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Non-specific spinal pain in young adults from a multidisciplinary perspective: An integrated examination of psychological, physical, and diagnostic factors

Theses of the Doctoral Dissertation

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1. Introduction

Non-specific low back and neck pain rank among the most common musculoskeletal disorders worldwide, including in Hungary, imposing a considerable public health and economic burden (GBD 2021 Low Back Pain Collaborators, 2023; Wu et al., 2020). Approximately 90% of cases are non-specific in origin, attributable to both biomechanical and psychosocial factors, whereas specific pain is caused by more severe pathologies that require timely recognition (Deyo & Weinstein, 2001; Balagué et al., 2012). Among health sciences students, the high prevalence of low back pain (LBP) is associated with sedentary behavior, academic workload, and stress, while educational interventions can improve disease-specific knowledge, reduce fear, and enhance the effectiveness of future clinical practice (Vujcic et al., 2018; Christe et al., 2021). The presence of serious conditions can be evaluated using the so-called flag system. Clinical red flags assist in the identification of severe disorders, while yellow flags highlight psychosocial risk factors – such as anxiety and maladaptive beliefs – that contribute to chronicity (Linton & Shaw, 2011; Foster et al., 2018). Recognition of critical cases is often challenging and remains limited among both students and professionals, underscoring the need for structured education and a biopsychosocial perspective. Current guidelines emphasize that integrated approaches combining education and exercise therapy are more effective than traditional biomedical models (Jette et al., 2006; Kamper et al., 2014; Caneiro et al., 2020).

2. Aims of the Thesis

In the management of non-specific LBP, focusing solely on physical symptoms is insufficient, as stress and anxiety play a significant role in the development and maintenance of symptoms. Our study aimed to examine the impact of a one-time educational intervention on the knowledge of health sciences students regarding low back pain, as well as to assess how psychological factors influence pain intensity and daily functioning. In addition, we analyzed the relationship between daily sitting time, sports participation, and LBP. As a secondary objective, we evaluated the differential diagnostic skills and clinical decision-making of practicing physiotherapists in Hungary, based on their educational level, using a problem-solving task integrated into a questionnaire.

Hypothesis I.

We hypothesize that perceived stress and anxiety show a significant association with non-specific LBP among health sciences students, that is, substantial psychological burden (stress and anxiety) is related not only to the presence of LBP but also to the intensity of pain and the degree of functional limitation.

Hypothesis II.

We hypothesize that students who experienced LBP within the past three months exhibit higher levels of stress and anxiety compared to those who have not recently experienced LBP.

Hypothesis III.

We hypothesized that a single educational program would significantly improve knowledge related to low back pain among students both with and without LBP.

Hypothesis IV.

We hypothesized that the knowledge of Hungarian physiotherapists would be comparable to that reported in international studies, and that MSc graduates would achieve better results than those with a BSc degree.

3. Materials and methods

3.1. Study design and sample in a study assessing the knowledge of students in health sciences education

Participants were recruited from the faculties of medicine and health sciences at the University of Szeged. Inclusion criteria were: age between 19–35 years, student status in medicine or health sciences, and participation in an educational program. Exclusion criteria were the presence of specific LBP or another musculoskeletal disease, acute illness, psychological disorder, or incomplete completion of questionnaires. A total of 172 students were included in the analysis: 137 health sciences students, 25 medical students, 3 dentistry students, and 7 pharmacy students (155 women, 17 men; mean age: 20.33 ± 1.47 years; BMI: 22.32 ± 3.64). The study was approved by the Regional Human Biomedical Research Ethics Committee of the University of Szeged and the National Public Health Centre (approval no. 48894-7/2020/EÜIG), and all participants provided informed consent for the anonymous handling of their data. Before the intervention, students completed an online questionnaire

package including items on demographics, weekly sports participation, daily sitting hours, medical history, psychological state, pain, and disease-specific knowledge. Based on VAS scores, 61 students (52 women, 9 men; BMI: 22.01 ± 3.61) were assigned to the non-LBP group, and 111 students (103 women, 8 men; BMI: 22.48 ± 3.66) to the LBP group.

3.2. Study design and sample in a study assessing the knowledge of practicing physiotherapists

Inclusion criteria were physiotherapists aged 25–65 years with at least a BSc degree obtained in Hungary, actively working in the country, and providing consent to the anonymous use of their data. Exclusion criteria included failure to meet any of these requirements or not actively practicing as a physiotherapist. The online survey was conducted via the EvaSys system between June 23 and September 10, 2022. The study was approved by the Scientific and Research Ethics Committee of the Medical Research Council (ETT TUKEB) (approval no. IV/3426-1/2022/EKU). A total of 140 completed questionnaires were received, and after applying the exclusion criteria, 128 responses were analyzed (114 women, 14 men; mean age: 34.65 ± 8.88 years).

3.3. Methodology and the applied measurements in a study assessing the knowledge of students enrolled in health science programs

3.3.1 Psychological scales

Cohen et al. (1983) measured perceived stress using the Perceived Stress Scale (PSS), a self-report questionnaire that includes both negative and positive perception categories, where higher scores indicate greater stress levels. We used the validated Hungarian version (Stauder & Konkoly, 2006), and stress levels were categorized as low (0–13), moderate (14–26), and high (27–40) following the classification applied by Anandhalakshmi et al. (2016). Trait and state anxiety were assessed with the State-Trait Anxiety Inventory (STAI-T, STAI-S), a 40-item self-report questionnaire for evaluating both forms of anxiety. STAI scores below 40 indicated the absence or minimal presence of symptoms, while scores above 40 reflected moderate or severe, clinically significant symptoms (Spielberger, 1983; Spielberger & Sydeman, 1994).

3.3.2 Questionnaires for assessing pain

The intensity of low back pain experienced in the past 3 months was assessed using the Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst pain) (Delgado et al., 2018).

In addition, participants completed the Hungarian-validated version of the Oswestry Disability Index (ODI) (Valasek et al., 2013), a self-report questionnaire assessing functional limitations caused by pain. Based on ODI scores, disability can be classified as minimal (0–20%), moderate (20–40%), severe (40–60%), crippled (60–80%), or bedbound/complete disability (80–100%) (Fairbank et al., 1980).

3.3.3 LKQ questionnaire

The Hungarian-validated version of the Low Back Pain Knowledge Questionnaire (LKQ) (Maciel et al., 2009; Kovács-Babócsay et al., 2019) was completed by participants both before and after the educational program to assess their knowledge related to LBP. The questionnaire comprises 16 items that address spinal anatomy, biomechanics, mechanisms of spinal disorders, as well as prevention, treatment, and rehabilitation. These items can be categorized into three domains: general aspects, concepts, and treatment. Scores range from 0 to 24, with higher values indicating greater knowledge.

3.3.4 Education Program

Our participants attended a standardized one-hour educational session, which presented the epidemiology, symptoms, types, various treatment options, and prevention of LBP. The role of psychosocial factors (e.g., stress, anxiety) was addressed, along with red-flag symptoms requiring specialist consultation. The lecture was delivered by two physiotherapists with both clinical and academic experience. Participants had the opportunity to ask questions during the session, and after the program, they completed the LKQ questionnaire again to assess changes in their knowledge related to LBP.

3.3.5 Data collection and analysis

Sample size estimation was performed using G*Power (Version 3.1.9.2), which indicated a minimum sample of 146 participants based on PSS and STAI scores (effect size d = 0.5, $\alpha = 0.05$, statistical power = 0.9). Statistical analyses were conducted in Statistica (Version 13.5.017). Data were summarized using descriptive statistics, including means and standard deviations. Normality was assessed with the Shapiro–Wilk W test. Weekly sports participation and daily sitting hours were normally distributed, whereas LKQ, VAS, ODI, PSS, STAI-T, and STAI-S data were not. Physical activity intensity was categorized according to MET values (Haskell et al., 2007) as light (<3.0 MET), moderate (3.0–6.0 MET), and vigorous (>6.0 MET). Between-group differences were examined using independent t-tests (normally distributed data) or Wilcoxon–Mann–Whitney U tests (non-normally distributed data).

Intragroup changes in LKQ scores were analyzed with the Wilcoxon signed-rank test. Multiple linear regression was performed to examine the relationship between pain intensity (VAS) and ODI, STAI-S, STAI-T, PSS, weekly sports participation, and daily sitting hours. For Spearman's rank correlation, standard thresholds were applied ($\rho = 1$ – perfect positive monotonic correlation, $1 > \rho \geq 0.8$ – strong positive monotonic correlation, $0.8 > \rho \geq 0.4$ – moderate positive monotonic correlation, $0.4 > \rho > 0$ – weak positive monotonic correlation, $\rho = 0$ – no correlation). Statistical significance was set at $p \leq 0.05$.

3.4. Methodology and the applied measurements in a study assessing the knowledge of practicing physiotherapists

3.4.1 Questionnaire

The compiled questionnaire recorded participants' general data (age, gender) and included questions on educational background (highest degree obtained, year of graduation, postgraduate training) as well as professional experience (work history, characteristics of the current workplace, and the number of patients treated per week). The inclusion and exclusion process was initiated based on these responses in accordance with the predefined criteria.

3.4.2 Case studies

In the second part of the research, a differential diagnostic assessment was conducted based on case studies, where participants were required to select the appropriate treatment plan from predefined options (Jette et al., 2006; Ladeira, 2018). Participants reviewed eight cervical spine cases (CS1–8), compiled from case reports published in the international literature, which included patient history, complaints, symptoms, and examination findings. From 18 possible options, participants had to select a minimum of 1 and a maximum of 5 treatment choices, including physiotherapy options, recommendations, and referral to a physician. Two cases described musculoskeletal (MSK) problems (CS4, CS6) (Wachidah & Herawati, 2021; Rahman & Godfred, 2014; Abd Jalil et al., 2010), while the remaining six were classified as critical medical (CM) cases involving life-threatening conditions with so-called red flag symptoms (CS1–3, CS5, CS7–8) (Ross & Cheeks, 2008; Smith et al., 2014; Mathers, 2012; Gomez et al., 2020; Bayer et al., 2021; Lyons et al., 2018; Chaniotis, 2011). Responses were evaluated against the correct decisions reported in the literature. In CM cases, the appropriate solution was referral to a physician, either alone or supplemented with recommendations such as imaging, immobilization, or psychological support. Choosing physiotherapy alone, or physiotherapy in combination with physician referral, was considered incorrect. In MSK cases, physiotherapy

treatment was regarded as the correct decision, whereas referral to a physician alone or in combination with physiotherapy was deemed incorrect.

3.4.3 Data collection and analysis

Statistical analyses were performed using R software (version 4.0.2). Descriptive statistics characterized the participants and their treatment decisions, with results reported as mean ± SD and frequency (%). Decisions within the MSK and CM categories, as well as their interrelationships, were examined using logistic regression. Odds ratios (OR) and corresponding 95% confidence intervals (CI) were calculated. A p-value ≤ 0.05 was considered statistically significant.

4. Results

4.1. Study assessing the knowledge of students enrolled in health science programs

The following section presents the results on the associations between daily sitting time, weekly sports participation, pain, functional disability, and psychological factors. Overall, 50.58% of participants reported engaging in vigorous physical activity. In the LBP group, 18.91% performed light, 36.03% moderate, and 45.04% vigorous intensity activity, while in the non-LBP group, the proportions were 14.74%, 24.59%, and 60.65%, respectively. No significant differences were found between groups in sports participation ($t = 0.01$, $p = 0.98$) or sitting time ($t = 1.60$, $p = 0.10$). Spearman's correlation indicated a weak but significant negative association between sports participation and psychological factors in both groups (LBP: STAI-S rs = −0.22, STAI-T rs = −0.23, PSS rs = −0.22; non-LBP: STAI-S rs = −0.27, STAI-T rs = −0.25, PSS rs = −0.38).

4.2. Study assessing the knowledge of practicing physiotherapists

The results of our second study were based on data from 140 physiotherapists holding a BSc, MSc, or PhD degree. After applying the inclusion and exclusion criteria, the data of 128 participants were analyzed: 101 held a BSc degree, 26 an MSc degree, and 1 a PhD degree; however, the latter two were combined into a single study group. The average work experience was 10.04 ± 8.17 years among BSc graduates, compared to 8.61 ± 6.61 years in the other group.

4.3. Results supporting Hypothesis I.

Significant psychological stress was associated with the presence, intensity, and functional limitation of LBP, with statistically significant differences observed in pain, subjective disability, and trait anxiety. Based on the PSS, participants overall reported moderate

stress levels, with higher values in the LBP group, although the difference was not statistically significant ($p = 0.06$). In the total sample, the State-Trait Anxiety Inventory indicated moderate or high levels of anxiety. In the non-LBP group, 46% exceeded the cut-off score of 40 for state anxiety and 54% for trait anxiety, while in the LBP group, 46% exceeded the threshold for state anxiety and 60% for trait anxiety, warranting screening for anxiety disorders. Clinically significant anxiety (≥43) was also frequent: in the LBP group, 39% showed elevated state anxiety and 53% elevated trait anxiety, whereas in the non-LBP group, the corresponding values were 38% and 51%, respectively.

4.4. Results supporting Hypothesis II.

In the LBP group, the VAS indicated mild pain, while the ODI reflected minimal functional limitation in both groups; however, the Mann–Whitney U test confirmed a significant difference between them ($U = 858.5$, $p < 0.01$). Spearman's correlation revealed significant, moderate positive associations between PSS and anxiety in both groups (non-LBP: STAI-T $rs = 0.73$, STAI-S $rs = 0.66$; LBP: STAI-T $rs = 0.74$, STAI-S $rs = 0.67$). Multiple linear regression predicting pain intensity (VAS) was significant ($F = 41.290$, $p < 0.001$, $R^2 = 0.612$). Trait anxiety ($\beta = 0.264$, $p = 0.031$) and subjective functional limitation (ODI; $\beta = 0.731$, $p < 0.001$) were positively associated with pain, whereas state anxiety, perceived stress, sports participation, and sitting hours were not significantly related. Furthermore, ODI correlated positively with anxiety in both groups (non-LBP: STAI-S $rs = 0.35$, STAI-T $rs = 0.41$, $p < 0.01$; LBP: STAI-T $rs = 0.19$, $p < 0.05$).

4.5. Results supporting Hypothesis III.

The Mann–Whitney U test showed no significant differences in LBP-related knowledge between groups, either before ($U = 3{,}363$, $p = 0.94$) or after ($U = 3{,}377$, $p = 0.97$) the educational intervention. Intragroup LKQ analysis revealed significant knowledge gains in both groups, with the Wilcoxon test indicating that post-intervention scores were statistically significantly higher than pre-intervention scores (LBP: $Z = 5.36$, $p < 0.01$; non-LBP: $Z = 3.09$, $p < 0.01$). After applying the Bonferroni correction ($\alpha = 0.0031$), significant improvements were observed in the LBP group (Questions 4 and 10) and in the non-LBP group (Question 10), with additional items showing a trend toward improvement. Overall, the educational intervention led to improvements in concepts, general knowledge, and treatment-related questions in the LBP group, whereas in the non-LBP group, improvements were limited to treatment knowledge. Nevertheless, in both groups, treatment-related scores showed the most pronounced gains.

4. 6. Results supporting Hypothesis IV.

In the MSK cases (CS4, CS6), 61.7% of respondents made the correct treatment decision, whereas in the CM cases (CS1, CS2, CS3, CS5, CS7, CS8) only 22.7% did so. No significant differences were found in decisions regarding MSK cases based on participants' educational level: 59.4% of physiotherapists with a BSc degree and 70.4% of those with an MSc degree answered correctly. In the CM cases, recognition rates were low in both the BSc and MSc groups. Among those who had received postgraduate training in cervical spine care, the majority (67.9%) chose the appropriate treatment method for MSK cases. Similarly, in the CM cases, we found a correct decision rate of 26.7%, which was slightly higher than the result for the total sample.

5. Discussion

5. 1. Relationship between the presence of LBP and anxiety levels

Stress and anxiety are associated with non-specific LBP, and our results confirmed their relationship with the presence, intensity, and functional limitations of pain. Previous studies have likewise demonstrated that stress is a predictor of psychological disorders (Zeng et al., 2023), a contributor to health deterioration among students (Riley et al., 2019), and a risk factor for musculoskeletal conditions (Vinstrup et al., 2020). Anxiety has been linked to hypervigilance and heightened pain sensitivity (Brown et al., 2018), chronic pain and depression (Morley, 2008), as well as LBP-related disability (Konno & Sekiguchi, 2018; Bener et al., 2013). Our findings underscore the role of trait anxiety in the severity of LBP and further suggest that even students without LBP may experience anxiety-related functional impairment, supporting its role as a risk factor in the future development of LBP (Arola et al., 2010; Pinheiro et al., 2017).

5. 2. The relationship between stress, anxiety, and LBP

We hypothesized that students who had experienced LBP in the past 3 months would report higher levels of perceived stress and anxiety compared to those without LBP. Our results showed moderate stress levels in the non-LBP group and high stress levels in the LBP group, while both groups demonstrated moderate anxiety. Applying the recommended ≥40 cut-off, state anxiety scores in the non-LBP group and trait anxiety scores in the LBP group exceeded this threshold, with the LBP group additionally exhibiting clinically significant state anxiety scores. Trait anxiety was significantly higher in the LBP group compared to the non-LBP group. The present study identified an association between perceived stress and anxiety in both groups

of health sciences students, supporting the findings of Onieva-Zafra et al. (2020) and Herbert (2022) on the relationship between stress and anxiety, where trait anxiety has been identified as the strongest predictor of perceived stress.

5. 3. One-time education training related to knowledge about the LBP. The relationship between physical activity and psychological factors

Improvements in LBP-related knowledge were observed in both groups; however, the LBP group achieved more substantial gains. This finding is consistent with the results of Kanaan et al. (2023), who reported that integrating LBP education into physiotherapy improved disease-specific knowledge and supported better treatment outcomes. These results may indicate that personal experience can enhance receptivity and information processing. No associations were found between sitting time, physical activity, and LBP, which is consistent with the findings of Balling et al. (2018). However, we observed a negative relationship between physical activity and psychological factors, supporting evidence that regular exercise has beneficial effects on mental health and reduces anxiety, depression, and stress, as reported by Wegner et al. (2014) and Schuch et al. (2016). Our findings highlight the role of psychological factors in LBP and underscore the need to integrate psychosocial knowledge into health sciences curricula. Although the LKQ is a validated Hungarian tool for assessing LBP-related knowledge, it does not include items addressing psychological aspects. Our findings, therefore, suggest the need for developing a new, multidisciplinary questionnaire.

5. 4. Relationship between qualification level and differential diagnostic ability

Several studies have reported that physiotherapists often overlook signs indicative of serious pathology, resulting in inaccurate differential diagnoses (Jette et al., 2006; Ladeira, 2018). Our findings confirmed this tendency, as recognition of “red flag” conditions requiring urgent intervention was also low among Hungarian professionals. International data similarly highlight deficiencies: correct decisions were made by 52.7% of therapists (Ladeira, 2018), 62% (Keller et al., 2022), and 79% (Jette et al., 2006), while in the latter study, only 49.6% fully identified all critical cases. In our study, the level of academic qualification did not significantly influence decision accuracy, underscoring the need for targeted professional continuing education to improve clinical safety and effectiveness.

5. 5. Limitations

5.5.1. The knowledge of health science students – Limitations

Our study has several limitations. Self-reported data may have biased the accuracy of sitting time and physical activity, and the cross-sectional design does not allow for establishing causal relationships. The single-center setting, the exclusion of non-Hungarian-speaking students, and the gender imbalance may also limit the generalizability of the findings, although the latter is consistent with both national and international trends in health sciences education and the healthcare workforce. Furthermore, the study did not capture detailed characteristics of sedentary behavior, and the intensity of physical activity was not directly measured but estimated using MET values, which may have overlooked essential associations with LBP. Future research should employ more comprehensive and objective methods to assess physical activity and sedentary behavior, and include more diverse student populations to enhance the validity and generalizability of the conclusions.

5.5.2 The knowledge of practicing physiotherapists – Limitations

The main limitation of the study is that the case descriptions do not fully reflect the information obtainable during real patient examinations. The questionnaire had a limited ability to assess participants' knowledge and skills, as it was unable to ask clarifying questions, which may have complicated the differential diagnosis. Another limitation was that postgraduate training was not always directly related to the presented cases, and most scenarios focused on cervical spine problems. Future research should include cases covering the entire spine and other musculoskeletal conditions to provide a more comprehensive assessment of physiotherapists' differential diagnostic skills.

6. Conclusion and practical implications

Although the results related to the educational program are based on self-reported data, a cross-sectional design, and a single-center sample, they nevertheless support the importance of applying the biopsychosocial framework in the prevention and management of non-specific LBP among young adults. LBP is one of the most common musculoskeletal problems, and to date, no studies have been conducted in Hungary that examined the impact of psychological factors on non-specific LBP, or the combined effect of a single multidisciplinary educational intervention on health sciences students' knowledge of LBP. The aim of our study was therefore to explore the relationship between psychological factors (perceived stress and anxiety) and non-specific LBP in this population. Our results reinforce the necessity of the biopsychosocial

approach. The management of LBP cannot be reduced to biomechanical aspects alone; psychological dimensions must also be considered. We highlighted the importance of education and demonstrated that integrating cognitive–behavioral strategies and stress management techniques into exercise-based rehabilitation programs may improve patient engagement and clinical outcomes. Furthermore, through our innovative assessment of differential diagnostic skills, our results also revealed that physiotherapists make more effective decisions in musculoskeletal cases, while deficiencies persist in recognizing and referring critical medical conditions that require urgent intervention. These shortcomings in differential diagnosis further emphasize the need to revise training curricula and supplement them with practice-oriented and specific modules. Overall, our research highlights that enhancing differential diagnostic knowledge, providing disease-specific education, adopting a multidisciplinary approach, and integrating psychosocial factors are crucial for preparing students and future professionals, as well as for ensuring effective, patient-centered care.

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LIST OF PUBLICATIONS

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I. **Kasza, B.B.,** Nákity, K., Finta, R., Pásztor, N., Kurokawa, T., Sápi, M., Domján, A. (2025). Investigating the impact of perceived stress and anxiety on nonspecific low back pain among future health care professionals in Hungary: a cross-sectional study. FRONTIERS IN PSYCHOLOGY 16 Paper: 1463414, 11 p. https://doi.org/10.3389/fpsyg.2025.1463414
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SJR indicator: Q4, IF: 0,6

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