European Spine Journal (2019) 28:1586–1593
https://doi.org/10.1007/s00586-019-05986-3

ORIGINAL ARTICLE

Association of perceived physical overload at work with pain and disability in patients with chronic non-specific low back pain: a 6-month longitudinal study

Samantha J. Demarchi[1] · Crystian B. Oliveira[1] · Marcia R. Franco[2] · Priscila K. Morelhão[1] · Thalysi M. Hisamatsu[1] · Fernanda G. Silva[1] · Tatiana M. Damato[1] · Rafael Z. Pinto[3,4]

Received: 3 October 2018 / Revised: 1 April 2019 / Accepted: 19 April 2019 / Published online: 3 May 2019

Abstract

Background Physical overload at work has been described as a risk factor for the development of low back pain. However, few studies have investigated the prognostic value of perceived physical overload at work in patients with chronic low back pain.

Objective To investigate the association of perceived physical overload at work with pain and disability over a period of 6 months in patients with chronic non-specific low back pain.

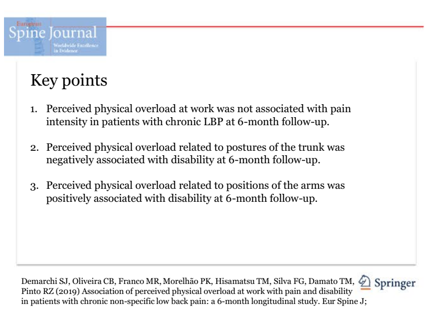
Methods Patients with chronic LBP seeking physiotherapy care were considered eligible. Clinical data collected were: pain intensity, disability, fear of movement, depression and perceived physical overload at work. Linear regression analyses were used to investigate the association of perceived physical workload at work at baseline with pain intensity and disability at 6-month follow-up. The total score and the score for each category of the physical overload at work questionnaire were analyzed separately.

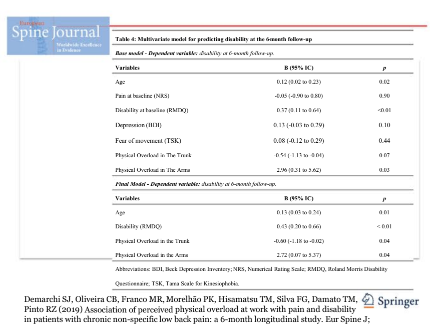
Results Ninety-two patients with chronic low back pain were included in the analysis. The subcategories of the physical overload questionnaire were not significantly associated with pain intensity at 6-month follow-up. However, age, disability at baseline and perceived physical overload related to postures of the trunk ($B = -0.60$ 95% CI -1.18 to -0.02) and related to positions of the arms ($B = 2.72$ 95% CI 0.07 to 5.37) were significantly associated with disability at 6-month follow-up.

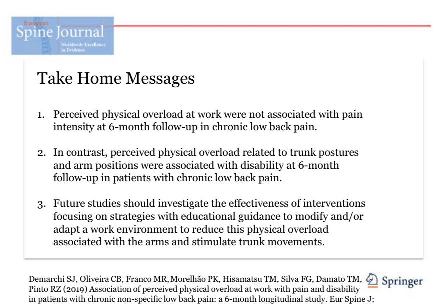
Conclusion Although perceived physical overload at work was not associated with pain intensity in patients with chronic LBP at 6-month follow-up, we identified a significant association between perceived physical overload related to postures of the trunk and positions of the arms with disability at 6-month follow-up.

Graphical abstract

These slides can be retrieved under Electronic Supplementary Material.







Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00586-019-05986-3) contains supplementary material, which is available to authorized users.

Extended author information available on the last page of the article

Keywords Low back pain · Physical overload · Pain intensity · Disability

Introduction

Low back pain (LBP) is a prevalent musculoskeletal condition that imposes high financial costs to health care systems [12, 26]. Most patients with LBP seeking care in primary health care systems are diagnosed with non-specific LBP, defined as the presence of pain not attributable to any specific cause [2]. Although the prognosis is generally favorable in the first weeks [24], patients with chronic LBP (i.e., pain lasting more than 3 months) still show moderate pain and disability over a year [8]. Given that a great proportion of health care costs are attributable to chronic LBP, identifying factors that predict a better outcome may help clinicians to better educate patients about the LBP prognosis.

Several factors may contribute to the prognosis of chronic LBP including mechanical factors [7, 48]. Mechanical or physical factors are defined as an imbalance between the functional load, that is, the effort required during work and daily activities, and functional capacity [15]. This imbalance may be caused by physical overload at work attributable to cumulative traumas, dynamic activities related to trunk flexion and rotation movements, lifting or charging loads, exposure to long working hours without pauses and the adoption of static and inadequate postures [1, 21]. Most of these working activities are associated with psychological and physical fatigue [17] or perceived exertion [35] which is commonly reported by patients with chronic occupational LBP [5, 37]. Furthermore, given that patients with LBP often report pain and fear-avoidance beliefs during work activities [16, 34], the perceived physical overload at work may also lead to difficulties in performing daily and leisure activities [22, 43]. Considering the conflicting evidence for physical job demands, or weak association for any factor, such as prognostic factor of chronic LBP [46], additional studies may help to understand the role of the perceived physical overload at work for this population.

Previous studies have described physical overload at work [19] as a risk factor for the development of LBP. However, there is a paucity of studies investigating the prognostic value of this factor in people with chronic LBP. Therefore, the objective of this study was to investigate whether perceived physical overload at work measured at baseline predicts pain and disability at 6-month follow-up in patients with chronic non-specific LBP. Understanding the role of perceived physical overload at work in the course of chronic LBP may encourage the development of new educational and interventional strategies for the management of chronic LBP.

Methods

This exploratory study is a prospective longitudinal study with a 6-month follow-up.

Participants

Participants were recruited in two outpatient university physiotherapy clinics through advertising as well as social media in the community. Participants with chronic non-specific LBP (i.e., low back pain without any attributable cause lasting for at least 3 months) were considered eligible in this study if they: aged between 18 and 60 years old and scored at least "moderate" in questions 6 and 7 of the 36-Item Short-Form Health Survey. Participants were excluded if they had: at least two signs that indicate neural compression (weakness, alterations in the reflex or loss of sensitivity); previous surgical procedure in the spine; serious cardiovascular or neurological pathologies; and had any "red flag" confirmed by a checklist [28]. This study was approved by the university ethics research committee (CAAE36332514.0.0000.5402).

Sample size

According to a rule of thumb, at least ten patients are needed for each independent predictor included in the model in a regression analysis [31]. Therefore, we recruited at least 90 patients with chronic LBP accounting to the five categories of the physical overload questionnaire and remaining variables (i.e., age, gender and BMI) for further adjustments in the final model.

Procedures

After the participants voluntarily signed the consent form, we administered the self-reported questionnaires at baseline assessment regarding the following information: sociodemographic, anthropometric data, duration of symptoms, pain intensity, disability, fear of movement, depression, physical activity level and the perceived physical overload. Participants were offered a 2-month course of usual physiotherapy program described elsewhere in previous studies [27]. In summary, the physiotherapy program was administered twice a week for 2 months and consists of supervised exercises therapy (e.g., stabilization exercises, walking) which is in accordance with current guidelines recommendations for treatment of patients with chronic LBP [28]. At 6-month follow-up from baseline assessment, we collected again information on pain intensity and disability.

Instruments

At baseline assessment, sociodemographic and anthropometric data such as age, gender, body mass index (BMI), employment status, educational level and duration of symptoms were collected. In addition, we administered the following questionnaires:

- Pain intensity: pain intensity was measured by the 11-point numerical rating scale (NRS) [36] for assessment of pain ranging from "0" (no pain) to "10" ("worst possible pain"). The NRS demonstrated excellent correlation between two applications among patients with chronic pain ($r=0.98$) [38].
- Disability was measured using the Roland Morris disability questionnaire (RMDQ) [25]. This instrument contains 24 items with a total score ranging from "0" (no disability) to "24" (maximum disability). The Brazilian version of the RMDQ demonstrated excellent reliability in patients with chronic LBP (ICC: 0.94) [25].
- Fear of movement was measured using the Tampa Scale for Kinesiophobia (TSK), which consists of 17 questions with a score ranging from 1 to 4 (questions 4, 8, 12 and 16 have inverted scores) [41]. The total score varies from 17 to 68, with higher scores indicating greater aversion to movement. The Brazilian version of the TSK showed excellent reliability in patients with chronic LBP (ICC: 0.93) [9].
- Depression: depression was measured using the Beck Depression Inventory (BDI) which has 21 questions with scores of 0–3 each [14]. The total questionnaire score ranged from "0" (no depression) to "63" (high levels of depression). The Brazilian version of the BDI showed an excellent reliability in a community sample [13].
- Perceived physical overload: Perceived physical overload at work was measured using the physical overload at work questionnaire [20]. This instrument contains 19 items in the form of pictograms grouped into five categories. For each item, the respondent rates how often he/she works in a specific body posture or a task, from 0 to 4 (0 = never; 1 = seldom, 3 = sometimes; 4 = often; 5 = very often). The five categories are: (1) five items related to postures of the trunk (POT): item 1—straight, upright (i.e., trunk bent 5° forward), item 2—slightly inclined (i.e., trunk bent 45° forward), item 3—strongly inclined (i.e., trunk bent 75° forward), item 4—twisted, item 5—laterally bent; (2) three items related to positions of the arms (POA): item 6—both arms below shoulder height, item 7—one arm above shoulder height, item 8—both arms above shoulder height; (3) five items related to position of the legs (POL): item 9—sitting, item 10—standing, item 11—squatting (i.e., trunk bent 15° forward), item 12—kneeling one or both knees, item 13—walking and moving; (4) 3 items related to weight lifting with the straight trunk (POST): item 14—lifting light weights (i.e., < 10 kg), item 15—lifting medium weights (i.e., 10–20 kg), lifting heavy weights (i.e., > 20); and (5) 3 items related to weight lifting inclined trunk (POIT): item 17—lifting light weights (i.e., < 10 kg), item 18—lifting medium weight (i.e., 10–20 kg), and item 19—lifting heavy weight (i.e., > 20) [20]. The scores for each category are obtained by multiplying the frequency of each position during work by the physical load of each position using pre-established values [28]. The total score of the questionnaire is obtained summing the score of the five categories.

Data analysis

Descriptive statistics were used for reporting data using frequency with proportion (i.e., categorical data), mean with standard deviation (SD) (i.e., normal distribution) and median with interquartile range (IQR) (i.e., non-normal distribution). We used the Wilcoxon Signed rank test to investigate the statistical differences between the 6-month follow-up and the baseline data on pain intensity and disability. We also calculate the proportion of patients achieving a minimal clinical important change at 6-month follow-up for pain intensity (i.e., reduction in more than 1 out of 10 points in the NRS) and disability (i.e., reduction in more than 4 out of 24 points in the RMDQ) [30].

Univariate and multivariate linear regression analyses were used to investigate the association between perceived physical overload at work (POT, POA, POL, POST, and POIT categories) with pain intensity and disability at the 6-month follow-up. The potential covariates investigated included: age; gender; BMI; fear of movement, depression; and pain and disability at baseline assessment. The group of variables was selected for inclusion in the regression analysis considering the objective of this study of investigating the association of perceived physical overload at work with pain and disability at 6-month follow-up. Therefore, given that specific body posture or task has been reported as risk factor for LBP [42] and may also have a role in the chronic LBP prognosis, we separately investigated the influence of each physical overload category at work (i.e., POT, POA, POL, POST and POIT categories). Depression and fear of movement were also included in the analyses because these psychological factors are often associated with clinical outcomes in people with chronic LBP [32, 50] and therefore may influence the results of this association. Finally, the remaining variables (age, gender, BMI and pain and disability at baseline) were included as potential covariates for adjusting the model considering individual characteristics of the sample at baseline.

First, we performed univariate linear regression analyses for identifying the potential variables candidates to the base model of the multivariate analysis. For the univariate analyses, the dependent variables were pain or disability at 6-month follow-up and the independent variables were measures of perceived physical overload at work (POT, POA, POL, POST, and POIT categories), age, gender, BMI and pain intensity and disability at baseline assessment. All variables with p values equal or lower than 0.25 were selected as candidates for inclusion in the base model of the multivariate analysis [3]. We adopted a more conservative p value in order to ensure that any potential predictor would not be included in the base model of the multivariate analysis. For the multivariate analyses, the base models were created including the variables with p values equal or lower than 0.25. Then, we used the backward elimination approach to remove the least significant variable with the highest p value. We repeated this approach until only variables with a p value lower than 0.05 have remained in the model. There was no indication of multicollinearity as none of the independent variables were highly correlated ($r < 0.6$) All statistics were performed on IBM SPSS software version 20.0 (IBM corporation, Somers, NY, USA).

Results

From January 2015 to July 2017, 175 participants were screened considering our inclusion criteria and 102 participants were considered eligible to this study. The reasons for exclusion included the presence of serious pathology or radicular pain, the presence of acute or subacute LBP, or older than 60 years. Of these, 92 participants (90%) completed the 6-month follow-up and were included in the analysis. Fifty-nine (64.1%) were women with a mean (SD) age of 40.4 years (11.6) and median [IQR] duration of symptoms of 24 months [6; 60]. The median [IQR] pain intensity and disability was of 7.0 [6.0; 8.0] and 12.0 [9.0; 16.0], respectively. At 6-month follow-up, there was a significant reduction in the median pain intensity and disability levels of − 2.0 [− 4.0; 0.0] and − 4.0 [IQR: − 10.0; − 0.2], respectively. More than half of the participants reported a difference for pain intensity ($n = 56$ [61%]) and disability levels ($n = 48$ [52%]) greater than the MCIC. The characteristics of the sample are described in Table 1.

Table 2 describes the results of the univariate analyses for pain and disability at 6-month follow-up. The results of the univariate analyses showed that age, pain at baseline and disability at baseline were associated ($p < 0.25$) with pain intensity at 6-month follow-up. For disability, the univariate analyses showed that age, pain at baseline, disability at baseline, perceived physical overload related to postures of the trunk and perceived physical overload related to positions of the arms were associated ($p < 0.25$) with disability at 6-month follow-up.

Table 1 Characteristics of the sample

Characteristics	($n = 92$)
Sex (women), *n* (%)	59 (64.1%)
Age (years)	40.4 (11.6)
Symptoms duration (months)	24 [6; 60]
BMI (kg/cm^2)	27.9 (5.2)
Depression (BDI, 0–63)	11.2 (7.6)
Fear of movement (TSK, 17–68)	45.8 (6.3)
Physical overload questionnaire	
POT	5.0 (2.0)
POA	0.7 (0.4)
POL	1.1 (0.6)
POST	3.9 (3.1)
POIT	10.3 (4.3)
Total score	21.1 (7.4)
Baseline data	
Pain intensity (NRS, 0–10)	7 [6; 8]
Disability (RMDQ, 0–24)	12 [9; 16]
6-month follow-up	
Pain intensity (NRS, 0–10)	5 [3; 7]*
Disability (RMDQ, 0–24)	6 [2; 11]*

NRS numerical rating scale, *RMDQ* Roland Morris disability questionnaire, *TSK* Tampa Scale For Kinesiophobia, *BDI* Beck depression inventory, *SD* standard deviation, *POT* physical overload in the trunk, *POA* physical overload in arms, *POL* physical overload in the legs, *POST* physical overload loading with straight trunk, *POIT* physical overload loading with inclined trunk

Values are mean (standard deviation) or median [interquartile range] unless otherwise specified

*$p < 0.05$ verified by the Wilcoxon signed rank test

Tables 3 and 4 show the results of multivariate linear regression analysis with pain intensity and disability, respectively, at 6-month follow-up as dependent variable. The base model includes the variables with $p < 0.25$ from the univariate regression, and the final model represents the variables after eliminating the nonsignificant variables with $p > 0.05$. For pain intensity, only age and depression remained in the final model explaining 15% of the variance in the dependent variable. For disability, perceived physical overload related to trunk postures, perceived physical overload related to arm positions, age and disability at baseline demonstrated were statistically significant and remained in the final model. The final model explained 28% of the total variance in the measure of disability at 6-month follow-up. Higher perceived physical overload related to trunk postures (i.e., POT) was negatively associated with disability at the 6-month follow-up ($B = -0.60$ 95% CI − 1.18 to − 0.02), meaning that perceived higher physical overload related to trunk postures are associated with lower disability levels at 6-month follow-up. In addition, perceived physical overload related to positions of the arms (i.e., POA) was positively associated

Table 2 Univariate regressions for prediction of pain intensity and disability levels at 6-month follow-up

	Pain intensity at 6-month follow-up	*p*	Disability at 6-month follow-up	*p*
Sex	0.26 (−0.91 to 1.44)	0.65	0.53 (−2.27 to 3.33)	0.71
Age	0.06 (0.01–0.11)	0.10	0.17 (0.06 to 0.28)	<0.01
BMI	0.05 (−0.06 to 0.16)	0.37	0.14 (−0.12 to 0.39)	0.30
Pain at baseline (NRS)	0.23 (−0.12 to 0.59)	0.20	0.72 (−0.13 to 1.58)	0.09
Disability at baseline (RMDQ)	0.06 (−0.05 to 0.17)	0.25	0.49 (0.25 to 0.73)	<0.01
POT	−0.05 (−0.33 to 0.23)	0.73	−0.51 (−1.16 to 0.15)	0.13
POA	0.62 (−0.63 to 1.86)	0.33	3.23 (0.31 to 6.13)	0.03
POL	0.05 (−0.94 to 1.04)	0.93	−0.82 (−3.18 to 1.53)	0.49
POST	−0.06 (−0.24 to 0.12)	0.49	−0.00 (−0.44 to 0.43)	0.98
POIT	0.04 (−0.09 to 0.17)	0.59	−0.02 (−0.33 to 0.30)	0.92
Depression (BDI)	0.09 (0.02–0.12)	0.01	0.18 (0.07 to 0.35)	0.04
Fear of movement (TSK)	0.01 (−0.09 to 0.09)	0.96	0.29 (0.08 to 0.49)	< 0.01

BDI Beck depression inventory, *NRS* numerical rating scale, *RMDQ* Roland Morris disability questionnaire, *SD* standard deviation, *POT* physical overload in the trunk, *POA* physical overload in arms, *POL* physical overload in the legs, *POST* physical overload loading with trunk straight, *POIT* physical overload loading with inclined trunk, *TSK* Tampa Scale for Kinesiophobia

Values are unstandardized B (95% confidence interval) unless otherwise specified

Table 3 Multivariate model for prediction of pain intensity at the 6-month follow-up

Variables	*B* (95% CI)	*p*
Base model—dependent variable: pain intensity at 6-month follow-up		
Age	0.06 (0.02 to 0.11)	0.01
Pain at baseline (NRS)	0.14 (−0.24 to 0.53)	0.47
Disability at baseline (RMDQ)	0.01 (−0.11 to 0.12)	0.99
Depression (BDI)	0.09 (0.20 to 0.16)	0.01
Final model—dependent variable: pain intensity at 6-month follow-up		
Pain at baseline (NRS)	0.14 (−0.20 to 0.49)	0.41
Age	0.06 (0.02 to 0.11)	<0.01
Depression (BDI)	0.09 (0.02 to 0.16)	0.01

BDI Beck depression inventory, *NRS* numerical rating scale, *RMDQ* Roland Morris disability questionnaire

with disability at the 6-month follow-up ($B = 2.72$ 95% CI 0.07 to 5.37), meaning that higher perceived physical overload related to arm positions is associated with higher disability levels at 6-month follow-up.

Table 4 Multivariate model for predicting disability at the 6-month follow-up

Variables	*B* (95% IC)	*p*
Base model—dependent variable: disability at 6-month follow-up		
Age	0.12 (0.02 to 0.23)	0.02
Pain at baseline (NRS)	−0.05 (−0.90 to 0.80)	0.90
Disability at baseline (RMDQ)	0.37 (0.11 to 0.64)	<0.01
Depression (BDI)	0.13 (−0.03 to 0.29)	0.10
Fear of movement (TSK)	0.08 (−0.12 to 0.29)	0.44
Physical overload in the trunk (POT)	−0.54 (−1.13 to −0.04)	0.07
Physical overload in the arms (POA)	2.96 (0.31 to 5.62)	0.03
Final model—dependent variable: disability at 6-month follow-up		
Age	0.13 (0.03 to 0.24)	0.01
Disability at baseline (RMDQ)	0.43 (0.20 to 0.66)	<0.01
Physical overload in the trunk (POT)	−0.60 (−1.18 to −0.02)	0.04
Physical overload in the arms (POA)	2.72 (0.07 to 5.37)	0.04

BDI Beck depression inventory, *NRS* numerical rating scale, *POA* physical overload in the arms, *POT* physical overload in the trunk, *RMDQ* Roland Morris disability questionnaire, *TSK* Tampa Scale for Kinesiophobia

Discussion

Our results demonstrated that perceived physical overload at work was not associated with pain intensity at 6-month follow-up in chronic LBP. However, perceived physical overload related to trunk postures and arm positions was associated with disability at 6-month follow-up. Although overall perceived physical overload at work has been considered a risk factor for the development of LBP, our study shows that perceived physical overload at work for the trunk and the arms may have a different role as a prognostic factor in the course of chronic LBP.

To our knowledge, this is the first study investigating the role of perceived physical overload at work for specific body regions as a prognostic factor for the clinical course of chronic LBP. Although perceived physical overload at work was not associated with pain intensity at 6-month follow-up, our final model showed that physical overload at work may influence disability at 6-month follow-up explaining 28% of the variance of the disability levels. This percentage may be considered adequate considering the number of variables ($n=4$) in the final model of our study when compared to previous studies predicting disability in people with chronic LBP which ranges from 3% ($n=1$) to 35% ($n=8$) [6, 33, 51]. Regarding the available evidence in the field, two previous studies showed conflicting results that overall physical activity at work influences pain intensity and disability in patients with chronic LBP. While Bendix et al. [4] found an association between work force and pain intensity at 1-year follow-up, Hansson et al. [18] did not find any work-related predictor for pain intensity and disability at 2-year follow-up. One fact that might explain the conflicting results is the different methods for assessment of physical overload at work. Although there is a lack of studies investigating the prognostic role of perceived physical overload at work, evidence from previous systematic reviews suggest a potential role as a risk factor for the development of LBP. Heneweer et al. [19] included eleven studies investigating the association between perceived physical workload and LBP. The authors showed that the intensity of workload was a moderate to strong risk factor for LBP. In addition, recent reviews support that perceived physical overload at work is a risk factor for chronic musculoskeletal pain including chronic LBP [23, 49] and osteoarthritis.

Our findings support that higher perceived physical overload related to position of the arms might be associated with worse disability levels over time in patients with chronic LBP. This means that higher frequency performing arm movements, especially above shoulder height, may be associated with a worse prognosis. This finding aligns with longitudinal studies demonstrating that strenuous arm movements increase the risk of developing LBP [10, 11]. One explanation might be attributable to the deficit of postural control following an arm flexion of patients with chronic LBP compared to healthy individuals [39, 44, 45]. While healthy individuals perform a trunk extension in opposite direction to the resultant motion, patients with chronic LBP have a reduced spinal motion due to altered muscle activation after arm movements [44, 45]. This might result in long-term pain and disability in this population. Given that patients can learn how to perform or avoid specific arm tasks at work, the efficacy of educational strategies on how to handle with high frequencies of arm tasks at the workplace might be tested in future trials.

Noteworthy, higher perceived physical overload related to postures in the trunk was associated with lower disability at 6-month follow-up. This means that higher frequency performing trunk movements such as inclination, twisting and lateral bending may be associated with a better prognosis. To our knowledge, no study was conducted investigating the association between with frequency of postures in the trunk and disability in patients with chronic LBP. However, this finding conflicts with available evidence showing that twisting and bending may be associated with development with LBP and pain intensity [29, 40, 47]. One explanation to our findings might be that after performing repetitive trunk movements, patients might change their perception that these movements would be harmful to the spine and return to their normal activities. Therefore, patients with chronic LBP who perform trunk movements may feel more confident to perform daily activities, or even practice physical activity, which is recommended by current clinical practice guidelines [28] and may be the explanation for resulting in less disability over time [33].

A limitation of this study is that we included only adults between 18 and 60 years of age seeking physiotherapy care for chronic LBP which may restrict the generalizability of our findings. Future studies should be conducted to investigate the influence of perceived physical overload in a general working population with chronic LBP as well as other types of LBP such as acute and subacute LBP. In addition, we investigated perceived physical overload using a self-report questionnaire due to its low cost and easy application. Future studies should be conducted using objective methods (e.g., actPAL and accelerometers) to assess the physical overload at work as prognostic factor of individuals with LBP.

Conclusion

Our findings revealed that perceived physical overload at work was not associated with pain intensity in patients with chronic LBP at 6-month follow-up. However, we identified a significant association between perceived physical overload related to postures of the trunk and positions of the arms with disability at 6-month follow-up. Future studies should investigate the effectiveness of interventions focusing on strategies with educational guidance to modify and/or adapt a work environment reducing the perceived physical overload associated with the arms and stimulating trunk movements.

Funding This research did not receive any funding. C.B.O., T.M.H. and M.R.F. were supported by São Paulo Research Foundation (FAPESP/Grant Nos. 2016/03826-5, 2016/04113-2, 2015/07704-9). P.K.M. was supported by the Coordenação de Pessoal de Aperfeiçoamento de Pessoal de Nível Superior—Brazil (CAPES)—Fiance Code 001.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest relevant to this article to disclose.

Research ethics committee CAAE36332514.0.0000.5402 (Sao Paulo State University Ethics Research Committee).

References

1. Amorim AB, Simic M, Pappas E et al (2018) Is occupational or leisure physical activity associated with low back pain? Insights from a cross-sectional study of 1059 participants. Braz J Phys Ther. https://doi.org/10.1016/j.bjpt.2018.06.004
2. Bardin LD, King P, Maher CG (2017) Diagnostic triage for low back pain: a practical approach for primary care. Med J Aust 206(6):268–273
3. Bendel RB, Afifi AA (1977) Comparison of stopping rules in forward "stepwise" regression. J Am Stat Assoc 72(357):46–53
4. Bendix AF, Bendix T, Haestrup C (1998) Can it be predicted which patients with chronic low back pain should be offered tertiary rehabilitation in a functional restoration program? A search for demographic, socioeconomic, and physical predictors. Spine (Phila Pa 1976) 23(16):1775–1783 **(discussion 83–84)**
5. Bento TPF, Genebra CVS, Maciel NM, Cornelio GP, Simeão SFAP, Vitta A (2019) Low back pain and some associated factors: is there any difference between genders? Braz J Phys Ther. https://doi.org/10.1016/j.bjpt.2019.01.012
6. Chan HL, Chiu TT (2008) The correlations among pain, disability, lumbar muscle endurance and fear-avoidance behaviour in patients with chronic low back pain. J Back Musculoskelet Rehabil 21(1):35–42
7. Coenen P, Kingma I, Boot CR, Twisk JW, Bongers PM, van Dieën JH (2013) Cumulative low back load at work as a risk factor of low back pain: a prospective cohort study. J Occup Rehabil 23(1):11–18
8. Costa LCM, Maher CG, McAuley JH et al (2009) Prognosis for patients with chronic low back pain: inception cohort study. BMJ 339b:3829
9. de Souza FS, Marinho SC, Siqueira FB, Maher CG, Costa LO (2008) Psychometric testing confirms that the Brazilian-Portuguese adaptations, the original versions of the Fear-Avoidance Beliefs Questionnaire, and the Tampa Scale of Kinesiophobia have similar measurement properties. Spine (Phila Pa 1976) 33(9):1028–1033
10. Elders LA, Burdorf A (2004) Prevalence, incidence, and recurrence of low back pain in scaffolders during a 3-year follow-up study. Spine 29(6):E101–E106
11. Elders LA, Heinrich J, Burdorf A (2003) Risk factors for sickness absence because of low back pain among scaffolders: a 3-year follow-up study. Spine 28(12):1340–1346
12. Global Burden of Disease II, Prevalence Collaborators (2016) Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1545–1602
13. Gomes-Oliveira MH, Gorenstein C, Lotufo Neto F, Andrade LH, Wang YP (2012) Validation of the Brazilian Portuguese version of the Beck Depression Inventory-II in a community sample. Braz J Psychiatry 34(4):389–394
14. Gorenstein C, Andrade LHSG (1996) Validation of a Portuguese version of the Beck Depression Inventory and State-Trait anxiety inventory in Brazilian subjects. Braz J Med Biol Res 29(4):453–457
15. Griffith LE, Shannon HS, Wells RP et al (2012) Individual participant data meta-analysis of mechanical workplace risk factors and low back pain. Am J Public Health 102(2):309–318
16. Grotle M, Vollestad NK, Brox JI (2006) Clinical course and impact of fear-avoidance beliefs in low back pain: prospective cohort study of acute and chronic low back pain: II. Spine (Phila Pa 1976) 31(9):1038–1046
17. Halim I, Omar AR, Saman AM, Othman I (2012) Assessment of muscle fatigue associated with prolonged standing in the workplace. Saf Health Work 3(1):31–42
18. Hansson TH, Hansson EK (2000) The effects of common medical interventions on pain, back function, and work resumption in patients with chronic low back pain: a prospective 2-year cohort study in six countries. Spine (Phila Pa 1976) 25(23):3055–3064
19. Heneweer H, Staes F, Aufdemkampe G, van Rijn M, Vanhees L (2011) Physical activity and low back pain: a systematic review of recent literature. Eur Spine J 20(6):826–845
20. Hollmann S, Klimmer F, Schmidt K-H, Kylian H (1999) Validation of a questionnaire for assessing physical work load. Scand J Work Environ Health 25:105–114
21. Hoogendoorn WE, Bongers PM, de Vet HC et al (2000) Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. Spine 25(23):3087–3092
22. Macfarlane GJ, Thomas E, Papageorgiou AC, Croft PR, Jayson MI, Silman AJ (1997) Employment and physical work activities as predictors of future low back pain. Spine 22(10):1143–1149
23. Maniadakis N, Gray A (2000) The economic burden of back pain in the UK. Pain 84(1):95–103
24. Menezes Costa LC, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LOP (2012) The prognosis of acute and persistent low-back pain: a meta-analysis. CMAJ 184(11):E613–E624
25. Nusbaum L, Natour J, Ferraz MB, Goldenberg J (2001) Translation, adaptation and validation of the Roland-Morris questionnaire—Brazil Roland-Morris. Braz J Med Biol Res 34(2):203–210
26. Olafsson G, Jonsson E, Fritzell P, Hagg O, Borgstrom F (2018) Cost of low back pain: results from a national register study in Sweden. Eur Spine J 27(11):2875–2881
27. Oliveira CB, Franco MR, Demarchi SJ et al (2018) Psychometric properties of the photograph series of daily activities—short electronic version (PHODA-SeV) in patients with chronic low back pain according to COSMIN checklist. J Orthop Sports Phys Ther 48(9):719–727
28. Oliveira CB, Maher CG, Pinto RZ et al (2018) Clinical practice guidelines for the management of non-specific low back pain in primary care: an updated overview. Eur Spine J 27(11):2791–2803
29. Ovayolu O, Ovayolu N, Genc M, Col-Araz N (2014) Frequency and severity of low back pain in nurses working in intensive care units and influential factors. Pak J Med Sci 30(1):70–76
30. Parreira PdCS, Costa LdCM, Takahashi R et al (2014) Kinesio taping to generate skin convolutions is not better than sham taping for people with chronic non-specific low back pain: a randomised trial. J Physiother 60(2):90–96
31. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR (1996) A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol 49(12):1373–1379
32. Pinheiro MB, Ferreira ML, Refshauge K et al (2016) Symptoms of depression as a prognostic factor for low back pain: a systematic review. Spine J 16(1):105–116
33. Pinto RZ, Ferreira PH, Kongsted A, Ferreira ML, Maher CG, Kent P (2014) Self-reported moderate-to-vigorous leisure time physical activity predicts less pain and disability over 12 months in chronic and persistent low back pain. Eur J Pain 18(8):1190–1198
34. Poiraudeau S, Rannou F, Baron G et al (2006) Fear-avoidance beliefs about back pain in patients with subacute low back pain. Pain 124(3):305–311
35. Ringheim I, Indahl A, Roeleveld K (2019) Reduced muscle activity variability in lumbar extensor muscles during sustained sitting in individuals with chronic low back pain. PLoS ONE 14(3):e0213778
36. Ross R (1997) Clinical assessment of pain. In: Van Deusen J, Brunt D (eds) Assessment in occupational therapy and physical therapy. HB Saunders, Philadelphia

37. Salvetti Mde G, Pimenta CA, Braga PE, McGillion M (2013) Prevalence of fatigue and associated factors in chronic low back pain patients. Rev Lat Am Enfermagem 21(Spec):12–19
38. Sendlbeck M, Araujo EG, Schett G, Englbrecht M (2015) Psychometric properties of three single-item pain scales in patients with rheumatoid arthritis seen during routine clinical care: a comparative perspective on construct validity, reproducibility and internal responsiveness. RMD Open 1(1):e000140
39. Shahbazi Moheb Seraj M, Sarrafzadeh J, Maroufi N, Ebrahimi Takamjani I, Ahmadi A, Negahban H (2019) Comparison of postural balance between subgroups of nonspecific low-back pain patients based on O'Sullivan classification system and normal subjects during lifting. Arch Bone Joint Surg 7(1):52–60
40. Shan X, Ning X, Chen Z, Ding M, Shi W, Yang S (2013) Low back pain development response to sustained trunk axial twisting. Eur Spine J 22(9):1972–1978
41. Siqueira FB, Teixeira-Salmela LF, Magalhães LC (2007) Análise das propriedades psicométricas da versão brasileira da escala tampa de cinesiofobia. Acta Ortop Bras 15:19–24
42. Steffens D, Ferreira ML, Latimer J et al (2015) What triggers an episode of acute low back pain? A case-crossover study. Arthritis Care Res (Hoboken) 67(3):403–410
43. Tiemessen IJ, Hulshof CT, Frings-Dresen M (2008) Low back pain in drivers exposed to whole body vibration: analysis of a dose–response pattern. Occup Environ Med 65(10):667–675
44. Tsao H, Galea MP, Hodges PW (2008) Reorganization of the motor cortex is associated with postural control deficits in recurrent low back pain. Brain 131(Pt 8):2161–2171
45. Tsao H, Hodges PW (2008) Persistence of improvements in postural strategies following motor control training in people with recurrent low back pain. J Electromyogr Kinesiol 18(4):559–567
46. Verkerk K, Luijsterburg PAJ, Miedema HS, Pool-Goudzwaard A, Koes BW (2012) Prognostic factors for recovery in chronic nonspecific low back pain: a systematic review. Phys Ther 92(9):1093–1108
47. Villumsen M, Samani A, Jørgensen MB, Gupta N, Madeleine P, Holtermann A (2015) Are forward bending of the trunk and low back pain associated among Danish blue-collar workers? A cross-sectional field study based on objective measures. Ergonomics 58(2):246–258
48. Wai EK, Roffey DM, Bishop P, Kwon BK, Dagenais S (2010) Causal assessment of occupational lifting and low back pain: results of a systematic review. Spine J 10(6):554–566
49. Walker B, Muller R, Grant W (2003) Low back pain in Australian adults: the economic burden. Asia Pac J Public Health 15(2):79–87
50. Wertli MM, Rasmussen-Barr E, Held U, Weiser S, Bachmann LM, Brunner F (2014) Fear-avoidance beliefs—a moderator of treatment efficacy in patients with low back pain: a systematic review. Spine J 14(11):2658–2678
51. Woby SR, Watson PJ, Roach NK, Urmston M (2004) Are changes in fear-avoidance beliefs, catastrophizing, and appraisals of control, predictive of changes in chronic low back pain and disability? Eur J Pain 8(3):201–210

Affiliations

Samantha J. Demarchi[1] · Crystian B. Oliveira[1] · Marcia R. Franco[2] · Priscila K. Morelhão[1] · Thalysi M. Hisamatsu[1] · Fernanda G. Silva[1] · Tatiana M. Damato[1] · Rafael Z. Pinto[3,4]

✉ Rafael Z. Pinto
rafaelzambelli@gmail.com
http://www.ufmg.br
http://www.eeffto.ufmg.br

[1] Department of Physical Therapy, School of Science and Technology, Sao Paulo State University (UNESP), Presidente Prudente, Brazil

[2] Department of Physical Therapy, Centro Universitário UNA, Contagem, Brazil

[3] Department of Physical Therapy, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Brazil

[4] Sydney School of Public Health, Faculty of Medicine and Health, The University of Sydney, Sydney, Australia