Original Article

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Static balance and its association with pain and disability in females with low back pain – a pilot cross-sectional study

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Abstract

Introduction: Research on low back pain (LBP) indicates sex differences in the prevalence and degree of disability, which is more significant in females and shows possible balance deficiencies. This study aimed to answer the following research questions: (i) is there a difference in static balance between healthy and females with LBP, (ii) is there a correlation between pain and static balance in females with LBP, and (iii) is there a correlation between static balance and disability in females with LBP. *Methods*: A cross-sectional research was conducted in a physiotherapy outpatient setting on a sample of 50 subjects, females with LBP and healthy volunteers, divided into two equal groups. Data collected from all respondents were: age, weight and height, the centre of pressure path length and rectangle area, Romberg area quotient and space quotient measured via a stabilometric force platform. In the LBP group, the pain was assessed using the Numeric Pain Rating Scale, and disability was assessed using the 24-item Roland Morris Disability Questionnaire. Nonparametric statistical tests were used: the Mann-Whitney test (i) and the Spearman correlation coefficient (ii and iii) with a defined significance level set at $p<0.05$. *Results*: Statistical analysis revealed (i) a difference in static balance between healthy females and those with LBP, (iii) a correlation between disability and static balance and (ii) no correlation between pain and static balance in LBP. *Conclusion*: Females with LBP have static balance deficiencies, which are correlated with their disability but not with pain which should be considered during physiotherapy.

Keywords: low back pain, postural balance, standing position

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INTRODUCTION

Low back pain (LBP), predominantly nonspecific and not associated with severe or potentially profound causes [1], represents a priority clinical, socioeconomic and social problem due to the consequences of years spent with disabilities [2], activity restrictions and absenteeism [3]. Frequently described as a complex problem, LBP has multiple contributors to pain and associated disability, which are of different origins; psychological, biophysical, social, comorbidities, and pain-processing mechanisms [3]. Due to its occurrence, LBP, unfortunately, takes on the adjective of universality and is very often a keyword in diverse empirical research. Manifesting alterations of LBP are person various and can be different in quantity and quality, but with one similarity; decreased quality of life. Research indicates gender differences in prevalence and degree of disability, more significant in females [4], apropos their biological attributes and physical and physiological characteristics. However, in the case of gender differences in quality of life, recent research has shown no differences in self-perception of quality of life and health between males and females with LBP [5].

Additionally, research shows that people with LBP may present static balance deficiencies [6] and poorer postural control than healthy controls [7], affecting their functional ability and, consequently, quality of life. Namely, postural control is a prerequisite to performing physical and daily activities in static or dynamic conditions [8]. Simultaneously, pain, preferentially localised in the lower back, can induce postural control alteration [9]. This type of pain is associated with altered proprioception and muscle strength, affecting the quality of the sensory information and compromising the relationship between postural responses and sensory input [10], so pinpointing the altered proprioception as one of the possible causes of balance deficiencies in individuals with LBP [11]. In addition to static balance, the control of erect posture may be more integrated into the motion control scheme than previously considered [8], thus making the question of static balance deficiencies in LBP [6,11] even more exciting and worth further research. Moreover, there is evidence that the stabilisers of the spine in an upright posture, the multifidus that condition lumbosacral alignment and postural sway, are morphologically and functionally altered in LBP [12]. However, studies in which static balance has been objectively assessed and its relationship to pain and disability investigated are insufficient, especially in females, who are significantly more vulnerable to LBP. It is necessary to identify balance deficit in people with LBP to help their rehabilitation [11] using objective methods by which we can quantify it and see its relationship to pain and disability. LBP is a multidimensional phenomenon [12] and can result in severe biopsychosocial consequences; therefore, it is essential to consider all possible alterations and their interrelationship during the assessment to provide an adequate treatment program.

The purpose of this pilot cross-sectional study was to answer the questions of whether there is (i) a difference in static balance between healthy and females with LBP, (ii) a correlation between pain and static balance in females with LBP, and whether there is (iii) a correlation between static balance and disability in females with LBP. The contribution of this research will be the findings based on accurate and verifiable data and their application in practice to enhance the rehabilitation of females with LBP.

MATERIALS AND METHODS

Participants

The study included two target groups - the females with LBP and healthy females. The first target group were females with LBP admitted to outpatient physiotherapy. The second group consisted of healthy volunteers who were female employees at the Department of Rehabilitation and Orthopaedics Aids, University Hospital Centre Zagreb. Exclusion criteria in the healthy group were the following: age (<18), present chronic or acute musculoskeletal pain, vestibular, visual, sensorimotor disorders, pregnancy, taking medications which affect balance and alcohol consumption in the past 24 hours. Subjects with impaired cognitive abilities, inability to follow verbal instructions, being unable to

give informed consent and physical and mental problems could reduce the reliability of assessments. Exclusion criteria in the LBP group were: age (<18), LBP associated with severe or potentially profound causes, spine surgery, perceived pain intensity less than 4 according to Numeric Pain Rating Scale, vestibular, visual, sensorimotor disorders, pregnancy, use of mobility aids, taking medications that affect balance and alcohol consumption in the past 24 hours. Subjects with impaired cognitive abilities, inability to follow verbal instructions, being unable to give informed consent and physical and mental problems could reduce the reliability of assessments.

To collect a convenience sample of volunteers in the healthy group, the female employees of the Department of Rehabilitation and Orthopaedics Aids, University Hospital Centre Zagreb, were informed personally and via the bulletin board about the purpose of the research and the inclusion and exclusion criteria. Twenty-five healthy females responded to the invitation, with whom the research physiotherapist once again went through the eligibility procedure. When sampling the LBP group, the goal was to collect the same number of subjects as in the healthy group while ensuring that the age range was similar. Females with LBP pain were initially screened on their first visit to physiotherapy treatment, and those who did not meet any exclusion criteria were offered to participate in this research with a full explanation of the research's need, purpose, and objectives. Based on informed consent, the selection was completed when 25 females with LBP who did not meet any exclusion criteria were selected, totalling 50 respondents in the study. There were no dropouts in any cohort through the cross-sectional trial process.

Ethics

This cross-sectional research was conducted in the Department of Rehabilitation and Orthopaedics Aids and its physiotherapeutic outpatient unit from January until April 2022. The study was approved by the Ethics Committee of the University Hospital Centre Zagreb (Class: 8.1-22/5-2, Number: 02/21 AG) and has followed the tenets of the Declaration of Helsinki. All the respondents signed the informed consent. Following the study design, an effort was made to follow STROBE recommendations.

Methods and apparatus for balance assessment

Initially, age, height and weight data for calculating Body Mass Index were collected from all subjects. Both groups evaluated the static balance using a stabilometric force platform (Cosmogamma R50300). Postural parameters were recorded by projecting the body's centre of pressure (COP) with eyes closed (EC) and eyes open (EO). Parameters included for the analysis were: COP path length and rectangle area, the Romberg area quotient and the space quotient. Romberg's quotient is an index of the measured instability during eyes closed with respect to the eyes open, used to discriminate the role of competing for sensory input in postural regulation [13]. It is considered that the average value of the Romberg quotient in healthy persons is >1. Values far exceeding 1 indicate that the person depends on visual information to provide sensory input for balance control [14]. The expected average value of the quotient will generally rely on the similarity of the postural parameters, i.e. path length while standing with EC and EO. The measurement procedure involved the subjects standing on a stable surface of the force platform with EO and EC [14,15] for 30 seconds, using their most natural foot posture [14]. The assessment protocol was administered by an experienced evaluator, a physiotherapist with training in handling the used force platform.

Pain and disability assessment

In the LBP group of subjects, the pain was assessed using a Numeric Pain Rating Scale (NPRS), with a unidimensional measure of pain intensity ranging from 0 (no pain) to 10 (worst pain imaginable) and categorising pain as mild (scores 1–3), moderate (scores 4–6), and severe (>7) [16]. The NPRS is available in various public domains and is free for clinical and research work. Simultaneously, the 24-item Roland Morris Disability Questionnaire (RMDQ) was used to evaluate the level of disability. The questionnaire contains 24 statements related explicitly to physical functions, most often limited in patients with LBP. The marked statement carries one point, so the questionnaire is scored from 0 to 24 points, where a higher sum indicates a higher level of disability [17, 18]. The

intraclass correlation (ICC) of RMDQ ranges from 0.42 – 0.91 [19]. Croatian version of RMDQ was used, available free of charge on the official website of the organisation [20].

Statistical Analysis

Statistical data processing was performed in the PSPP program (GNU Project, version 1.4.1/5 September 2020). The Kolmogorov-Smirnov test was used for the data distribution normality check. Considering the asymmetric distribution, nonparametric tests were used: the Mann-Whitney test was used to determine the differences between the groups from the first research question, and the Spearman correlation coefficient was used to determine the correlations from the second and third research questions. The significance level was set at $p<0.05$.

RESULTS

A total of 50 middle-aged (MD=49), normal-weight (MD=23.7) female subjects participated in this research, of which 25 were healthy volunteers and 25 females with LBP. Females with LBP presented severe pain (MD=8) and disability (MD=15). Descriptive statistics of all collected data in the entire sample (N=50) and the sample of subjects with LBP (N=25) are shown in Table 1.

The difference in the static balance between healthy and females with LBP

Between the group of healthy females and females with LBP, there is no difference in static balance parameters except for one, the rectangle area with eyes open, which is significantly lower in healthy females (MD=20.94, n=25) than in females with LBP (MD=30.06, n=25), U=198.500, z=-2.212, p=0.027, r=0.31, as seen in Table 2.

Correlation between static balance and pain in females with LBP

Spearman's coefficient did not establish a connection between the pain intensity and any of the static balance parameters in females with LBP, as shown in Table 3.

Table 1. Descriptive statistics of the sample.

Variable	N	Md (Q1-Q3)
Age	50	49 (35.56)
Body Mass Index	50	23.7 (21.2; 26.7)
Length (mm) open eyes	50	277.8 (237.1; 342.6)
Rectangle-area (cm^2) open eyes	50	1.7 (1.4; 2.9)
Length (mm) closed eyes	50	364.4 (301.1; 487.8)
Rectangle-area (cm^2) closed eyes	50	2.6 (1.6; 3.7)
Romberg space quotient	50	1.3 (1.1; 1.5)
Romberg area quotient	50	1.5 (1.0; 1.9)
NPRS	25	8 (6.9)
RMDQ	25	15 (11.5; 20.5)

N – number of respondents, Md – Median, Q1-Q3 – the interquartile range, NPRS – pain intensity, RMDQ-disability score

Table 2. Mann-Whitney test results for static balance difference between healthy females and females with LBP.

Static balance parameters	U	z	p
Length (mm) open eyes	239.000	-1.426	0.154
Rectangle-area (cm^2) open eyes	198.500	-2.212	0.027*
Length (mm) closed eyes	271.000	-0.805	0.421
Rectangle-area (cm^2) closed eyes	220.000	-1.795	0.073
Romberg space quotient	300.000	-0.243	0.808
Romberg area quotient	262.500	-0.970	0.332

U- Mann Whitney test, z- z-value, *significant at $p<0.05$

Table 3. Spearman correlation coefficient between static balance parameters, pain and disability in females with LBP.

Static balance parameters	NPRS	RMDQ
Length (mm) open eyes	0.057	0.040
Rectangle-area (cm^2) open eyes	-0.011	0.017
Length (mm) closed eyes	-0.040	0.255
Rectangle-area (cm^2) closed eyes	-0.053	0.233
Romberg space quotient	-0.216	0.291
Romberg area quotient	-0.155	0.430*

NPRS- pain intensity, RMDQ- disability score, *significant at $p<0.05$

Correlation between static balance and functional disability in females with LBP

The Spearman coefficient determined a moderate positive correlation between the functional disability of females with LBP and the Romberg area quotient (Table 3), which tells us that the increased functional disability will also increase the quotient. No significant statistical correlation was observed in other variables.

DISCUSSION

Research shows that persons with LBP may present static balance deficiencies [6,11] and generally poorer postural control than healthy controls [7] as possible consequences of pain in the lower back [9] associated with altered proprioception and muscle strength [10]. However, there is not enough methodologically quality research to perpetuate these balance alterations and prove their connection with pain in this musculoskeletal dysfunction and the level of disability, especially in the more vulnerable group - women. Therefore, this research aimed to focus on women and answer the research questions about whether there is a difference in static balance between healthy females and those with LBP and whether there is a connection between pain intensity and disability with static balance in LBP.

A total of 50 middle-aged, normal-weight female subjects participated in this research, of which 25 were healthy volunteers and 25 females with LBP. Generally, females with LBP presented severe pain intensity and disability. Klemenc-Ketis reported moderate to severe disability in about 50% of the mixed-gender sample with LBP [21], while Buragadda et al., analysing a total of 227 females, reported moderate to severe disability in over 30% of them [22]. In addition to pain, perceived intensity in our respondents is not too different from other research; for instance, the study on females by Marini et al. defined LBP as severe in 34.8% and moderate in 40.6% of a total of 210 respondents [16]. However, given that our observational findings on the intensity of pain and disability are based on a small sample number and are not covered by the research questions *per se*, we highlight them only as a potential for future research.

In addition to the presence of static balance deficiencies [6] and generally poorer postural control [7] in persons with LBP, Braga et al. compared the static postural balance between females suffering from LBP and healthy subjects by moving the COP on a force platform during EO and analysing the area and the speed of displacement of both groups [11]. They concluded that females with LBP altered the static postural balance since there was an increase in the area parameter compared to healthy individuals, while velocity difference was not found. Although in our research, we analysed other postural parameters besides area in the conditions of EO and EC, it was only in the area EO parameter that we noticed a significant difference – a greater size of COP displacement in females with LBP in contrast to healthy subjects. Our finding is consistent with the result and with the conclusion of the research by Braga et al., thereby additionally providing an answer to the research question that points to the existence of static balance differences between healthy and females with LBP.

Brech et al. investigated the correlations between pain and the level of disability and postural balance among females with LBP by studying mean sway speeds in anteroposterior and mediolateral direction with EO and EC on a stable surface and an unstable surface [15]. Although the experimental parameters differed from ours, the results obtained from this research did not confirm any correlation between pain and altered postural balance. These results are very similar to ours in that no connection between pain intensity has been found with any observed parameter of static balance.

In addition to disability and static balance correlation, we determined a moderate positive correlation between the disability of females with LBP and the Romberg area quotient. This tells us that the increased functional disability will also increase the quotient. In contrast to ours, the results of the previous study showed an inverse correlation of balance with disability measured with the Oswestry Disability Index in females with LBP; the more significant the disability, the lower the sway speed [15]. Such a contradictory finding should be taken and interpreted with caution since, at first, it may signify good postural balance, given that there was minor COP displacement while maintaining the posture. Additionally, the literature says that smaller magnitudes of peak movement from the COP result from choosing the ankle strategy [23] in standing, even when the ankle strategy is not the most appropriate [24], like on unstable surfaces or when keeping their eyes closed. Considering that our research question was not focused on cause-and-effect relationships, we will only point out a positive correlation between disability and static balance.

In concluding this discussion, we will refer to Koch and Hänsel, which showed that persons with and without nonspecific LBP differed in several postural control parameters, such as the COP displacement, postural control strategy, and muscle activation patterns. Still, none of the parameters alone had significant effects, but in combination [25]. Therefore, although we have shown a difference in static balance between healthy females and those with LBP and a correlation of disability with static balance, while there is no correlation with pain intensity, it is essential to observe the parameters mentioned above in future studies also. In previous studies comparing static balance in healthy people and people with LBP, different methodological procedures were used, including the one used in this research, so replication of those studies with standardised procedures is imperative to obtain more convincing evidence of differences in postural control during standing [25].

Additionally, as a limitation in this research, we point out the convenience sample size, which included a smaller number of subjects and the possible lack of other characteristics of subjects with LBP that would have determined a more precise level of homogeneity. Still, we point out that the same modus was also observed in the available studies, which should be considered during future research. Despite the highlighted limitations, an effort was made to provide a thorough and detailed description of the participants and the research environment. Still, in the end, it is up to the readers to make the final assessment of the generalizability and application of the findings in their environment.

CONCLUSION

This pilot study showed that static balance, to a certain extent, differs significantly between healthy women and women with LBP, and while it correlates with a disability, it does not correlate with pain. The contribution of this research to clinical practice is reflected in the findings on balance alterations in females with LBP and its relationship with disability. At the same time, this gives importance to conducting new and more comprehensive research on balance deficiencies in LBP, especially among women who, despite their vulnerability, are partially neglected in research on this matter. In addition to the vulnerable group, female professional athletes are at an increased risk of developing low back pain, most often unrelated to severe pathology. Therefore, it would be valuable to include this group in future research and examine the differences and correlations observed in this research.

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Conflict of Interest

Authors state no conflict of interest.

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