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Functional training as a therapeutic approach for chronic low back pain

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Oryginal article

Abstract

Aim: The aim of this study was to assess the effectiveness of the applied functional training on pain level, lumbar spine range of motion, pelvic anterior tilt, and limitations in daily functioning caused by chronic pain.

Material and methods: Twenty women aged 20–24 with chronic low back pain participated in a 12-week therapy in the form of a functional training program. Both before and after the intervention period, measurements of lumbar spine range of motion and pelvic anterior tilt were taken for all participants. Pain levels were quantified using the VAS Scale, and disability levels were measured using the Oswestry Disability Index questionnaire. Statistical analysis were conducted using Statistica 13.3 (Student's *t*-test, Wilcoxon's signed-rank test, Pearson linear correlation).

Results: The proposed training program significantly reduced the pain level ($p < 0.05$) from 4.80 to 1.35. There was a significant improvement in the overall assessment of disability caused by spinal pain in the Oswestry Disability Index questionnaire. The lumbar spine range of motion changed significantly ($p < 0.05$) in each of the examined planes. A significant decrease in the pelvic anterior tilt angle in the neutral position was observed in the subjects.

Conclusions: The proposed functional training program contributed to reducing the perceived level of pain, improving the range of spinal motion and decreasing the degree of pelvic anterior tilt. The obtained results demonstrate the effectiveness of using functional training as a form of therapy in the treatment and prevention of low back pain and in improving the quality of participants' lives.

Keywords

- lumbar spine
- pain
- functional training

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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Introduction

The occurrence of chronic low back pain (CLBP) is one of the most challenging clinical problems to solve, as it not only affects the physical aspect but also encompasses both pathoanatomical and psychological factors.

For years, it has remained a public health problem and is a leading cause of disability worldwide.[1] Patients with chronic (lasting more than 3 months) lumbar pain typically exhibit subjectively higher levels of disability and are less active than healthy individuals. Therefore, the use of therapy in the form of controlled functional training seems justified.[2] In case of chronic low back pain, changes occur at the level of the central nervous system. This leads to motor control impairments and numerous movement restrictions, likely due to a lack of interaction between patients sensory and motor systems, as well as reduced ability for proprioceptive postural control.[3] The International Classification of Diseases (ICD-11) emphasises the role of functional limitations associated with the occurrence of chronic pain. The level of pain severity not only refers to intensity but also its impact on the individual's functioning and quality of life.[4] In the meta-analysis conducted by Rodriguez et al., it was found that while most exercise interventions showed benefits, Pilates, strength training, and core training were identified as the most effective approaches for reducing pain and disability level.[5]

The aim of this study was to assess the effectiveness of the applied functional training on pain level, lumbar spine range of motion, pelvic anterior tilt, and limitations in daily functioning caused by chronic pain.

Material and methods

In the study approved by The Bioethics Committee at the Regional Medical Chamber in Cracow (No. 158/KBL/OIL/2022) following the fulfilment of inclusion and exclusion criteria, participated 20 women (Experimental Group) between the age of 20 and 24 ($\bar{x}$ = 21,75) who reported experiencing chronic low back pain. The inclusion criteria for the study were: age between 2025 years, female gender, presence of chronic (over 3 months) low back pain, good general health including absence of injuries and surgical interventions within the lumbar spine, lack of coexisting diseases that could affect the outcome of the applied therapy, willingness to participate in the study and training program, non-participation in regular, organised, and individual sports activities. The exclusion criteria were: current acute conditions or previous surgical interventions within the lumbar spine, inability to participate in regular training, engagement in other forms of organised or individual physical activity, neurological diseases, coexisting diseases, scoliosis, and contraindications to participating physical exertion. Participants were informed about planned measurements and forms of therapy. Women signed consent forms to participate in the project.

All assessments of the women qualified for the project were conducted twice: before and after 12 weeks of training, between January and May 2023.

Height and body mass of the participants were determined using a medical scale. Based on the obtained results, the body mass index (BMI), calculated as the quotient of body mass [kg] and the square of height [m^2], fell within the normal range for the participants. Detailed data regarding the basic morphological characteristics of the women qualified for the project are presented in Table 1.

Table 1. Characteristics of participants in the experimental group

Group (n = 20)	$\bar{x}$ ± SD	Me	Min–Max
Age [years]	21.75 ± 1.21	22.00	20.00–24.00
Body height [cm]	164.45 ± 5.78	165.00	150.00–173.00
Body mass [kg]	56.15 ± 6.81	55.00	42.00–69.00
BMI [kg/m^2]	20.72 ± 1.83	20.64	16.65–23.88

$\bar{x}$ – arithmetic mean; Me – median; Min – minimum value; Max – maximum value; SD – standard deviation; n – group size

Visual Analog Scale (VAS)

The level of perceived low back pain was assessed using the Visual Analog Scale (VAS) ranging from 0 to 10, where 0 indicates no pain and 10 represents the highest possible intensity of pain.[6]

Questionnaire ODI

The Oswestry Disability Index (ODI) questionnaire quantifies the level of disability caused by lumbar spine and the functional capacity of patients in their daily activities. It consists of ten items rated on a five-point ordinal scale, where 0 indicates no limitations and 4 indicates extreme limitations in functioning for the respondents. The score within the range of 0–4 from the entire questionnaire indicates no disability. A higher total score means greater physical disability: 5–14 – mild level, 15–24 – moderate and 25–34 – severe. Scores ranging from 35–50 indicate complete disability in the patient's daily functioning.[7,8]

BROM

The measurements of pelvic anterior tilt and lumbar spine range of motion including flexion, extension, lateral flexion, and rotations to the right and left were determined using the Back Range of Motion Instrument – BROM II inclinometer, following the methodology described in scientific articles.[9,10]

Improvement program

The women participated in a 12-week therapy in the form of a functional training program. A training plan, created as a table and provided to the participants, based on fundamental functional patterns, was scheduled over the course of 12 weeks. It comprised three separate sections focusing on motor control and stabilisation, muscle strengthening, and stretching exercises. The participants performed the assigned exercises three times a week for 45 minutes each session. Once a week, the exercises were conducted in a gymnasium, and twice a week, independently at home. In case of any occurrence of discomfort or pain, efforts were made to identify the cause and eliminate it if it was related, for example, to incorrect exercise technique.

Statistical analysis methods

Statistical analyses were conducted using Statistica 13.3 software (StatSoft, USA). Measurement results were processed using descriptive statistical methods, including arithmetic mean ($\bar{x}$), median (Me), minimum (Min), maximum (Max), and standard deviation (SD). Statistical significance was set at $p < 0.05$. Due to the nature of the analysed variables, after verifying the normality of the distribution using the Shapiro-Wilk test, both parametric and non-parametric significance tests were applied. In cases where the distribution was found to be approximately normal, the parametric test Student's *t*-test for dependent samples, while for distributions deviating from normality, the nonparametric Wilcoxon's signed-rank test was applied. The strength and direction of the relationship between certain variables were determined based on the Pearson correlation coefficient values.

Results

After 12 weeks of exercises, the experimental group demonstrated statistically significant improvements ($p < 0.05$) in all investigated parameters compared to the initial results (Table 2). Based on the conducted statistical analysis of pain intensity levels, a significant reduction was observed ($p < 0.05$). Prior to the commencement of training, the average pain level in the experimental group was 4.8, which after 12 weeks decreased to an average of 1.35. The overall assessment of disability caused by spinal pain in the Oswestry Disability Index (ODI) questionnaire showed a significant improvement ($p < 0.05$). Initially, the average total score was 13.7. Disability was not observed in one woman, while 13 participants were assessed to have mild disability, and 6 had moderate disability. In the second study, 14 women were found to have no disability, while 6 showed mild disability, resulting in an average overall score of 4.25 points.

The mobility of the lumbar spine significantly changed ($p < 0.05$) in each of the examined planes. Before the therapy, the range of rotation to the right side averaged 11.50°, which increased to 18.10° post-therapy. Regarding left-side rotation, the mean value was 11.95° pre-therapy, which increased to 17.60° post-therapy. Analysing the results of lateral bending to the right, a significant increase from an average of 24.65° to 29.50° was observed, and to the left, from 24.20° to 30.60°. The change in the value of lumbar spine flexion between the first and second measurements averaged 7.85°, significantly decreasing from an initial 33.95° to 26.10°. An increase in the extension range from 7.70° to 12.90° was noted. There was a significant decrease in the pelvic anterior tilt angle in the neutral position among participants undergoing functional training, decreasing from an average of 27.45° to 24.70°.

The analysis of results between the VAS and ODI variables revealed a significant, positive correlation of moderate strength ($r = 0.45$, $p < 0.05$) before the therapy. An increased level of perceived pain assessed using the VAS scale was associated with a higher overall score obtained in the ODI questionnaire – indicating an increased degree of disability and limitations in daily functioning. However, such relationships were not observed in the follow-up assessment after 12 weeks of exercises (Table 3).

Table 2. The pain level (VAS), degree of disability (ODI), lumbar spine range of motion [°] and pelvic anterior tilt [°] measured in women participated in a 12-week training program

Variables	Group (n = 20)	$\bar{x} \pm$ SD	Me	Min–Max	*p*
VAS	before	4.80 ± 158	4.50	3.00–8.00	$p = 0.000$
	after	1.35 ± 0.98	1.50	0.00–3.00	
ODI	before	13.70 ± 5.98	12.00	4.00–24.00	$p = 0.000$
	after	4.25 ± 3.19	4.00	0.00–11.00	
Right rotation	before	11.50 ± 3.72	11.00	7.00–22.00	$p = 0.000$
	after	18.10 ± 3.97	18.50	12.00–28.00	
Left rotation	before	11.95 ± 4.32	11.00	8.00–27.00	$p = 0.001$
	after	17.60 ± 3.66	19.00	10.00–23.00	
Right lateral flexion	before	24.65 ± 8.49	25.00	9.00–40.00	$p = 0.002$
	after	29.50 ± 7.61	30.00	10.00–42.00	
lLeft lateral flexion	before	24.20 ± 7.73	24.00	10.00–38.00	$p = 0.000$
	after	30.60 ± 6.17	31.00	20.00–41.00	
Flexion	before	33.95 ± 9.59	24.50	12.00–50.00	$p = 0.007$
	after	26.10 ± 8.18	24.50	13.00–40.00	
Extension	before	7.70 ± 2.02	8.00	4.00–11.00	$p = 0.000$
	after	12.90 ± 2.73	14.00	8.00–18.00	
Pelvic anterior tilt	before	27.45 ± 3.38	28.00	20.00–33.00	$p = 0.000$
	after	24.70 ± 3.16	25.00	19.00–30.00	

$\bar{x}$ – arithmetic mean; Me – median; Min – minimum value; Max – maximum value; SD – standard deviation; n – group size; $p < 0.05$ – statistically significant differences; VAS – pain intensity; ODI – overall sum of points.

Table 3. Relationships between the level of perceived pain (VAS) and degree of disability (ODI)

Variables	Pearson $r(X,Y)$	*p*
VAS & ODI before	0.45	0.04
VAS & ODI after	0.34	0.15

Before – measurement before 12 weeks; after – measurement after 12 weeks; designation of result in red colour- statistically significant difference $p < 0.05$; VAS – pain intensity; ODI – overall sum of points; Pearson – Pearson correlation coefficient.

The correlation coefficient parameters and significance level for the remaining relationships did not exceed the established threshold, indicating a lack of statistically significant association between the level of perceived pain, functional limitations and the degree of pelvic anterior tilt (Table 4). Nonetheless, a clear trend is observed, suggesting that an increased pelvic anterior tilt may contribute to higher level of pain and increased degree of disability among the participants.

Table 4. Relationships between the level of perceived pain (VAS), degree of disability (ODI) and the degree of pelvic anterior tilt [°]

Variables	Pearson $r(X,Y)$	*p*
VAS & PAT before	0.18	0.46
VAS & PAT after	0.03	0.89
ODI & PAT before	0.39	0.09
ODI & PAT after	0.21	0.37

Before – measurement before 12 weeks; after – measurement after 12 weeks; designation of result in red colour – statistically significant difference $p < 0.05$; VAS – pain intensity; ODI – overall sum of points; PAT – pelvic anterior tilt; Pearson – Pearson correlation coefficient.

Discussion

In current times, there are numerous methods aimed at reducing spinal pain in patients and improving their overall quality of life. Increasing range of motion, improving functional capacity, and motor skills should be the main goal of physiotherapists during selecting methods of work with patients. Available literature indicates the effectiveness of employing comprehensive physiotherapy in treating lumbar spine pain complaints.[11] Our research demonstrates that an elevated level of pain assessed on the Visual Analog Scale (VAS) correlated with increased disability, resulting in reduced women's daily functional capacity before starting training. The engagement of participants in functional training significantly impacted on the measured parameters. Van Dillen et al.[12] emphasise that therapy for individuals with LBP should encompass both the aspect of education and modification of the way of performing everyday functional activities. In individuals undergoing specific training aimed at learning movement control and reducing lumbar spine movement towards pain-provoking directions, while simultaneously increasing the use of other joints for tasks, a significant improvement in quality of life, reduced disability level assessed using the Oswestry Disability Index (ODI), and decreased pain level was observed. These findings align with our results, indicating that the implementation of functional training substantially contributed to pain reduction and improvement in participants' quality of life. Initially, ODI scores indicated a mild degree of disability, which progressed to lack of disability in the second assessment. In our study, after 12 weeks of functional training, a reduction in lumbar spine flexion range of motion was noted. This may be associated with changes in lumbo-pelvic-hip rhythm. Developing motor control skills and reducing movement in particular lumbar spine segments required an increased hip joint flexion range of motion, which had been previously limited due to pain syndromes.[13] Zbylut i Wódka[14] suggested use of general motor exercises and physical therapy treatments significantly reduced the level of perceived pain and improved mobility while it did not noticeably improve lumbar spine movement control among the women. In contrast, individuals performing stabilising exercises with the Kinetic Control program exhibited a notable enhancement in their ability to control lumbar spine flexion and extension during specific tests. In a randomised clinical trial Van Dillen et al.[15] demonstrated that individuals with CLBP who received person-specific motor control training to modify functional activity performance, experienced greater short- and long-term improvement in function compared to those who performed strength and stretching exercises. Pain level, physical function, and psychological outcomes also improved to a greater extent in the motor control training group relative to the other. This suggests that the treatment priority for individuals with chronic LBP is to provide a person-specific form of training aimed at learning new movement strategies, that are then used during daily functional activities. In conducting meta-analysis Sadler et al.[16] delineate an association between limited lateral flexion range of motion (ROM) and the occurrence of chronic pain complaints. Restricted ROM, as well as decreased lumbar lordosis and excessively tight hamstrings, may be considered risk factors for the development of lumbar spine pain conditions. The obtained results align with our observations, wherein the implementation of training led to a reduction in pain level and an increase in lateral flexion range of motion among the subjects. Salt et al.[17] and Malarvizhi et al.[18] observe a significant correlation between pain level and increased pelvic anterior tilt. This is consistent with our results where we noted a trend in which increased anterior pelvic tilt was associated with greater pain level among the participants. In the research conducted by Jimenez-Del-Barrio et al.[19] indicated that enlarged pelvic anterior tilt during walking is linked to a limitation in hip extension range of motion and disruption of biomechanical relationships within the lumbopelvic-hip complex, which could contribute to the development of spinal pain. After the applied therapy, there was a significant decrease in pelvic anterior tilt among participants undertaking our functional training program. This resulted in changes in lumbar spine range of motion. Reducing the level of restriction through the application of functional training may serve as a prevention or treatment for chronic lumbar pain. Observations from our studies regarding changes in range of motion are consistent with the findings of Al-Banawi et al.,[20] where the implementation of two interventions based on the McKenzie method resulted in increased lumbar spine extension and rotation range of motion. Altuğ et. al.[21] indicate that kinesiophobia is higher in patients with chronic low back pain, while their level of activity is lower, and the degree of disability is higher compared to healthy individuals. Pain experienced by patients restricts both their physical activity as well as social life. Elimination of movement-related fear in patients due to CLBP, positively impacts their quality of life.

Our findings are consistent with the observations of the authors and demonstrate that the implementation of therapy in the form of functional training, under the supervision of a qualified person, beneficially impacts the reduction of pain level and improvement in daily functioning.

Conclusions

1. The proposed functional training program contributed to reducing the perceived level of pain, improving the range of spinal motion and decreasing the degree of pelvic anterior tilt.
2. The obtained results demonstrate the effectiveness of using functional training as a form of therapy in the treatment and prevention of low back pain and in improving the quality of participants' lives.

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