DOES A HIGH LEVEL OF PHYSICAL ACTIVITY IN INDIVIDUALS WITH LOW BACK PAIN ENSURE BETTER POSTURAL STABILITY?

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Abstract

An increase in the level of physical activity has become an important part of recommendations in the management of low back pain (LBP). While the effect of a low level of physical activity on postural stability is becoming clear, the possible effect of high level of physical activity in individuals with LBP has received less attention to date. Objective. The aim of this study was to find out whether there exist differences regarding postural stability taking into account the level of physical activity in individuals with and without LBP. Methods. This cross-sectional study included 58 participants with LBP and 24 healthy persons. Participants were divided into two subgroups, i.e. participants with a moderate level of physical activity (MPA) and participants with a high level of physical activity (HPA). A questionnaire was used to assess LBP prevalence. Postural stability was assessed with the use of the dynamographic platform. Results. There were no differences between groups for any of the centre of pressure (COP) parameters assessed: average velocity (V), area of the ellipse (AoE), length of the ellipse in the anterior-posterior direction (LoEAP) and length of the ellipse in the medial-lateral direction (LoEML). Conclusion. Our study showed that in the group of participants with LBP a high level of physical activity does not ensure better postural stability than a moderate level of physical activity. However, physical activity helps people with LBP to prevent postural instability.

Keywords*: Postural stability, Low back pain, Physical activity*

Introduction

Impaired postural stability has been reported in many disorders including low back pain (LBP). Studies suggest that individuals with a history of LBP often have abnormalities in the motor control of deep trunk muscles, characterized by delayed neuromuscular recruitment (Hodges, 2001), delayed and decreased activity of deeper muscles (Macdonald, et al., 2010), increased co-contraction of superficial muscles (Cholewicki, et al., 2002) and changes in the lumbosacral proprioception (Brumagne, et al., 2000; Tong, et al., 2017). These abnormalities may predispose to postural instability.

Studies revealed that physical activity is significant for preventing and treating LBP, and an increase in the level of physical activity has become an important part of recommendations in the management of LBP (Abenhaim, et al., 2000; Jacob, et al., 2004; Foster, et al., 2018). Physical activity helps to prevent a reduction in muscular strength and a decrease in postural stability (Alsufiany, et al., 2020). Moreover, a reduction in physical activity and the associated muscle weakening might have significant negative consequences for postural stability, and thus may lead to the impaired ability to perform daily activities safely and effectively (Skelton, 2001). This applies to all people, especially individuals with LBP. Exercising is of great importance to improve functional ability and health-related quality of life, and to prevent of worsening disability in patients with LBP (Foster, et al., 2018). A recent study has shown that inactive individuals with LBP demonstrated poorer static postural stability compared to their active peers (Alsufiany, et al., 2020). Furthermore, in a prognostic study by Pinto et al. (2014) patients with chronic low back pain (CLBP) who had a moderate or higher activity level at baseline showed less disability at 12 months' follow-up than those who had a sedentary lifestyle.

On the other hand, there is evidence that a high level of physical activity may be dangerous for the lower back. Frequent lifting, bending and twisting as well as extreme sports activities are potential risk factors for LBP (Hoogendoorn, et al., 1999; Hoogendoorn, et al.,2002). Low back pain is common in athletes (Feet, et al., 2017; Farahbakhish et al., 2018). Heneweer et al. (2009) described the correlation between the

level of activity and LBP as a U-shaped curve – i.e. both too little activity and too much activity are hazardous for spinal health.

While the effect of a low level of physical activity on postural stability is becoming clear, the possible effect of high level of physical activity in individuals with LBP has received less attention to date. In this situation, it seems interesting to show how a high and a moderate level of physical activity (MPA, HPA; respectively) in individuals with LBP have an impact on postural stability. To the best of our knowledge, postural stability in people with LBP has not yet been analysed taking into account different levels of physical activity. The aim of this study was to find out whether there exist differences regarding postural stability taking into account the level of physical activity in individuals with and without LBP.

Methods

This cross-sectional study included 3rd-year students of a Bachelor course in Physical Education. The inclusion criteria were as follows: a) male, b) age between 20 and 25 years. Participants were excluded from the study if they: a) had any neurological, cardiovascular, rheumatic or vestibular disorders; b) used medications that might alter postural stability; c) were unable to carry out the postural balance tests.

Eighty two individuals participated in the study, including 58 persons with a history of LBP, and 24 healthy persons. Healthy persons had no history of LBP within the last year.

Moreover, participants were divided into two subgroups, i.e. (a) students with a moderate level of physical activity (MPA) and (b) students with a high level of physical activity (HPA). The inclusion criteria in the MPA group were as follows: a) attending physical education classes included in the curriculum (within three years of studying, each student attends 798 h of sports classes); b) undergoing no sports training at the time of the research or in the past (within the last year); c) taking up leisure-time physical activity no more than once per week and no longer than 60 min. The inclusion criteria in the HPA group were as follows: a) attending physical education classes included in the curriculum; b) training a minimum of 90 min per day – 5 times per week, c) training experience – a minimum of 3 years. The HPA group included individuals who trained one of the following team sports: handball, volleyball or basketball.

All the participants gave their written informed consent. The study was conducted in accordance with the Declaration of Helsinki, and the research was accepted by the Senate Scientific Research Ethics Commission (1/2019).

Questionnaire

A questionnaire was applied as a research tool (Kędra, et al., 2017). All the participants filled in the questionnaire during classes at the university with one of the study authors present. The questionnaire was anonymous and voluntary.

The first page of the questionnaire included an explanation of the study aim and instructions. Personal information section consisted of questions about age, body mass and height. The main section of the questionnaire included questions regarding:

a) training (sport) – sports discipline, number of training days per week, number of training hours per day;

b) experiencing LBP within the last year (12 months). LBP was assessed using the following question: „Have you experienced low back pain for the last year (12 months)?". The answer options were: „no", „yes". "Yes" was considered to denote the presence of LBP. Individuals who responded negatively to this question were asked not to answer the remaining questions.

Individuals who declared that they had experienced LBP in the period of the last year (12 months) answered the questions in the second part. The second part of the questionnaire included a question regarding the frequency of LBP.

Stance analysis

Postural stability was assessed with the use of the dynamographic platform Zebris FDM 1.8 (Force Distribution Measurement, dimensions 208x56x2.1 cm, System Stance Analysis, Medical GmbH, Germany), which measures the centre of pressure (COP) signal. During the measurement, the force exerted by the subjects' feet was recorded by the sensors at a sampling rate of 120 Hz, and the COP signal was registered. The platform was connected to the WinFDM software. The system automatically performed basic analyses of the registered signals.

The assessment of postural stability was based on the following parameters:

1) COP shift parameter: COP average velocity (V);

2) COP surface area parameters: area of the ellipse (AoE), length of the ellipse in the anterior-posterior direction (LoEAP) and length of the ellipse in the medial-lateral direction (LoEML).

Procedure

Prior to the study, each participant was provided with detailed information about the test procedures and the research methodology. Participants reported to be free of neurological, cardiovascular, metabolic, rheumatic or vestibular disorders, and any disease that would interfere with their normal postural

stability. The participants did not feel pain during the test.

Participants were examined individually while standing on a platform in a place indicated by the researcher. The task involved maintaining a two-legged stance with eyes open. The participants were standing barefoot on the platform with their feet apart at a self-selected distance, but without exceeding the shoulder width. Their arms were hanging at their sides in a comfortable position. For the duration of the recording, the participants were further instructed to "stand as still as possible" (Zok, et al., 2008). Two successive trials of 30 seconds duration each were conducted with 5 sec adaptation period that was not recorded. After a 1-min break, the procedure was repeated. Mean of two tests was used. The measuring device was calibrated prior to the examination of every student.

The research was conducted in the Body Posture Laboratory at the Regional Centre for Research and Development. All the tests were performed in the morning hours in the laboratory rooms which were safe and quiet.

Statistical analysis

The collected material was analysed with the use of Statistica 13.3 calculation software. The qualitative parameters were described using basic measurements of descriptive statistics for qualitative variables, i.e. percentage. The quantitative parameters were described using basic measurements of descriptive statistics, i.e. mean and standard deviation. Demographic characteristics variables (height and weight) were compared with Student`s T-test. Chi square test was used to identify significant differences in the percentage of LBP and healthy participants at different levels of physical activity, and to compare the frequency of LBP taking into account the level of physical activity. The compliance of the results with normal distribution was checked with the Shapiro-Wilk test. Due to the fact that the distribution of all variables differed from the normal distribution, a Box-Cox transformation was used to normalise the variables. The data were analysed using a two-factor ANOVA and the eta-squared (η2) effect size was calculated to analyse the interaction effects. The between-subject factors were group (LBP and healthy) and the level of physical activity (a moderate and a high level of physical activity). Post-hoc Tuckey`s tests were applied. The data of postural stability parameters were not normalized according to the height of each student because there was no significant difference in height between the groups ($p>0.05$). Statistical significance was set at $p<0.05$.

Results

Declared prevalence and frequency of LBP

Out of 82 study participants, 58 (70.7%) declared having experienced LBP within the last 12 months. LBP was common among participants with HPA than among their peers with MPA (76.7% vs. 64.1%, respectively). However, this was not significant ($p=0.21$) (Table 1).

Having analysed the declared incidence of LBP, it may be concluded that the largest group was constituted by respondents who experienced pain rarely, i.e. 1–2 times per year (43.1%). While analysing the frequency of LBP with regard to the level of physical activity, it was noted that subjects with HPA declared rare pain (1-2 times per year) often (45.5% vs. 40.0%, for HPA and MPA, respectively). Frequent and constant pain (more than 1-2 times per month) was also declared often by participants with HPA than by subjects with MPA (33.3% vs. 24.0%, respectively). The difference was not statistically significant ($p=0.44$) (Table 2).

Postural stability analysis

The analysis of the COP parameters revealed that participants with LBP achieved lower values of the average velocity of the COP (V), area of the ellipse (AoE), length of the ellipse in the anterior-posterior direction (LoEAP) and length of the ellipse in the medial-lateral direction (LoEML) than students without LBP. Students with LBP and with HPA were characterised by higher values of V, AoE and LoEAP than the respondents with MPA (Table 3). There were no differences between groups for any of COP parameters assessed: average velocity (V), area of the ellipse (AoE), length of the ellipse in the anterior-posterior direction (LoEAP) and length of the ellipse in the medial-lateral direction (LoEML) (Table 4).

Table 1 Characteristics of LBP and healthy groups

		LBP n= 58 (70.7%)	**Healthy** n= 24 (29.3%)	***p* value**
Demographic characteristics				
Body height (m)	M (SD)	1.8 (0.1)	1.8 (0.1)	0.21
Body weight (kg)	M (SD)	80.1 (8.6)	78.5 (9.9)	0.41
Level of PA				
MPA	n (%)	25 (64.1)	14 (35.9)	0.21
HPA	n (%)	33 (76.7)	10 (23.3)	

LBP – low back pain; M – mean; SD – standard deviation; PA – physical activity; MPA – moderate level of physical activity; HPA – high level of physical activity. Demographic characteristics variables (body height and body weight) were compared with Student`s T-test. Chi-square test was used to compare the level of physical activity. Statistical significance was set at $p<0.05$.

Table 2 The frequency of LBP taking into account the level of physical activity

	Total	**MPA (n=25)**	**HPA (n=23)**	***p* value**
	n (%)	n (%)	n (%)	
LBP frequency (n=58)				
Very rare LBP (1-2/year)	25 (43.1)	10 (40.0)	15 (45.5)	
LBP a few times a year (3-6/year)	16 (27.6)	9 (36.0)	7 (21.2)	0.44
Frequent or constant LBP (more than 1-2 months)	17 (29.3)	6 (24.0)	11 (33.3)	

LBP – low back pain; MPA – moderate level of physical activity; HPA – high level of physical activity.

Table 3 Means and standard deviations for COP parameters taking into account LBP and the level of physical activity

COP parameters	**Level of PA**	**LBP**	**Healthy**
		M (SD)	M (SD)
V [mm/s]	MPA	5.7 (1.2)	7.4 (2.2)
	HPA	6.4 (2.3)	6.2 (2.6)
AoE [mm^2]	MPA	125.4 (45.2)	168.7 (71.9)
	HPA	137.0 (80.2)	147.1 (99.4)
LoEAP [mm]	MPA	8.6 (3.3)	10.3 (4.6)
	HPA	8.9 (4.4)	8.5 (3.6)
LoEML [mm]	MPA	19.5 (6.3)	20.3 (7.4)
	HPA	22.4 (9.4)	24.1 (14.8)

LBP – low back pain; M – mean; SD – standard deviation; PA – physical activity; MPA – moderate level of physical activity; HPA – high level of physical activity; V – average velocity of COP; AoE – area of the ellipse; LoEAP - length of the ellipse in the anterior-posterior direction; LoEML – length of the ellipse in the medial-lateral direction.

Table 4 Summary of analysis of variance for COP parameters

Parameters	Group (LBP and healthy)	Level of PA	Group x Level of PA
V [mm/s]	F = 1.894 p = 0.17 η^2 = 0.02	F = 1.068 p = 0.30 η^2 = 0.01	F = 3.376 p = 0.07 η^2 = 0.04
AoE [mm^2]	F =1.299 p = 0.26 η^2 = 0.02	F =0.710 p = 0.40 η^2 = 0.00	F = 0.853 p = 0.36 η^2 = 0.01
LoEAP [mm]	F = 0.906 p = 0.795 η^2 = 0.01	F = 0.068 p = 0.344 η^2 = 0.00	F = 0.016 p = 0.9 η^2 = 0.00
LoEML [mm]	F = 0.461 P = 0.50 η^2 = 0.01	F = 0.838 P = 0.36 η^2 = 0.00	F = 0.478 P = 0.49 η^2 = 0.00

PA – physical activity; V – average velocity of COP; AoE – area of the ellipse; LoEAP - length of the ellipse in the anterior-posterior direction; LoEML – length of the ellipse in the medial-lateral direction.

Discussion

The aim of this study was to find out whether there exist differences regarding postural stability taking into account the level of physical activity in individuals with and without LBP. Our study did not reveal difference in postural stability taking into account a moderate and a high level of physical activity in individuals with and without LBP. This is the first study to compare differences in postural stability taking into account different levels of physical activity, so comparing our results with other research findings is difficult.

Our results showed that participants with LBP were found to have postural stability that is similar to those without LBP. Similar findings were reported in other studies (Brumagne, et al., 2008; Caffaro, et al., 2014; MacRae, et al., 2018). While the effect of a low level of physical activity on postural stability in individuals with LBP is becoming clear (Alsufiany, et al., 2020), the possible effect of HPA has received less attention to date. Our results revealed that there was no difference in postural stability taking into account a moderate and a high level of physical activity in individuals with and without LBP. In line with our results, other researchers reported no statistically significant differences of COP parameters between athletes with and without back pain in standing with eyes open (Appiah-Dwomoh, et al., 2019) and in standing with eyes closed (Oyarzo, et al., 2014). Some findings may explain why postural stability was not significantly different between active individuals with and without LBP. Participants with HPA were less likely to develop functional limitations as compared to a sedentary group (Paterson, & Warburton, 2010). Moreover, van Dieen et al. (2019) suggested that any dysfunction in body posture caused by LBP might have been adequately compensated during the static test.

Our study revealed that in the group of participants with LBP a high level of physical activity does not ensure better postural stability than a moderate level of physical activity. However, our results revealed that physical activity (of a moderate and a high level) helps participants with LBP to prevent postural instability. Physical activity is significant for preventing and treating back pain and an increase in the level of physical activity has become an important part of recommendations in the management of LBP (Abenhaim, et L., 2000; Jacob, et al., 2004, Foster, et al., 2018). Our findings are in line with recommendations in the management of LBP.

Study limitations

The present study adopted a cross-sectional design, therefore causality cannot be inferred. Another limitation of the study is the fact that physical activity is one of many factors affecting postural stability. Therefore, it is important to consider other factors that can affect postural stability. Moreover, different sports were considered together. Future research could usefully include larger athlete sample sizes, with a view to identifying differences between sports.However, these limitations did not affect the

value of the presented results significantly. Further studies require consideration of other variables.

Study strengths

The present study addressed PE students, with a view to ensuring a similar level of physical activity within the last three years. According to the authors' knowledge, it is the first study to compare differences in postural stability taking into account different levels of physical activity (MPA and HPA).

The reliability of the questionnaire applied in this study was assessed (Kędra, et al., 2017). The Kappa coefficient value for all the analysed variables was equal to or higher than 0.93, which indicates the reliability of information gathered with it.

Conclusion

Our study showed that in the group of participants with LBP a high level of physical activity does not ensure better postural stability than a moderate level of physical activity. Physical activity (of a moderate and a high level of physical activity) helps people with LBP to prevent of postural instability. Our findings are in line with recommendations in the management of LBP.

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