Impact of poor prognostic risk for chronic low back pain on functionality and lumbopelvic stability: a cross-sectional observational study

Impacto do risco de mau prognóstico para dor lombar crônica na funcionalidade e na estabilidade lombopélvica: um estudo observacional transversal

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ABSTRACT
Internal load to deal with physical exercise demand depends on the psychophysical capacity. As psychosocial aspects affect patients suffering chronic low back pain (CLBP), we hypothesized that the higher the risk of poor prognosis, the lower the psychophysical capacity and, consequently, the worse the performance in functional tasks that involve walking. To verify the impact of the risk of poor prognosis of patients with CLBP on functional performance and physiological intensity (PI), representative of the task internal load, in a walking test and on lumbopelvic region static and dynamic stability. Cross-sectional observational study. Volunteers of both sexes, physically inactive, were divided into four groups according to the Start Back Screening Tool: control (CG) CLBP free, and low (LrG), medium (MrG), high (HrG) poor prognostic risk. The outcomes were static stability, with emphasis on the action of the transverse and multifidus muscles, and dynamic stability of the lumbopelvic region, both measured by a biofeedback pressure unit, as well as functional capacity, and physiological intensity in the 6-minute walk test. The GEE and complementary metrics (minimum detectable change and effect size) were used for statistical analysis. The sample consisted of 70 volunteers. The outcomes were proportionally affected by the risk of poor prognosis (the higher the risk, the worst performance) and the complementary metrics corroborated inferential statistics. The risk of poor prognosis negatively and proportionally impacts both the static and dynamic lumbopelvic stabilization capacity and the performance and the PI in walking of individuals with CLBP.

Keywords: locomotion, gait, rehabilitation, physiological monitoring.

RESUMO
A carga interna para lidar com a demanda de exercícios físicos depende da capacidade psicofísica. Como os aspectos psicossociais afetam os pacientes que sofrem de dor lombar crônica (DLC), levantamos a hipótese de que quanto maior o risco de mau prognóstico, menor a capacidade psicofísica e, consequentemente, pior o desempenho em tarefas funcionais que envolvem a caminhada. Verificar o impacto do risco de mau prognóstico de pacientes com DLC no desempenho funcional e na intensidade fisiológica (IP), representativa da carga interna da tarefa, em um teste de caminhada e na estabilidade estática e dinâmica da região lombopélvica. Estudo observacional transversal. Voluntários de ambos os sexos, fisicamente inativos, foram divididos em quatro grupos de acordo com o Start Back Screening Tool: controle (GC) livre de DLC e baixo (LrG), médio (MrG), alto (HrG) risco de mau prognóstico. Os resultados foram a estabilidade estática, com ênfase na ação dos músculos transverso e multifídio, e a estabilidade dinâmica da região lombopélvica, ambas medidas por uma unidade de pressão de biofeedback, bem como a capacidade funcional e a intensidade fisiológica no teste de caminhada de 6 minutos. O GEE e as métricas complementares (mudança mínima detectável e tamanho do efeito) foram usados para análise estatística. A amostra foi composta por 70 voluntários. Os desfechos foram proporcionalmente afetados pelo risco de mau prognóstico (quanto maior o risco, pior o desempenho) e as métricas complementares corroboraram a estatística inferencial. O risco de
mou prognóstico impacta negativa e proporcionalmente tanto a capacidade de estabilização lombopélvica estática e dinâmica quanto o desempenho e o PI na marcha de indivíduos com DLC.

Palavras-chave: locomoção, marcha, reabilitação, monitoramento fisiológico

1 INTRODUCTION

Low back pain is a syndrome with high global prevalence that carries a significant social and individual burden and is among the leading musculoskeletal disorders that cause the most morbidity and years living with disability. It is estimated that approximately 84% of adults will complain of low back pain at some point in their lives, and the recurrence rate after the first episode varies between 24% and 80%. Part of those with acute low back pain complaints can evolve to chronic low back pain (CLBP), with records showing that the prevalence of CLBP tripled between 1996 and 2006 (Burden et al., 2015; Ramdas & Jella, 2018; Zaina et al., 2020). In Brazil, it is estimated that the prevalence of patients between 20 and 59 years old with CLBP is around 19.6% (Meucci et al., 2015).

Although some studies recognize that functional capacity is negatively impacted by CLBP, with reduced level of physical activity (Lin et al., 2011), impairments of several orders such as in locomotor performance (Carvalho et al., 2015, 2016; Rahimi et al., 2020), in aerobic conditioning (Duque et al., 2009, 2011), in motor control (van Dieën et al., 2017), the repercussion of CLBP on functionality is still controversial due to the great individual variability in the patients' responses to the painful experience. Therefore, several studies do not corroborate the premise that those who suffer from CLBP will invariably be dysfunctional (Carvalho et al., 2019; Henchoz et al., 2015; van Dieën et al., 2019b).

There are some reasons that can justify the difficulty of studies to show differences in the functional variables between people with CLBP and their healthy peers. These reasons range from methodological inadequacies to the fact that the adaptive capacity and the coping with pain are singular and, therefore, each individual reacts to the situation in a particular way (van Dieën et al., 2019a). Therefore, in relation to the mechanistic approaches to understand chronic pain, it is observed that there is a migration from those biomedical models to biopsychosocial models that predict a complex interrelation between biological, psychological factors and the social context (Hadjistavropoulos et al., 2011; O'Sullivan, 2005; Zaina et al., 2020). In addition, the
greater the contribution of psychosocial aspects to the CLBP clinical condition of patients with chronic pain syndrome, the greater the risk of a poor prognosis (Pilz et al., 2014).

Since pain is a subjective sensation, it is recognized that in CLBP, given its biopsychosocial etiology, not only the anatomopathological aspects but also the psychosocial ones contribute markedly to the dysfunctional scenery, generating distortions between the findings from quantifiable objective measurements and subjective measurements related to the perception of the impact of the disease on the individual (Carvalho et al., 2017; van Weering et al., 2011). Thus, it recognizes the need for continued research to better understand the link between psychosocial aspects and functional tasks in CLBP, considering the relevance of functionality for rehabilitation.

Tolerance to perform functional tasks is dependent not only on the intensity with which it is executed, which represents the external component of the activity total load, but also on the psychophysical capacity of the performer for the dynamic physiological adjustments to occur, which corresponds to the internal component of the total load (Impellizzeri et al., 2019). Locomotion activities represent one of the most elementary attributes of functionality (Ertelt, 2014), and walking speed is considered the sixth vital sign (Middleton et al., 2015). However, investigations on the effects of CLBP on walking tend to focus on the external load component, such as mechanical and metabolic parameters of walking (Carvalho et al., 2019; Henchoz et al., 2015; Hicks et al., 2017; Najafi et al., 2019; Rahimi et al., 2020), and the control of internal load is not presented or is poorly valued.

Since the internal load depends on the psychophysical capacity (Impellizzeri et al., 2019) and, in the case of CLBP, this capacity can be affected by psychosocial aspects, we hypothesized that the higher the risk of poor prognosis, the lower the psychophysical capacity and, consequently, the worse the performance in functional tasks that involve walking. It is also assumed that, due to histomorphological and structural changes in the muscles responsible for stabilizing the trunk that result in poor control in CLBP (Ebenbichler et al., 2001) an increased risk of poor prognosis potentiates such changes.

Therefore, it seems pertinent to question whether the stratification of patients with CLBP, in relation to the risk of developing a poor prognosis, can better evidence the possible differences in motor control measurements of the trunk stabilizers and in functional measurements related to walking when compared with individuals without CLBP. Therefore, the objective of the present
study was to verify the impact of the risk of poor prognosis of patients with CLBP on functional performance and physiological intensity (PI), representative of the task internal load, in a walking test and on lumbopelvic region static and dynamic stability.

2 METHODOLOGY

2.1 PARTICIPANTS

This is a cross-sectional observational study previously approved by the institutional Human Beings Ethics Committee under protocol number 2625847. The sample was composed of volunteers of both sexes, physically inactive, selected in a non-probabilistic and intentional manner. All volunteers received information about the study, its objectives, and procedures, and provided their free and informed consent to participate.

Initially, a screening evaluation was carried out to i) determine whether the volunteer had CLBP or was asymptomatic and identify non-inclusion or exclusion factors; ii) allocation of the volunteers in the groups according to the risk of developing poor prognosis; iii) identification of sample characterization variables such as age (years), body mass (kg), and height (m).

The following criteria were adopted for inclusion in the CLBP groups i) volunteers with reports of persistent low back pain for more than three months; ii) low back pain with physical characteristics compatible with mechanical etiology according to the evaluation and treatment guidelines proposed by the American College of Physicians and the American Pain Society (Chou et al., 2007). For inclusion in the control group, the volunteers could not present musculoskeletal disorders in the spine and neither in lower limbs or systemic diseases that could compromise walking or lumbopelvic stability.

For volunteers with CLBP, the risk of developing a poor prognosis was determined using the Start Back Screening Tool (SBST) questionnaire. It is a questionnaire composed of nine items, with items 1 to 4 related to pain, dysfunction, and comorbidity, and the last five items (items 5 to 9) make up the psychosocial subscale (Pilz et al., 2014). Volunteers, according to the characteristics obtained by screening and by the SBST, were distributed among the four groups: control group (CG = no CLBP); CLBP group with low risk of developing poor prognosis (LrG = total score between 0 and 3 points on the SBST); CLBP group with medium risk of developing poor prognosis (MrG = total score greater than 3 on the SBST and score less than or equal to 3
on the psychosocial subscale); CLBP group with high risk of developing poor prognosis (HrG =
total score greater than 3 on the SBST and score greater than 3 on the psychosocial subscale).

The non-inclusion and exclusion criteria were i) history of spinal surgery; ii) pregnancy; iii) absence of safe hemodynamic conditions to perform walking and decompensated hypertensive patients; iv) associated comorbidities such as history of low back pain of non-mechanical origin and/or symptomatic musculoskeletal disorders in the lower limbs; v) resistance to performing the test due to kinesiophobia.

The sample size calculation was based on two studies that performed walking tests in volunteers with CLBP and whose effect sizes obtained were 0.58 (Bertor et al., 2013) and 0.30 (Fracaro et al., 2013), respectively. The sample calculation was performed using the free software G-Power 3.1 with the following input data: effect size: 0.38; significance level: 0.05; power: 0.80%; number of groups: 4. The total sample “n” needed to be estimated was 80 volunteers, 20 in each group.

2.2 METHODOLOGICAL PROCEDURES AND DATA PROCESSING

Each volunteer came to the laboratory for two sessions on different days.

- Session 1

In this session, after the screening, variables related to the static and dynamic stabilities of the lumbopelvic region were measured.

The measurements of the dynamic and static stability of the deep muscles of the lumbopelvic region were evaluated by a MioStab (Miotec®, Porto Alegre, Brazil) pressure biofeedback unit (UPB). Static stability was tested both with emphasis on the muscular action of the transverse abdominal muscle and on the muscular action of the lumbar multifidus. Prior to the tests, the volunteers were familiarized and trained regarding the movements necessary for the tests. Compensatory movements were corrected and avoided during the tests.

In all tests, both static and dynamic, participants were positioned in dorsal decubitus, with arms extended along the body, knees flexed, and feet supported on the stretcher. The UPB pressure bag was inflated to the pressure established for each test and positioned horizontally and centered in the region that includes the last ribs and the posterior superior iliac spine. After positioning, the assessed was asked to perform a forced respiratory cycle and, if necessary, the
For the evaluation of static stability with emphasis on the transverse muscle, the pressure bag was inflated at a pressure of 40 mmHg and the volunteer was instructed to breathe normally and, when exhaling, to contract the muscles of the perineal and abdominal regions simultaneously to bring the umbilical scar toward the spine and promote compression on the pressure bag. The compression was sustained for at least 10s. Three attempts were requested, with a two-minute interval between each, and the mean pressure sustained during each contraction was recorded. The mean value of the three attempts was considered as the test result. The test indicates good static stability when the contraction generates a pressure increase in the bag of at least 10 mmHg, and this increase is sustained for at least 5s.

For the evaluation of static stability with emphasis on the multifidus, the pressure bag remained at 40 mmHg and the volunteer was instructed to breathe normally and, on exhaling, was asked to contract the multifidus muscles of the lumbar portion to move the lumbar spine away from the pressure bag, promoting lumbar hyperlordosis. This separation lasted at least 10s and three attempts were requested, with a two-minute interval between each one. The average pressure sustained during each contraction was recorded. The result of the test was considered the mean value of all attempts. The test indicates good static stability when it generates a pressure decrease in the bag of at least 6 mmHg, sustained for at least 5s.

For the evaluation of dynamic stability, the pressure bag remained at 40 mmHg and the volunteer was instructed to breathe normally and, when exhaling, to perform abduction of one of the lower limbs, at the maximum possible amplitude, with the intention of touching the lateral face of the limb on the stretcher while maintaining foot support, returning to the initial position afterwards. Three attempts were requested, with a two-minute interval between them. In this test, the volunteer's ability to at least maintain the initial pressure established was evaluated. The assessed individuals who could not maintain the minimum pressure of 40 mmHg during the test were considered as having deficient dynamic stability. The mean pressure sustained during each contraction was recorded, and the mean value of the three attempts was considered the result of the test.

For the statistical analyses related to the stabilizing function of the lumbopelvic region, the variation between the reference pressure of the test (40 mmHg) and the average pressure that...
the volunteer sustained during the execution of the test (Δ mmHg = realized pressure - reference pressure) were considered. For static stability with emphasis on the transverse and for dynamic stability, the Δ mmHg tends to be positive, while for static stability with emphasis on the multifidus, the Δ mmHg tends to be negative.

- Session 2

At session 2, the participants were evaluated as to functional performance and the PI during the six-minute walk test (6MWT). Before the test, the patients rested for at least 10min. After this period blood pressure (BP), peripheral oxygen saturation (SpO2), dyspnea level (Borg Scale), and heart rate (HR) in rest (HRrest) were measured. The test was performed in a walkway free of people circulation. Before the test beginning, the participants were instructed as to the test execution and instructed to walk as fast as possible, but without running, until the examiner indicated the moment to stop. Each volunteer performed two tests with a minimum interval of 15min between them for rest (test-retest).

The test-retest aimed to eliminate the learning effect and assure the reproducibility of the procedure. At the test end, the vital data were evaluated again to analyze the variance of effort physiological parameters.

In the 6MWT, the volunteers walked in a 30-meter walkway delimited from the ground by a metrically demarcated strip so that each complete back and forth movement totaled 60 m and it was considered a complete lap. During the entire lap, the evaluator walked discreetly behind each volunteer to check the HR and SpO2, being they recorded minute by minute. Standardized phrases of encouragement were also given (Britto, Aparecida & Souza, 2006).

The accomplished distance (AD) by the volunteer was obtained by the product of the number of completed laps and the distance traveled, added to the surplus in meters of the last incomplete lap:

\[ AD = (n° \text{ of completed laps} \times 60 \text{ m}) + \text{meterage surplus in the incomplete lap} \]

The predicted distance (PD), which is the expected distance according to the individual characteristics, was previously calculated according to the following equation, in which the male scored 1 (one) and the female scored 0 (zero) (Britto et al., 2013):
$PD = 356.658 - (2.303 \times \text{age}) + (36.648 \times \text{sex}) + (1.704 \times \text{height}) + (1.365 \times \Delta HR)$

The $\Delta HR$ was obtained by equation (Britto et al., 2013):

$HR_{6^{\circ}min} - HR_{rest}$

Where:

$HR_{6^{\circ}min}$ represents the HR recorded exactly at the end of the test, at the sixth min; $HR_{rest}$ was the HR recorded before the beginning of the test after 10 min of rest.

The performance in the walk test was normalized using the equation:

$6MW\text{T performance} = \left( \frac{AD}{PD} \right) \times 100$

Where:

AD is the distance performed in the test and PD is the predicted distance.

The 6MWT normalization equation predicts the performance of each volunteer according to the following classification i) 1 (performed=predicted); ii) less than 1 (performed<predicted); iii) greater than 1 (performed>predicted).

The PI was quantified by the variation in HR. The determination of the HR variation was based on an equation proposed in literature (García-Ramos et al., 2015) that takes into account the predicted maximum HR ($HR_{max}$), the $HR_{rest}$ measured before the beginning of the test, and the average HR recorded during the 6MWT ($HR_{exercise}$):

$PI = \left( \frac{HR_{exercise} - HR_{rest}}{HR_{max} - HR_{rest}} \right) \times 100$

The $HR_{max}$ was predicted by equation 220-age (Camarda et al., 2008). The $HR_{exercise}$ was determined by the mean of all HR measurements performed during the test. The
classification of the PI was made by the following criteria i) very low: less than 40%; ii) low: between 40 and 60%; iii) moderate: between 61 and 80%; iv) strong: above 81%.

2.3 STATISTICAL ANALYSIS

The SPSS 20 software was used for statistical analysis. The significance level adopted was 5% (α = 0.05).

The comparative inferential statistics between the groups were made by the generalized linear model (GzLM), which is based on maximum likelihood and uses the Wald chi-square test (Wald χ²) to identify the effect of the variables in the generalized linear model. The best fit of the data was tested by two distribution models: Linear and Gamma. The model that obtained the lowest value of akaike's information criterion (AIC), was chosen as the model with the best fit, and the Gamma model was lower in all comparisons. The least significant difference test was used as a post hoc test.

The factor used in the analyses was the group (CG, LrG, MrG, and HrG) and the dependent variables were: the static stability of the transverse and multifidus muscles; dynamic stability; the performance of the 6MWT; and the PI.

Aiming to present complementary metrics to inferential statistics, to better understand the changes, or lack of changes in the variables, measures of reproducibility, responsiveness, and effect size were calculated. To determine the reproducibility and responsiveness for the 6MWT and the PI, we used only the data from the CG and the data for the test-retest analyses were those from the two attempts of the 6MWT.

Relative reproducibility was tested by the intraclass correlation coefficient (ICC) and absolute reproducibility by the standard error of measurement (SEM). We applied the ICC2,k (bidirectional random model) (Weir, 2005), and the strength of the reliabilities were described as: 0.0-0.50 poor; 0.50-0.75 moderate; 0.75-0.90 good; greater than 0.90 excellent (Koo & Li, 2016). The SEM was determined by the square root of the error variance.

Responsiveness was evaluated by the minimal detectable change (MDC) determined by the equation: $MDC = SEM \cdot 1.96 \cdot \sqrt{2}$ (Mathur et al., 2005; Weir, 2005). The MDC was used as a reference to verify whether the differences between the means of the groups, found in the inferential statistics, were real or due to variability.
The effect size (ES) was calculated both for the comparisons between the CG test-retest means ($\bar{x}_{\text{retest1}} - \bar{x}_{\text{test}}$; $\bar{x}_{\text{retest2}} - \bar{x}_{\text{test}}$; $\bar{x}_{\text{retest2}} - \bar{x}_{\text{retest1}}$) and for the comparison of the inferential statistics between the groups ($\bar{x}_{\text{LrG}} - \bar{x}_{\text{CG}}$; $\bar{x}_{\text{MrG}} - \bar{x}_{\text{CG}}$; $\bar{x}_{\text{HrG}} - \bar{x}_{\text{CG}}$; $\bar{x}_{\text{MrG}} - \bar{x}_{\text{LrG}}$; $\bar{x}_{\text{HrG}} - \bar{x}_{\text{LrG}}$; $\bar{x}_{\text{HrG}} - \bar{x}_{\text{MrG}}$). The ES allows evaluating and qualifying the significance of inferential results by demonstrating the clinical importance of finding (Lindenau & Guimarães, 2012). The ES was calculated by Hedges’ g with the following interpretation (Espirito Santo & Daniel, 2015): insignificant <0.19; small 0.20 - 0.49; medium 0.50 - 0.79; large 0.80 - 1.29; very large >1.30.

3 RESULTS

The sample was composed by 70 volunteers. The descriptive and inferential statistical analyses in relation to the variables characterizing the sample can be seen in Table 1. It was observed that there was a difference between the groups only for age, with the volunteers in the CG and LrG groups being younger than the volunteers in the MrG and HrG groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>n</th>
<th>Wald $\chi^2$ Statistical (3 degrees of freedom)</th>
<th>p-value</th>
<th>Mean</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>CG</td>
<td>20</td>
<td></td>
<td>&lt;0.001</td>
<td>30.7</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>LrG</td>
<td>20</td>
<td>57.407</td>
<td></td>
<td>33.9</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>MrG</td>
<td>20</td>
<td></td>
<td></td>
<td>47.8</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>HrG</td>
<td>10</td>
<td></td>
<td></td>
<td>46.9</td>
<td>B</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>CG</td>
<td>20</td>
<td></td>
<td></td>
<td>72.8</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>LrG</td>
<td>20</td>
<td>1.043</td>
<td>0.791</td>
<td>76.0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>MrG</td>
<td>20</td>
<td></td>
<td></td>
<td>77.6</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>HrG</td>
<td>10</td>
<td></td>
<td></td>
<td>76.7</td>
<td>B</td>
</tr>
<tr>
<td>Height (m)</td>
<td>CG</td>
<td>20</td>
<td></td>
<td></td>
<td>1.70</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>LrG</td>
<td>20</td>
<td>1.920</td>
<td>0.589</td>
<td>1.69</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>MrG</td>
<td>20</td>
<td></td>
<td></td>
<td>1.66</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>HrG</td>
<td>10</td>
<td></td>
<td></td>
<td>1.66</td>
<td>B</td>
</tr>
</tbody>
</table>

Note: CG: control group; LrG: low risk group; MrG: medium risk group; HrG: high risk group; “n”: number of volunteers per group; significance level: 0.05. Different letters indicate statistical difference and equal letters indicate statistical equality.

Source: The authors

It is also observed that the HrG did not reach the number of volunteers recommended. Most of the volunteers screened and profiled in this group presented non-inclusion criteria in the sample, such as associated comorbidities (fibromyalgia, symptomatic osteoarthritis in other joints of the lower limbs, unstable hemodynamic conditions) or did not feel confident to perform
the test. So, it was calculated by the free software G-Power 3.1, a posteriori, and from the ESs found in the present study, the minimum ES to reach a power of 80% with the alpha of 0.05 in comparisons between groups where one has “n” = 20 and other “n” = 10. It was verified that for this condition, the ES equal to or greater than 1.00 reached the power of 80%.

We observed good relative reproducibility for the performance on the 6MWT (ICC = 0.89 [0.73 - 0.95]) and excellent for the PI (ICC = 0.93 [0.82 - 0.97]). The absolute reproducibility, determined by the SEM, of 0.031 for the 6MWT and 6.32% for the PI, showed a variability in the measurement around 3.5% of the mean value of the performance in the 6MWT and 13.3% in the PI. The ESs for the differences in the performance of the 6MWT (0.02 [-0.23 to 0.35]) and for the PI (0.07 [-0.09 to 0.40]) in the test-retest were classified as insignificant.

In comparisons between groups, statistical differences were found for the static stability of the transverse abdomen muscle (Wald $\chi^2$ (3) = 44.9; $p<0.001$), for the static stability of the lumbar multifidus (Wald $\chi^2$ (3) = 89.6; $p<0.001$), for dynamic stability (Wald $\chi^2$ (3) = 40.5; $p<0.001$), for the 6MWT (Wald $\chi^2$ (3) = 64.1; $p<0.001$) and for the PI (Wald $\chi^2$ (3) = 13.6; $p=0.003$) (Figure 1)

In addition, we can observe in Figure 1 that in relation to the 6MWT the differences between the means for each pair of observations that involved HrG, being them HrG-GC; LrG-HrG; MrG-HrG, they were above the MDC. For the PI, the differences between the means that were above the MDC were the pairs of comparisons between MrG-CG; HrG-CG; LrG-HrG.
Figure 1: Unit distribution for each variable measure, and for all volunteers around the mean, and its respective 95% confidence interval for the defects: static stability with emphasis on the Transverse (Figure 1A) and Multifidus (Figure 1B); dynamic stability (Figure 1C); performance (Figure 1D) and PI (Figure 1F) in the 6MWT. For performance (Figure 1E) and PI (Figure 1G) in the 6MWT we present the differences between the means of each comparison pair between groups ($\bar{x}$ LrG – $\bar{x}$ CG; $\bar{x}$ MrG – $\bar{x}$ CG; $\bar{x}$ HrG – $\bar{x}$ CG; $\bar{x}$ MrG – $\bar{x}$ LrG; $\bar{x}$ HrG – $\bar{x}$ LrG; $\bar{x}$ HrG – $\bar{x}$ MrG) and the responsiveness value obtained by the minimum detectable change (MDC).

Note: control group (CG); low risk of poor prognosis group (LrG); medium risk of poor prognosis group (MrG); high risk of poor prognosis group (HrG); 6-minute walk test (6MWT); physiological intensity (PI). Different letters indicate statistical significance and equal letters indicate statistical equality.

Source: The authors
Figure 2 shows the graphs referring to the ESs for all observation pairs of all outcomes.

Figure 2: Graphical representation of effect sizes obtained for the differences between the means for each pair of comparison groups ($\bar{x}_{LrG} - \bar{x}_{CG}$; $\bar{x}_{MrG} - \bar{x}_{CG}$; $\bar{x}_{HrG} - \bar{x}_{CG}$; $\bar{x}_{MrG} - \bar{x}_{LrG}$; $\bar{x}_{HrG} - \bar{x}_{LrG}$; $\bar{x}_{HrG} - \bar{x}_{MrG}$) for transverse (2A) and multifidus (2B) static stabilities, dynamic stability (2C), 6MWT (2D), and PI (2E).

Note: control group (CG); low risk of developing poor prognosis group (LrG); medium risk of developing poor prognosis group (MrG); high risk of developing poor prognosis group (HrG); 6-minute walk test (6MWT); physiological intensity (PI). Colors represent the interpretation of effect size: insignificant <0.19 (gray); small 0.20 - 0.49 (yellow); medium 0.50 - 0.79 (blue); large 0.80 - 1.29 (red); very large > 1.30 (green).

Source: The authors

4 DISCUSSION

From the analysis of the results, it was verified that the hypothesis of the study was met and that the risk of poor prognosis for CLBP negatively impacts the static and dynamic stabilities of the lumbopelvic region, and walking performance and the PI. By a more general analysis, it is suggested that those most affected are those with high risk of developing poor prognosis; that the
low risk does not generate important impact, so as not to differentiate them from their healthy peers; and that the medium risk seems to compromise functionality to a lesser degree than the high risk.

The static stability of the transverse muscle was progressively affected according to the risk of poor prognosis. The volunteers from the CG showed to be stable; the LrG presented less stability capacity than the CG, but still showed to be stable; both the MrG and HrG presented instability, since the average of both groups was below 10 mmHg. In relation to the multifidus static stability, it was possible to notice again a progression from the CG to the HrG, pointing out that the LrG, MrG, and HrG groups presented worsened stabilization capacity in relation to the CG, with the LrG volunteers presenting themselves stable. There was no difference between the MrG and HrG groups and both presented unstable. Corroborating the findings of the inferential statistics, the ESs found were very large for all the comparison pairs related to the transverse. For the multifidus, the comparison pairs also presented very large ESs, except for the comparison between MrG and HrG, which had a small ES.

From the mean values of the pressure maintained during the dynamic stability test, all the groups were considered unstable, but the CG, LrG, and MrG groups did not present statistical differences among themselves; and the HrG presented worse dynamic stability in relation to all the other groups, and therefore this dysfunction was more pronounced in this group. These findings are reinforced by the ESs, since in all pairs of comparisons in which the HrG was involved, the ESs obtained were very large. For the other pairs of comparisons, the ESs varied from moderate (CG-MrG), small (LrG-MrG), and insignificant (CG-LrG), paying attention to the fact that as the amplitude of the risk of poor prognosis decreased, the ESs also became smaller.

A previous study that evaluated the stability of the lumbopelvic region (Ko et al., 2016), more specifically rotational stability, demonstrated that those suffering from CLBP had lower scores on rotational stability tests in comparison to healthy populations. Corroborating, another study (Kim et al., 2017) demonstrated that people with CLBP present decreased muscle activity of abdominal muscles during some phases of walking in comparison to asymptomatic participants.

The ability to stabilize the spine is dependent not only on the muscular capacity of strength and endurance, but also on the efficiency and precision of the central nervous system in
regulating the motor act (Hodges, 2003). Although deficits in motor planning have been reported in patients with CLBP, generating delays in the recruitment of the deep muscles of the lumbopelvic region, which includes the transverse and multifidus, with potential harm to the dynamic stability of the spine in functional tasks (Hodges, 2001; Moseley et al., 2004), the evidence on rehabilitation through motor control exercises in patients with CLBP, besides being low, does not show that motor control training of the lumbopelvic muscles has a clinical relevance in various functional outcomes, or can predict dysfunction (Mannion et al., 2012; Saragiotto et al., 2016).

It is suggested that, possibly, the no subdivision of patients with CLBP as to the risk of poor prognosis may favor the appearance of the characteristics of those with low and medium risk, which in the present study showed functional characteristics close to those of the CG, rather than those with high risk, since the latter seem less likely to be included in the sample for presenting associated comorbidities or for greater fear of movement. Therefore, there may be difficulty in showing the differences between healthy controls and those with CLBP when the possible differences created by the way the patient manages and faces the disease are not considered.

A good trunk stabilization capacity is necessary to meet the functional demand. A study that evaluated the effect of motor control training to enhance the recruitment of the transverse abdominal in patients with CLBP, in comparison with general exercise and manipulation, reinforced that the recruitment of this muscle is impaired in those people with CLBP, and that motor control training is an efficient approach to increase muscle function. In addition, the authors of that paper found that there was a moderate association between the improvement in muscle function and the improvements in the functional measures performed in the study, but that the effect of the training was more efficient for those whose recruitment capacity was more deteriorated (Ferreira et al., 2010). Although these authors did not subdivide the sample as to the risk of poor prognosis, their findings corroborate those of the present study.

It is known that the activity of the trunk and spine muscles, especially that of the multifidus, is related to age. Aging tends to make muscular action less efficient (Crawford et al., 2018). One limitation of the present study is that the MrG and HrG presented higher mean ages than their peers in the CG and LrG. Therefore, we cannot rule out the contribution of changes caused by aging in the results found.
For the 6MWT and the PI, the interpretations of the results in this study were not based only on the p-value, but on complementary metrics as recommended by other researchers (Furlan & Sterr, 2018; Lee, 2016). Good relative reproducibility for the performance measures on the 6MWT and the PI corroborates the reliability of the findings. The SEM showed less variability in the data for the performance in the 6MWT, which, in percentage terms, was below 5%. On the other hand, the PI showed higher variability, with the SEM value corresponding to percentages higher than 10% in relation to the mean values.

The MDC ratified the p-value findings for almost all comparison pairs. For most pairs of comparisons, whenever the p-value showed no statistical difference, the difference between the means of the groups was below the MDC. In contrast, whenever the p-value indicated a statistical difference, the difference between the means of the groups was above the MDC. The exception was only for the comparison between the LrG and MrG for the PI, when the p-value showed a statistical difference, but the difference between the means of the groups was below the MDC, which indicates that this difference is not real, but occurred due to a measurement error due to variability. The high SEM value may explain this incongruence between inferential statistics and responsiveness.

In the 6MWT, it was observed that statistical differences occurred for all the comparison pairs in which the HrG was part, showing us that the volunteers in this group had a worsened performance, and for all these comparisons the clinical importance verified by the ESs was very large. As for the observation pairs involving the MrG in comparison to the CG and LrG, the ESs found were large. And the comparison between GC and LrG presented a small ES. Here, again, it is noted that the risk of poor prognosis seems to compromise functionality in a proportional manner.

Other studies that compared the functional performance of subgroups of patients with CLBP and their healthy peers by the 6MWT found no impairment in performance (Bertor et al., 2013; Fracaro et al., 2013). The groups subdivision in both studies followed the classification system proposed by the American College of Physicians and by the American Pain Society (Chou et al., 2007), and it was the same used in the present study. In the study by Bertor and colleagues (Bertor et al., 2013), volunteers with nonspecific and specific CLBP, being this last considered as low back pain potentially associated with radiculopathy or spinal stenosis, showed decreased dorsal and lower limb muscles strength compared to the healthy pair. However, even
so, they did not present worsened performance on the 6MWT. In the study by Fracaro and colleagues (Fracaro et al., 2013), volunteers with specific CLBP, with the same definition of the previous study, also found no difference in the performance of the 6MWT of healthy subjects and the group with CLBP, although the latter group presented exacerbated mood state in the domains of fatigue, tension, and mental confusion.

The 6MWT is a submaximal clinical test that is frequently used for populations with limiting health conditions because it evaluates, in an integrated but non-specific manner, the function of all physiological systems involved in walking (Britto et al., 2013; Mänttäri et al., 2018). Based on studies that showed that CLBP reduces the capacity of several systems that contribute to adequate walking performance, such as reduced back and lower limb strength (Bertor et al., 2013), deficit in motor control of stabilizing muscles (Ferreira et al., 2010; Kim et al., 2017; van Dieën et al., 2017), aerobic conditioning (Duque et al., 2009, 2011), it is intriguing that the studies did not find differences in the performance of low back pain patients.

The catastrophizing of pain has been suggested as a variable with high potential to influence the level of disability (Mannion et al., 2012) and, perhaps, this is the link between objective functional measures and the dysfunctional scenery presented by the patient, since under the same denomination of CLBP there may be differences in the perception and facing of the painful condition. The stratification by the risk of poor prognosis seems to expose these particularities on the beliefs related to pain, since the risk is projected precisely by the lesser or greater contribution of psychosocial factors (Pilz et al., 2014).

Both the CG and LrG performed the 6MWT in an PI classified as weak, but statistically higher than the PIs of the MrG and HrG, classified as very weak. The ESs for these comparisons were large. The comparison pair between CG and LrG, in addition to showing no statistical difference, had a small ES. There was also no statistical difference between MrG and HrG with insignificant ES.

As the 6MWT is a submaximal test for healthy subjects it is estimated that the HR achieved in the test varies between 64% and 94% of the HRmax (Mänttäri et al., 2018). As the total load of an activity is the sum of the external and internal load components (Impellizzeri & Marcora, 2009), the PI is a more faithful expression of the total load of the test than just the percentage of maximum HR achieved. The PI is an index that considers the amplitude of the difference between HRexercice and HRrest, which represents the external load, and the
amplitude of the difference between HRmax and HRrest, which represents the highest possible individual work capacity. The ratio between the external load and the work capacity gives us information on the behavior of the physiological adjustments necessary to maintain activity, which represents the internal load.

Since the volunteers in the groups with higher risk strata performed worse on the 6MWT when compared to the CG and LrG, indicating lower external load, it is justifiable that the PI of the latter two groups was higher. What our data could not answer is whether the worsened performance of the groups in the higher risk strata is a cause or consequence of the lower PI. For future studies, considering the perceived effort may add relevant information to the qualification of the PI.

It is known that aging produces a functional decline that is reflected in the ability to walk (Song & Geyer, 2018) and therefore, part of the reduced performance capacity and lower PI in the 6MWT may be a consequence of aging, since the groups in the higher risk strata were older than those in the LrG and CG.

The main contribution of this study is that the subdivision of those with mechanical CLBP into groups according to the risk of developing poor prognosis seems to highlight the differences in objective functional measurements, often not detected by approaches focused only in biological and physical aspects.

5 CONCLUSION

We conclude that the risk of poor prognosis negatively and proportionally impacts both the static and dynamic lumbopelvic stabilization capacity and the performance and PI in walking of individuals with CLBP.

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