21 (-25 to -16)	**<.0001**	**<.0001**	-2.28	1.84

SD = standard deviation, WAI: Work ability index, NFR: need for resting, WAI_1: Current work ability compared with the lifetime best, WAI_2: Work ability in relation to the demands of the job, WAI_3: Number of current diseases diagnosed by a physician, WAI_4: Estimated work impairment due to diseases, WAI_5: Sick leave during the past year (last 12 months), WAI_6: Own prognosis of work ability 2 years from now, WAI_7: Mental resources.

DISCUSSION

The main result of this study is the high feasibility and general efficacy of a workplace-based brief progressive training program among hospital porters to reduce pain symptoms and improving work ability and physical function.

Subjects allocated to the intervention group showed clinically relevant improvement in their perceived general pain status while most of controls did not change. A close and consistent association between changes on the patient global impression of change and pain intensity was found in a previous study, regardless of the pain cause, intervention, or participant characteristics like gender or age (Farrar et al., 2001). These positive results are reinforced by the statistically significant improvements found in other perceived outcomes like wellbeing, work satisfaction, desire to practice exercise, and level of energy in favour of the intervention group. Interestingly, when asked about the average pain intensity in specific locations, only two areas (hips/thighs and ankles/feet pain) showed statistically significant *group by time* interaction. Even though between-group pain differences at these body areas were below 2 points, these reductions were considered clinically important. This was based on a previous study (Lemieux et al., 2007) which defined the minimally clinically important difference as the product of the pooled SD and 0.2 according to our analysis. In addition, the moderate effect size found at hips/thighs denotes a quite consistent reduction among the intervention group. These results, together with a tendency favouring the intervention for reducing elbow pain with a moderate effect size, and the relevance of these specific body sites to perform working tasks such as transferring or carrying patients might have positively influenced the overall pain reduction. A hypoalgesic effect has been observed after exercise (Naugle et al., 2012). In fact, strength training of painful neck and shoulder muscles has also been shown to change pain threshold in other non-trained parts of the body (Andersen et al., 2012). Thus, a central adaptation of pain perception may explain the overall pain improvement. Although there are no previous studies in this specific population, similar results in pain have been found in other work populations. For instance, work-placed resistance training programs with a duration between 10-20 weeks reported an important reduction of pain among office workers (Andersen et al., 2010; Andersen, Saervoll, et al., 2011) and laboratory technicians (Jay et al., 2011), using different training materials like free weight exercises, elastic bands, or kettlebells. In the same vein, another study showed comparable findings with a work-placed

based resistance training program of 10 weeks among health workers (Jakobsen et al., 2015b). Despite the similarities between the interventions implemented in these studies, their results may not be directly compared with those obtained in the present study, due to the different physical demands between hospital porters and their sample.

Regarding the WAI, statistically significant differences have been found in favour of the intervention in the current work ability compared with the lifetime best (WAI 1) and the estimated work impairment due to diseases (WAI 4). Although there is no previous data in this specific population, a previous study found improved work ability in relation to the demands of the job (WAI 2) after a workplace-based training program in comparison with a home-based intervention in healthcare workers (Jakobsen et al., 2014). It should be taken into account that some WAI items - such as the number of current diseases diagnosed by a physician or the sick leave during the past year - are sensitive to change in response to short-term studies, affecting the overall WAI score. Besides supervision, training intensity seems a key aspect to design effective work-place interventions for improving WAI, especially in physically demanding jobs as the current case (Calatayud et al., 2015) and when using brief training sessions. In line with this, a previous intensive training program with less than 1hour of training per week was effective to prevent reduction of WAI in slaughterhouse workers with chronic pain (Sundstrup et al., 2014).

Improvement in physical function was evident in the intervention group. The Biering-Sorensen test improved in this group by 40 seconds, reaching a moderate effect size. These results may be relevant due to the association between a reduced performance in this test and low back pain (Mannion et al., 2011) and considering the elevated risk for low back pain in our population. The aforementioned results can be explained by the specific exercises used and the progressive overload. In addition, hip extensor strength gains, which was especially targeted with the squat and deadlift may have played an essential role, since this musculature has shown in previous studies to exert a greater and supplementary action when fatigue of the paraspinal lumbar musculature occurs (Clark et al., 2003). In addition, the number of push-ups improved by 20 repetitions after the intervention, resulting in a very large effect size. Previous literature (Hoozemans et al., 2014) found strong evidence that occupational pushing is linked with musculoskeletal symptoms, especially in the shoulders, as well as long-term sickness absence (Lund, Labriola, Christensen, Bültmann, & Villadsen, 2006) and unemployment (Lund, Iversen, & Poulsen, 2001). This highlights the

relevance of maintaining a proper pushing capacity, especially in works where pushing different weights is needed every day, as occurs with hospital porters.

A statistically significant difference was found in the self-rated use of analgesics, but without a *group by time* interaction. Nevertheless, the intervention group reduced by 1 the number of days per week where analgesics were needed, showing a moderate effect size. These findings are consistent with those observed in a previous study with an exercise intervention implemented at the workplace among healthcare workers, and they seem to be directly related to the decrease in pain found in the results of the intervention (Jakobsen et al., 2015b). In relation to the need for recovery after working hours and the subjective perception of the physical exertion during work, no differences were found between the two groups at the end of the study. A previous research in healthcare workers found significant differences and positive trends in the perception of physical effort and the need for recovery, respectively (Jakobsen et al., 2015c). The absence of positive results in the present study may be due to an insufficient sample or to the specific characteristics of the population studied.

Due to the group nature of the exercise program carried out in the intervention group, it should be considered that part of the effects might be due to the benefits of the social interaction itself.

Even participants were encouraged to maintain the exercise program on their own and elastic bands were facilitated to favor this circumstance, we did not include a follow-up beyond the end of the intervention program. However, it can be expected that physiological adaptations will progressively be lost when refraining from exercise. Future studies should verify the effectiveness of this intervention to maintain long-term effects but most importantly, to conduct longer interventions as well as to evaluate unsupervised exercise programs.

This study has both strengths and limitations. The main limitation is its non-randomized design. Nevertheless, the non-involvement of the researchers in the selection and allocation process allowed to minimize the selection bias. The unequal distribution of men and women was one of the main consequences of the randomization method that could not be controlled. Another common limitation of the active interventions like the present one is the impossibility to blind therapists and subjects. This fact can modify the self-perception of the changes produced by the intervention, being necessary a cautious interpretation of the results. The main strength of the study is the implementation of an easily applicable program in a reduced space, with several participants at a time, with reduced and cheap equipment. In

this way, the applicability and direct transfer of the results of this study are greatly increased. Moreover, the wide inclusion criteria allowed resulted in a generalizable sample of hospital porters. Importantly, this is the first study applying a workplace training program in hospital porters.

In conclusion, the present study demonstrates that the introduction of a brief work-placed progressive resistance training program is feasible and effective reducing musculoskeletal pain and improving work ability and physical function among hospital porters.

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