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Physical Activity in Workers with Low Back Pain is Associated with Paraspinal Muscle Mass

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SUMMARY

Background. One of the common musculoskeletal problems that most workers will experience at some point in their lives is low back pain. The aim of this study is to investigate the relationship between physical activity level and pain, disability and paraspinal muscle mass in workers with chronic low back pain.

Methods. One hundred thirty workers with chronic low back pain were included in the study. Demographic characteristics, pain, physical activity levels of all patients were evaluated. Paraspinal muscle cross-sectional areas (CSA) at the lumbar spine were measured. Participants were grouped according to their physical activity levels at work and their results were analyzed.

Results. It was found that there were significantly more males in the groups with moderate and severe physical activity, and more females in the groups with sedentary and mild activity. L2-3 and L3-4 paraspinal CSAs were found to be higher in those with moderate/severe physical activity at work. Male gender for paraspinal CSA at L2-3 and L3-4 levels, body mass index for paraspinal CSA at L2-3 levels, and age were found to be independent risk factors for L4-5 and L5-S1 paraspinal CSA.

Conclusions. Paraspinal muscle CSA was affected by occupational physical activity and total physical activity level.

KEY WORDS

Low back pain; lumbar spine; paraspinal muscles; physical activity; workers.

INTRODUCTION

Low back pain (LBP) can affect patients of all ages and is the leading cause of years lost due to disability (1). It is estimated that 70% to 85% of people experience LBP at any point in their lives and 20% become chronic (2). In recent studies, it has been stated that more LBP is seen especially in young and productive adults, and this situation can create a serious socioeconomic burden by affecting productivity (3). LBP is a common health problem in workplaces, and most workers are expected to experience LBP symptoms throughout their work-life (4). Heavy physical activities, including certain strenuous activities at work, have been shown to increase the risk of LBP (lifting, bending, awkward postures, and tasks considered to be physically demanding) (5).

There is not only work in these people's lives, but also leisure time activities in their daily life. Individuals with LBP may limit their physical activity due to fear of pain. What is more, although they need to exercise with medical advice, they may not be able to. Ironically, too much or too little physical activity can be associated with LBP, suggesting that physical activity is complex as an intervention for LBP (6). Different results have been reported in many studies examining the relationship between physical activity and LBP. While one systematic review stated that strenuous physical activity increased the risk of LBP, another systematic review found no association between the two (7, 8). In a meta-analysis, moderate to high levels of physical activity have been shown to protect against the development of lumbar radicular pain (9).

The paraspinal muscles (erector spinae, multifidus, and psoas major) support the spine and act as dynamic stabilizers of the spine (10). Degeneration of these muscles is a common feature of LBP, and imbalance in muscle strength can cause kinetic imbalance of the spine (11). Over the past

decade, an increasing number of studies have examined the interaction between paraspinal muscles, LBP, and spinal pathology in more detail (12). However, the relation of paraspinal muscle morphology, which is thought to have an important place in the etiology of LBP, with physical activity at workplace or leisure time, has not been investigated yet.
Hence, the aim of this study to evaluate the relationship between physical activity level at work and pain intensity, pain-related disability, and paraspinal muscle morphology of workers with chronic low back pain.

MATERIALS AND METHODS

Study setting and participants

This study was designed as a single-center, cross-sectional study of 133 workers who were admitted to the physical medicine and rehabilitation (PMR) outpatient clinic for chronic LBP between March 2021 and July 2021.
The inclusion criteria were patients aged 18-65, having LBP for more than 3 months, working in paid or unpaid work for at least 1 year, and literate enough to fill the scales.
Patients who changed their job within 1 year or took a break for more than 30 days, who received physical therapy or injection therapy for the low back in the last 6 months, who had chronic disease (cardiovascular, pulmonary, genitourinary, progressive/non-progressive neurological diseases) with a history of spinal structural deformity/instability/trauma/surgery, malignancy, and pregnancy were excluded from this study. In addition, patients with severe osteoarthritis and using wheelchairs were not included in the study.
Approval was obtained from the National and local Ethics Committee for this study (University of Health Sciences, Ankara Bilkent City Hospital, Turkey with the approval number: E2-21-136 – Date of approval: February 10, 2021) and procedures were conducted in accordance with the relevant principles of the Declaration of Helsinki. Before evaluations, participants were informed about the nature of the study and signed consent was obtained from each participant.

Demographic and disease characteristics

Information such as age, gender, years of education, body mass index (BMI), working time of the participants were recorded in the forms.

Measurements

Pain intensity (Visual analog scale), disability level (Quebec Back Pain Disability Scale), total physical activity (International Physical Activity Questionnaire-Short Form), physical activity level at work and in leisure time of all patients were evaluated and recorded in the forms.

- Quebec Back Pain Disability Scale (QBPDS) was performed to measure the functional disability in patients with LBP. This scale is a condition-specific questionnaire consisting of 20 questions and is scored between 0 and 5 points. High scores indicate a high disability (13).
- Visual Analogue Scale (VAS) is a scale for pain, and it consists of a 10 cm line with “no pain” at the left end (0 cm) and “worst pain imaginable” (10 cm) at the right end.
- International Physical Activity Questionnaire-Short Form (IPAQ) is used to evaluate the intensity of physical activity that individuals do in their daily life. It estimates total physical activity as MET-min/week (14).
- Physical activity levels at work grouped by formulation in the Nord-Trøndelag Health Study Physical Activity Level for Work (HUNT) study (15, 16). Hereby, the participants were grouped according to their workload and physical activity levels. The categories were determined as follows: 1) sedentary workers, 2) mild group - work that involves walking but does not require heavy lifting, 3) moderate group - work that mainly involve walking, 4) severe group - work that require heavy lifting and particularly strenuous physical activity (15).
- Physical activity in leisure-time: grouped by formulation in the HUNT-2 study. Accordingly, it is divided into three levels as no physical activity or light activity (level 1), ≤ 2 hours/week of strenuous physical activity (level 2), and ≥ 3 hours/week of strenuous physical activity in leisure time (level 3) (16).
- Paraspinal muscles: in the studies conducted, the lumbar vertebra level at which the paraspinal muscle area was best evaluated was defined as L3-4. In addition, studies of LBP have frequently evaluated the paraspinal muscle areas at the vertebral levels between L3 and S1 (17, 18). Therefore, in our study, the paraspinal muscle cross-sectional area (CSA) was evaluated with the MRI slice at the L2-3, L3-4, L4-5, and L5-S1 vertebra levels. Paraspinal muscle CSA measurements were evaluated in cm2 as applied in previous studies (19).

All calculations were used to trace the contour of the muscle of interest in the axial T2-weighted MRI image using a 1.5 Tesla MRI scanner with 5 mm slice thickness and the close polygon ROI tool (Image J 1.53 software program) for all CSA measurements.

Study protocol

Radiological evaluations in the study were made by two different experts to prevent bias. Then, by comparing the evaluations, a single result was obtained. After all evaluations, the participants were divided into 4 groups by their physical activities at work (**figure 1**). Each group was evaluated in terms of demographic, clinical, and radiological data.

The association between physical activity and pain intensity, disability, and paraspinal muscle morphology was examined. 3 participants in the severe group were not included in this study because they filled out the scales incompletely and the study was evaluated over 130 participants.

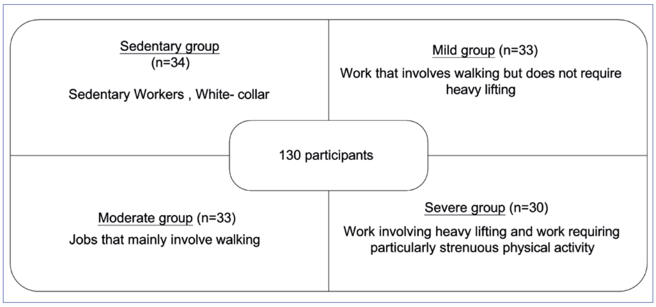

Figure 1. Groups of participants according to their physical activity at work.

Statistical analysis

Statistical Package for the Social Sciences (SPSS 15.0 for Windows) software was used for statistical analysis. In reporting descriptive statistics, the data were expressed as mean ± standard deviation (SD) and percentage (%) for categorical and nominal variables. Participants were grouped according to their physical activity (sedentary, mild, moderate, severe). The difference in demographic data and measurements between the groups was evaluated using ANOVA. Pearson's correlation test was performed to evaluate the relationship between work characteristics and muscle CSAs, and other assessment parameters. Models using age, gender, BMI, physical activities (work/leisure time) were analyzed with multivariate linear regression analysis to determine the predictor of physical activity at work and leisure time activity explaining variance of pain intensity, disability, and paraspinal CSA. A P-value of 0.05 or less was considered significant for all statistical results.

Table I. Sociodemographic data and clinical characteristics.

Variables	
Gender	
Female	73 (56.2%)
Male	57 (43.8%)
Age (years) mean (SD)	39.93 (12.89)
BMI (kg/cm²) mean (SD)	26.48 (4.62)
Years of education mean (SD)	9.47 (4.19)
Work duration (years) mean (SD)	17.72 (11.89)
Leisure time physical activity n (%)	
Light only	29 (22.3%)
≤ 2 hours hard per week	51 (39.2%)
> 3 hours hard per week	50 (38.5%)
QBPDS mean (SD)	42.77 (15.33)
IPAQ mean (SD)	4826.31 (7111.13)
VAS mean (SD)	5.77 (1.32)

SD: standard deviation; BMI: body mass index; QBPDS: Quebec Back Pain Disability Scale; IPAQ: International Physical Activity Questionnaire-Short Form; VAS: Visual Analogue Scale.

RESULTS

The mean age of the participants was 39.93 ± 12.89 years, 57 (43.8%) were male and 73 (56.2%) were female, and the mean BMI was 26.48 ± 4.62. The mean duration of work was 17.72 ± 11.89 years, and the mean years of education was 9.47 ± 4.19. The general demographic and clinical information of the participants are given in **table I**.

The comparison of the groups in terms of demographic, clinical and paraspinal CSA was given in **table II**. There was no significant difference between the groups in terms of age, BMI, duration of work, education, pain, and disability. A significant difference was found between the groups in terms

Table II. Comparison of demographic and clinical data between groups.

	Sedentary group (n = 34)	Mild group (n = 33)	Moderate group (n = 33)	Severe group (n = 30)	P-value
Gender n (%)					
Female	31 (91.2 %)	26 (78.8 %)	10 (30.3 %)	6 (20.0 %)	0.000*
Male	3 (8.8 %)	7 (21.2 %)	23 (69.7 %)	24 (80.0 %)	
Age mean (SD)	38.88 (12.35)	44.64 (10.58)	37.39 (13.54)	38.73 (14.29)	0.101

	Sedentary group (n = 34)	Mild group (n = 33)	Moderate group (n = 33)	Severe group (n = 30)	P-value
BMI mean (SD)	26.48 (5.07)	27.41 (4.41)	25.34 (4.08)	26.70 (4.85)	0.201
Work duration mean (SD)	17.94 (11.83)	20.91 (9.76)	15.21 (13.19)	16.73 (12.37)	0.157
Years of education mean (SD)	9.71 (4.43)	9.97 (4.76)	9.64 (3.81)	8.47 (3.66)	0.589
IPAQ mean (SD)	630.29 (506.52)	1892.82 (2787.56)	6659.73 (8231.26)	10791.87 (8380.80)	0.000*
Leisure time physical activity					
Light only	26 (76.5 %)	3 (9.1 %)	0 (0.0 %)	0 (0.0 %)	0.000*
≤ 2 hours hard per week	7 (20.6 %)	26 (78.8 %)	13 (39.4 %)	5 (16.7 %)	
> 3 hours hard per week	1 (2.9 %)	4 (12.1 %)	20 (60.6%)	25 (83.3 %)	
L2-L3 Paraspinal CSA mean (SD)	8.05 (2.53)	7.96 (2.45)	8.76 (2.11)	9.39 (1.92)	0.019*
L3-L4 Paraspinal CSA mean (SD)	8.61 (2.14)	9.26 (2.55)	9.92 (2.67)	10.66 (3.20)	0.031*
L4-L5 Paraspinal CSA mean (SD)	9.69 (3.00)	9.09 (1.97)	9.78 (2.25)	9.96 (2.59)	0.576
L5-S1 Paraspinal CSA mean (SD)	11.17 (3.46)	10.51 (3.14)	10.91 (2.72)	11.07 (4.37)	0.900
QBPDS mean (SD)	45.24 (14.89)	44.21 (16.91)	40.55 (14.21)	40.83 (15.37)	0.494
VAS mean (SD)	5.85 (1.26)	5.70 (1.55)	5.76 (1.25)	5.77 (1.22)	0.993

SD: standard deviation; BMI: body mass index; QBPDS: Quebec Back Pain Disability Scale; IPAQ: International Physical Activity Questionnaire-Short Form; VAS: Visual Analogue Scale; *p < 0.05.

of gender, total physical activity level, leisure time activities, L2-3, and L3-4 paraspinal CSA levels ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p = 0.019$, $p = 0.031$, respectively).

The correlation analysis between physical activity at work and leisure time based on VAS, QBPDS, paraspinal CSA were shown in **table III**. A positive correlation was found between physical activity at work and paraspinal CSA at L2-3, L3-4 levels, and IPAQ ($r = 0.264$, $p = 0.002$; $r = 0.265$, $p = 0.002$; $r = 0.596$, $p = 0.001$, respectively). Also, correlations were found between physical activity in leisure time and L2-3 paraspinal CSA, and IPAQ ($r = 0.207$, $p = 0.008$; $r = 0.011$, $p = 0.001$, respectively).

The results for the multivariate regression analyses were presented in **table IV**. Pain, disability, and physical activity (work/leisure time) were not determined as independent risk factors for paraspinal CSA ($p > 0.05$). Male gender was found to be effective in paraspinal CSA elevation at L2-3 and L3-4 levels (B = 1.956 (0.993/2.918), $p < 0.001$; B = 1.936 (0.788/3.084), $p = 0.001$). BMI was determined as a positive predictive risk factor for paraspinal CSA at the L2-L3 level (B = 0.096 (0.008/0.185), $p = 0.034$). Age was determined as the negative predictive risk factor for the increase in paraspinal CSA at L4-5 and L5-S1 levels (B = -0.045 (-0.082/-0.007), $p = 0.019$; B = -0.174 (-0.291/-0.057), $p = 0.004$).

Table III. Correlation between physical activity at work and leisure time, pain intensity, disability, paraspinal muscle cross-sectional area, age, BMI, and duration of work.

	Physical activity at work	Physical activity in leisure time
Age r/p	-0.072/0.418	-0.093/0.292
BMI r/p	-0.033/0.259	-0.072/0.418
Work duration r/p	-0.100/0.259	-0.048/0.591
VAS r/p	-0.010/ 0.908	-0.014/0.877
QBPDS r/p	-0.101/0.254	-0.012/0.894
L2-L3 Paraspinal CSA r/p	**0.264/0.002**	**0.207/0.018**
L3-L4 Paraspinal CSA r/p	**0.265/0.002**	0.099/0.261
L4-L5 Paraspinal CSA r/p	0.095/0.283	0.044/0.623
L5-S1 Paraspinal CSA r/p	-0.011/0.906	0.050/0.575
IPAQ r/p	**0.596/0.001**	**0.611/0.001**

r: correlation coefficient; BMI: body mass index; QBPDS: Quebec Back Pain Disability Scale; IPAQ: International Physical Activity Questionnaire-Short Form; VAS: Visual Analogue Scale; CSA: cross sectional area.

Table IV. Multivariate linear regression analysis.

	R2	B	SE	B	95%CI (lower-upper) for B	P-value
L2-L3 paraspinal muscle CSA	**0.173**					
Gender		1.956	0.486	0.420	(0.993_2.918)	0.000*
BMI		0.096	0.045	0.192	(0.008-0.185)	0.034*
L3-L4 paraspinal muscle CSA	**0.146**					
Gender		1.936	0.580	0.354	(0.788-3.084)	0.001*
L4-L5 paraspinal muscle CSA	**0.065**					
Age		-0.045	0.19	-0.232	(-0.082_-0.007)	0.019*
L5-S1 paraspinal muscle CSA	**0.164**					
Age		-0.174	0.059	-0.655	(-0.291_-0.057)	0.004*

B: Regression coefficients; CI: coefficient interval; SE: Standard error; P-values of multivariate linear regression analysis; CSA: cross sectional area; *p < 0.05.

DISCUSSION

In the current study, the effects of physical activity at work and in leisure time on pain intensity, pain-related disability, and paraspinal muscle mass were investigated in workers with chronic LBP. According to the data of the study, it was found that there were significantly more males in the groups with moderate and severe groups, and more females in the groups with sedentary and mild activity. Total physical activity levels were found to be significantly higher in the moderate and severe groups than in the sedentary and mild groups. It was found that patients who were more active during work were also more active in leisure-time activities. L2-3 and L3-4 paraspinal CSA levels were found to be significantly higher in those with moderate and severe groups, and L2-3 and L3-4 paraspinal CSA increased as the level of physical activity at work increased. Also, L2-3 paraspinal CSA increased as leisure-time physical activity increased. Male sex was found to be an independent risk factor for paraspinal CSA at L2-3 and L3-4 levels, BMI for paraspinal CSA at the L2-3 level, and age as an independent risk factor for L4-5 and L5-S1 paraspinal CSA.

Many adults are constantly exposed to physically demanding jobs, both in daily life and at work, and work productivity is affected by diseases of the musculoskeletal system. Work and leisure-time physical activities may not have similar effects on the low back area. Two studies that address both types of activity separately have shown that there were inverse correlations between leisure-time activities and LBP, and positive correlations between work activities and LBP (20).

The level of physical activity in the workplace shows subjective differences between individuals and requires a common objective classification. Grouping occupations according to physical activity level may provide more comparable data. In a review comparing questionnaires evaluating occupational physical activity, the formulation applied in HUNT was considered to have good validity (15, 21). Therefore, we classified the participants in this study according to the formulation in the HUNT study.

Studies have shown that strenuous physical work conditions increase the risk of chronic LBP (20). In this study, when we compared the workers with a light and heavy workload, no significant difference was found between the groups in terms of pain and disability, and the level of physical activity during work was not found to be effective on pain severity and disability. This may be since physical work demands affect individuals differently according to their physical capacities. An imbalance between hard work-related physical exposure and physical capacity may be a risk factor for LBP. In addition, it can be thought that the physical capacity of the individual, regardless of the workload, may be a risk factor for LBP. In our study, we found that as the level of physical activity in the workplace increased, paraspinal CSAs increased at L2-3 and L3-4 levels. The reason for this may be hypertrophy in the muscles due to high physical activity, as well as the development of atrophy in the muscles due to low physical activity. In addition, no significant difference was found in L4-5 and L5-S1 segments. These differences may be due to the biomechanical and anatomical differences between the L5 and other lumbar levels (22).

Previous studies have shown that the CSA of the paraspinal muscle tends to decrease with age (23, 24). In our study, we found that age was a negative predictive factor for L4-5 and L5-S1 paraspinal CSA. An age-related decrease in CSA suggests the development of progressive muscle atrophy and sarcopenia as part of the normal aging process. In future studies, age can be used as a variable in evaluating the relationship between paraspinal muscles and LBP.

In our study, BMI was found to be a positive predictor for L2-3 paraspinal CSA. Paraspinal muscles, like other parts of the body, are affected by the accumulation of fat in the body due to obesity. However, especially the lower lumbar region may not be affected by this fat accumulation (25). Similarly, in our study, it was observed that paraspinal CSAs at lower lumbar levels were independent of BMI.

In a meta-analysis, it was reported that there was no definite relationship between physical activity and the risk of low back pain (26). In our study, we found no association between leisure time physical activity and pain and disability. In a study examining the relationship between physical activity level and paraspinal muscle CSA, no relationship was found between these two (27). In this study, we showed that as the level of leisure-time physical activity increases, the CSA level increases at the L2-3 level. However, it should be kept in mind that physical activity is reported according to the individual's own perception and can be overestimated or underestimated (28, 29).

There are some limitations of our study. Our study was conducted on a small sample group, and with a larger group of participants, more precise data can be found between the level of physical activity at work and paraspinal muscle mass. The fact that the muscle and fat infiltration were not evaluated separately while evaluating the paraspinal muscle CSA may cause the paraspinal muscle mass to be measured excessively in our study. Also, measuring physical activity using a step counter tool such as a pedometer or accelerometer, rather than a self-report scale, can provide more objective data.

CONCLUSIONS

The association between physical work demands and the risk of LBP has been examined in different studies. However, this study is the first to evaluate the relationship between physical workload and paraspinal muscle mass in workers. Paraspinal muscle mass was affected by the duration of the profession, occupational physical activity, and total physical activity level, and we think that more comprehensive studies are needed on this subject. To understand the effect of physical activity on LBP and paraspinal muscle mass, more detailed evaluations of both physical activity and paraspinal muscle CSA (such as the presence of fat infiltration, multifidus, erector spinae, psoas major muscle areas) are needed. Studies on LBP should consider not only all aspects of physical activity (type, duration, frequency, and intensity) but also all areas of physical activity (leisure time, at home, and at work).

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None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

ZAY, DC, EU: conceptualization, study design, acquisition of subjects and/or data, data analysis and interpretation, writing – original draft, writing – review & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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