ELECTRONIC VERSION

Acta Balneologica

ISSN 2082 - 1867

Published since 1905

JOURNAL OF THE POLISH BALNEOLOGY AND PHYSICAL MEDICINE ASSOCIATION

2026 JANUARY-FEBRUARY VOL. LXVIII ISSUE 1 (191)

THERMAL MEDICINE – THERAPY, PREVENTION, REHABILITATION
PHYSICAL THERAPY • BIOKLIMATOLOGY • BALNEOGEOLOGY • BALNEOCHEMISTRY

Patronage of Committee of Rehabilitation, Physical Education and Social Integration of the Polish Academy of Sciences

ISSN 2082-1867

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Aluna Publishing

Acta Balneologica

PUBLISHER:
ALUNA Publishing
29 Z.M. Przesmyckiego St.
05-510 Konstancin Jeziorna, Poland
www.actabalneologica.pl

PROJECT COORDINATOR:
MEDDOM PRESS
tel. +48 604208453
barbadom@wp.pl

GRAPHIC DESIGN:
Joanna Gębalska

The journal is indexed in Web of Science – ESCI, Index Copernicus, EBSCO, Ministry of Science and Higher Education and the Polish Medical Bibliography

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ORIGINAL ARTICLE

Analysis of physical therapy in lumbosacral pain syndromes

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ABSTRACT

Aim: The aim of this study was to compare the effectiveness of physiotherapy combined with massage and kinesiotherapy versus massage and kinesiotherapy alone in patients with lumbosacral pain syndromes, based on changes in VAS and Laitinen scale scores.

Materials and Methods: A total of 30 patients aged 34–68 years with pain syndromes in the lumbosacral spine in the course of spinal osteoarthritis and lumbosacral discopathy were evaluated. They underwent physical therapy as follows: Group I (n=15) underwent physiotherapy, therapeutic massage + kinesiotherapy; Group II (n=15) underwent massage and kinesiotherapy. In Group I, physiotherapy included laser therapy, ultrasound therapy, and electrotherapy. The study patients were examined at a physiotherapy laboratory in Ostrowiec Świętokrzyski. The patients were examined twice, before the start of rehabilitation and after rehabilitation, over a 2-week outpatient treatment period. The study used a VAS for pain, the Laitinen scale (modified), and BMI.

Results: The treatment used in the study contributed to a reduction in pain in both study groups, with a significantly higher improvement seen in Group I. The severity and frequency of pain significantly decreased in Group I compared to Group II. A greater reduction in total Laitinen scores was also observed in the Group I. The treatment used in the study contributed to a reduction in physical activity limitation as assessed by the Laitinen scale in both study groups. No statistically significant correlation was found between age and VAS scores; however, age was positively correlated with baseline Laitinen scores and inversely correlated with post-treatment changes in Laitinen scores.

Conclusions: Physiotherapy combined with massage and kinesiotherapy was associated with greater improvement in pain intensity and symptom severity compared to massage and kinesiotherapy alone. Physical therapy and rehabilitation are a fundamental part of treatment in spinal pain syndromes.

KEYWORDS: lumbosacral pain syndrome, physiotherapy, kinesiotherapy, Visual Analogue Scale (VAS), Laitinen scale

Acta Balneol. 2026;68(1):5-13. doi: 10.36740/ABAL202601101

INTRODUCTION

Spinal pain syndromes constitute a highly complex problem that affects up to 80% of the population and occurs at least once during the lifetime [1-6]. The pain is caused by various mechanisms. O'Sullivan suggests that spinal pain should be divided into two groups: pain associated with impaired motor control and pain resulting from abnormal adaptive processes that lead to tissue overload.

Acute spinal pain is usually a reaction that involves inflammation and oedema, and the pain is so severe that it makes it impossible for the patient to work and perform everyday activities. These problems often become chronic and recurrent.

Processes that lead to the development of overload-induced changes are mostly shaped by mechanical factors, including especially those mechanisms that cause excessive overload of the spine, resulting in damage to the spinal structures [5-8].

Primary causes of intervertebral disc degeneration include mostly genetic factors (up to 60%) and environmental factors such as diet and mechanical strain. Post-traumatic intervertebral disc prolapse usually occurs in people aged 30 to 40 years [8, 9].

The nucleus pulposus may become displaced in various directions. The herniated fragment of the nucleus pulposus may cause severe radiating pain, often called radicular pain. Radiographic changes are visible in the affected fragments only.

The last stage of the degenerative changes is associated with the development of a chronic pain syndrome. The beginning of this stage is related to a situation where fibrotic processes dominate the processes of nuclear and annular disintegration.

It is also important to mention the process of vertebral body degeneration. Overactive osteoblasts cause ligament ossification and lead to the development of so-called osteophytes (bony outgrowths) on the edges of vertebral bodies.

Overall, the aetiology of spinal conditions is deemed to be multifactorial. It is a problem in the developed, industrialised, and urbanised countries [3,10-12].

A comprehensive neurological examination and functional tests are needed to diagnose chronic lumbosacral pain syndromes. Selected imaging methods are also used. The following four clinical tests are used to assess pain syndromes of the lower back: Lasegue's sign, Bragard's test, meningeal test, crossed Lasegue's sign [8, 9, 11].

Classic radiographs visualise intermediate signs of discopathy as well as early-stage degeneration of the disc and its lowering due to water loss. Degenerative and proliferative changes of the bone can also be clearly seen. Computed tomography also visualises intermediate signs of discopathy and in some cases helps observe the

herniated material. MRI showing the detailed structure of the intervertebral disc and the individual stages of degeneration is considered to be the reference examination used to visualise discopathy.

Physical therapy and rehabilitation methods are used to treat spinal pain syndromes [13-19].

AIM

To assess physical therapy and rehabilitation in pain syndromes in the lumbosacral spine. In particular, the study aimed to compare the effects of physiotherapy combined with massage and kinesiotherapy versus massage and kinesiotherapy alone on pain intensity and symptom severity measured using the VAS and Laitinen scales.

MATERIALS AND METHODS

A total of 30 patients aged 34-68 years with lumbosacral pain syndromes in the course of spinal osteoarthritis and lumbosacral discopathy were evaluated. They received physical therapy as follows: Group I of 15 people underwent physiotherapy, therapeutic massage + kinesiotherapy; Group II of 15 people underwent massage and kinesiotherapy. The patients were examined at a physiotherapy laboratory in Ostrowiec Świętokrzyski. The physiotherapy procedures used in the study patients included laser therapy, ultrasound therapy, and electrotherapy. The study patients were examined twice, before the start of rehabilitation and after rehabilitation. The patients were assessed in an outpatient setting for a period of 2 weeks.

The study used a VAS for pain, the Laitinen scale (modified), and BMI. A VAS allows patients to express the level of pain on a scale from 0 to 10, where 0 means a complete absence of pain and 10 means maximum pain. The Laitinen scale assesses pain in four dimensions: severity, frequency of pain, frequency of using analgesics, and physical activity limitation.

Quantitative results were presented as mean values with standard deviation (±SD); additionally, location parameters such as quartile 1: Q1, median: Me, quartile 3: Q3, and the min and max values were included. The Shapiro-Wilk test was used separately in each group to check whether the distribution of the results followed a normal distribution.

The Wilcoxon test for dependent variables was used to compare the pre- and post-treatment results. The data was compared for two independent groups using the Mann-Whitney test. The Spearman rank correlation test was used to analyse the correlation of the results for continuous parameters.

RESULTS

Analyses concerning the assessment of pain measured in the VAS are presented below. The comparisons show an assessment of the results recorded before treatment *vs.* those achieved after treatment, performed separately for each study group, and a comparison of the baseline values and the differences achieved after treatment between the groups.

VAS PAIN ASSESSMENT BEFORE AND AFTER TREATMENT

Group I (physiotherapy + massage + kinesiotherapy)

In this group, the pain score before treatment was 6.67±0.82 and the median was 7. After treatment, the score decreased by 4.8 points on average, reaching 1.87±1.30. An improvement was seen in all study patients, and the scores decreased by at least 3 points. A value of p=0.001 was achieved for the Wilcoxon test. The entire descriptive and statistical analysis is presented in Table 1.

Group II (massage + kinesiotherapy)

An analysis of data in this group also indicates a significant improvement. Before treatment, the pain score was 6.87±1.19 and the median was 7. After treatment, the score decreased by 3.4 points on average, reaching 3.40±1.99, and the median was 3. The p value for the Wilcoxon test was p=0.001, and the results are presented in Table 1.

BETWEEN-GROUP COMPARISON OF BASELINE VALUES AND TREATMENT EFFECT

A comparison of the baseline (pre-treatment) results and the values of the differences achieved after treatment (level of reduction) between the group undergoing physiotherapy + massage + kinesiotherapy and the group undergoing massage + kinesiotherapy is presented below. The results indicate that the two groups were similar before treatment. The difference in the mean value was 0.2 points, and the medians were the same (p=0.634).

A comparison of the reduction in the scores (assessment of treatment efficacy) indicates that a significantly higher improvement was seen in the group undergoing physiotherapy + massage + kinesiotherapy. The mean reduction in the scores was 4.80±1.01, while the scores with massage + kinesiotherapy alone decreased by 3.47±0.92. This means that the treatment efficacy was higher in Group 1. The entire descriptive and statistical analysis is presented in Table 2.

ANALYSIS OF SYMPTOM ASSESSMENT IN THE LAITINEN SCALE

Group I (physiotherapy + massage + kinesiotherapy)

Table 3 presents the results for the assessment of the degree of symptoms: pain severity, pain frequency, frequency of using analgesics and physical activity limitation. Comparisons show significant differences in patients after treatment.

The mean pain severity before treatment was 2.60±0.63 and the median was 3; after treatment, the respective values were 0.80±0.56 and 1. The difference between the pre-treatment and post-treatment scores indicates a statistically significant change at p=0.001 (improvement occurred in all patients). As for pain frequency, the mean score was 2.27±0.88 with a median of 2 before treatment and 0.80±0.56 with a median of 1 after treatment. The difference between the pre-treatment and post-treatment scores indicates a statistically significant change at p=0.001.

Table 1. Descriptive and statistical analysis for the comparison of results with respect to pain severity in the VAS before treatment *vs*. after treatment – Group I and Group II.

Examination	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Group I										
Before treatment	15	6.67	0.82	5	6	7	7	8	3.408	0.001
After treatment	15	1.87	1.30	0	0	2	3	4		
Differences	15	-4.80	1.01	-7	-5	-5	-4	-3		
Group II										
Before treatment	15	6.87	1.19	5	6	7	8	9	3.408	0.001
After treatment	15	3.40	1.99	1	2	3	5	7		
Differences	15	-3.47	0.92	-5	-4	-4	-3	-2		

Wilcoxon pairs test

Source: Own materials

Table 2. Descriptive and statistical analysis for the comparison of results with respect to pain severity in the VAS before treatment and the differences achieved after treatment between the groups.

Group	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Results before treatment										
physiotherapy + massage + kinesiotherapy	15	6.67	0.82	5	6	7	7	8	-0.477	0.634
massage + kinesiotherapy	15	6.87	1.19	5	6	7	8	9		
Differences achieved after treatment										
physiotherapy + massage + kinesiotherapy	15	-4.80	1.01	-7	-5	-5	-4	-3	-3.208	0.001
massage + kinesiotherapy	15	-3.47	0.92	-5	-4	-4	-3	-2		

Mann-Whitney U test

Source: Own materials

Table 3. Changes in Laitinen scale components and total score before and after treatment – physiotherapy + massage + kinesiotherapy group

Examination	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Pain severity										
Before treatment	15	2.60	0.63	2	2	3	3	4	3.408	0.001
After treatment	15	0.80	0.56	0	0	1	1	2		
Differences	15	-1.80	0.68	-3	-2	-2	-1	-1	-	
Pain frequency										
Before treatment	15	2.27	0.88	1	2	2	3	4	3.296	0.001
After treatment	15	0.80	0.56	0	0	1	1	2		
Differences	15	-1.47	0.92	-4	-2	-1	-1	0	-	
Frequency of using analgesics										
Before treatment	15	1.20	0.68	0	1	1	2	2	3.180	0.001
After treatment	15	0.00	0.00	0	0	0	0	0		
Differences	15	-1.20	0.68	-2	-2	-1	-1	0	-	
Physical activity limitation										
Before treatment	15	1.93	0.88	0	1	2	3	3	3.296	0.001
After treatment	15	0.13	0.35	0	0	0	0	1		
Differences	15	-1.80	0.86	-3	-2	-2	-1	0	-	
Total Laitinen score										
Before treatment	15	8.00	2.45	4	6	9	9	12	3.408	0.001
After treatment	15	1.73	1.22	0	0	2	2	4		
Differences	15	-6.27	2.19	-12	-7	-6	-5	-3	-	

Wilcoxon test

Source: Own materials

Table 4. Changes in Laitinen scale components and total score before and after treatment – massage + kinesiotherapy group

Examination	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Pain severity										
Before treatment	15	2.60	0.63	2	2	3	3	4	3.408	0.001
After treatment	15	1.33	0.49	1	1	1	2	2		
Differences	15	-1.27	0.46	-2	-2	-1	-1	-1	-	
Pain frequency										
Before treatment	15	2.60	0.91	1	2	3	3	4	3.180	0.001
After treatment	15	1.27	0.46	1	1	1	2	2		
Differences	15	-1.33	0.72	-2	-2	-1	-1	0	-	
Frequency of using analgesics										
Before treatment	15	1.40	1.18	0	1	1	2	4	2.666	0.008
After treatment	15	0.47	0.74	0	0	0	1	2		
Differences	15	-0.93	0.96	-3	-2	-1	0	0	-	
Physical activity limitation										
Before treatment	15	1.60	0.91	0	1	1	2	3	3.180	0.001
After treatment	15	0.53	0.83	0	0	0	1	2		
Differences	15	-1.07	0.59	-2	-1	-1	-1	0	-	
Total Laitinen score										
Before treatment	15	8.20	2.96	4	6	8	11	13	3.408	0.001
After treatment	15	3.60	2.13	2	2	3	5	8		
Differences	15	-4.60	1.99	-8	-6	-5	-3	-1	-	

Wilcoxon test *Source: Own materials*

Table 5. Descriptive and statistical analysis for the comparison of results with respect to degree of symptoms assessed according to the Laitinen scale before treatment and the differences achieved after treatment between the groups

Group	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Results before treatment										
physiotherapy + massage + kinesiotherapy	15	8.00	2.45	4	6	9	9	12	-0.104	0.917
kinesiotherapy + massage	15	8.20	2.96	4	6	8	11	13		
Differences	15	-0.93	0.96	-3	-2	-1	0	0	-	
Differences achieved after treatment										
physiotherapy + massage + kinesiotherapy	15	-6.27	2.19	-12	-7	-6	-5	-3	-1.911	0.056
kinesiotherapy + massage	15	-4.60	1.99	-8	-6	-5	-3	-1		
Differences	15	-1.07	0.59	-2	-1	-1	-1	0	-	

Mann-Whitney U test *Source: Own materials*

The next two parameters, frequency of using analgesics and physical activity limitation, were also statistically analysed with respect to differences between the pre-treatment and post-treatment scores. As before, a statistically significant reduction was found. All the descriptive and statistical results are presented in Table 3.

The frequency of using analgesics before treatment was 1.20±0.68. After treatment, the result was 0 in all patients. This translates into a value of p=0.001 for the Wilcoxon test performed.

The results for physical activity limitation were 1.93±0.88 before treatment and 0.13±0.35 after treatment. The result from a comparison performed using the Wilcoxon test indicated a value of p=0.001.

The final (summary) scores from the Laitinen scale were assessed. The results from the descriptive and statistical analysis are also presented in Table 3. The mean summary score before treatment was 8.00±2.45 with a median of 9.0 points on a 16-degree scale. The score after physiotherapy combined with massage + kinesiotherapy was 1.73±1.22 points, with a median of 2 points. The difference in the results is approximately 6.27 points, which translates into a significant difference between the groups (p=0.001).

Group II (massage + kinesiotherapy)

Table 4 presents the results for the degree of symptoms with respect to pain severity, pain frequency, frequency of using analgesics. Comparisons showed significant differences in the study patients after massage + kinesiotherapy.

The mean pain severity was 2.60±0.63 with a median of 3 before treatment and 1.33±0.49 with a median of 1 after treatment. The difference in the results between the pre-treatment and post-treatment examination indicates a statistically significant change at p=0.001 (improvement seen in all patients). The mean score for pain frequency was 2.66±0.91 with a median of 3 before treatment and 1.27±0.46 with a median of 1 after treatment. The difference in the results between the pre-treatment and post--treatment examination indicates a statistically significant change at p=0.001.

The next two parameters, frequency of using analgesics and physical activity limitation, were also statistically analysed with respect to differences between the pre-treatment and post-treatment results. As before, a statistically significant reduction was found. All the descriptive and statistical results are presented in Table 4. The frequency of using analgesics before treatment was 1.40±1.18; after treatment, the result was 0.47±0.74. This translates into a value of p=0.008 for the Wilcoxon test performed. The results for physical activity limitation were 1.60±0.91 before treatment and 0.53±0.83 after treatment. The result from a comparison performed using the Wilcoxon test indicated a value of p=0.001.

The final (summary) scores from the Laitinen scale were also compared. The results of the descriptive and statistical analysis are also presented in Table 4.

The mean summary score before treatment was 8.20±2.96 with a median of 8.0 points on a 16-degree scale. The score after massage therapy was 3.60±2.13 points, with a median of 3 points. The difference in the results is approximately 4.60 points, which translates into a significant difference between the groups (p=0.001).

COMPARISON OF RESULTS BETWEEN GROUPS FOR THE LAITINEN SCALE

A comparison of the baseline (pre-treatment) results and the values of the differences achieved after treatment (level of reduction) in the Laitinen scale between the group undergoing physiotherapy + massage + kinesiotherapy and the group undergoing massage + kinesiotherapy is presented below. The results indicate that the two groups were similar before treatment. The difference in the mean value was 0.2 points (p=0.917).

A comparison with respect to reductions in the scores in the Laitinen scale (assessment of treatment efficacy) indicates that a higher improvement was seen in the group undergoing physiotherapy + massage + kinesiotherapy (Table 5). The mean reduction in the score was 6.27±2.19, while the score with massage + kinesiotherapy alone decreased by 4.60±1.99. The p value for this comparison was p=0.056, which represents borderline statistical significance. This means that the first treatment was more effective than the other. The entire descriptive and statistical analysis is presented in the table below.

ASSESSMENT OF THE EFFECT OF SOCIODEMOGRAPHIC CHARACTERISTICS ON THE RESULTS

Comparison by sex

Sex as a factor had no effect on the results before treatment in the group of patients who underwent physiotherapy and massage + kinesiotherapy; the difference in the results was only approximately 0.45 points and the medians were the same. The results were also not significantly different in the case of the Laitinen scale before treatment, although the scores in women were slightly lower. The differences in the results differ by approximately 1.6 points and the medians differ by 2 points. The p value was p>0.05 in both cases, and the Mann-Whitney U test was used for the comparisons (Table 6).

Differences seen after physiotherapy + massage + kinesiotherapy also did not depend on sex; this was true for both pain severity in the VAS and pain severity in the Laitinen scale. The improvement was approximately 0.17 points higher in the VAS.

The improvement was also slightly higher in men than in women in the Laitinen scale (6.88 *vs.* 5.57). The p value was p>0.05 for both comparisons, indicating that sex had no effect on the degree of improvement in the results.

A comparison between women and men who underwent massage + kinesiotherapy also does not indicate any significant differences for the baseline values in the VAS and the Laitinen scale. The sex of the patients did not influence the baseline pain severity in the VAS and the Laitinen scale in this group. The results differ by only 0.51 points and the medians differ by 0.5 points. There was also no significant difference in the results in the Laitinen scale before treatment, although the scores were slightly higher in women. There is an approximately 0.69-point difference in the differences in the results. The p value was p>0.05 in both cases, and the Mann-Whitney U test was used for the comparisons (Table 6).

Similarly, sex did not have an effect on the degree of improvement after treatment in the VAS and the Laitinen scale. Differences achieved after massage therapy according to sex for the difference in the VAS pain severity differ by 0.07 points. For the Laitinen scale, the differences for the groups differ by 0.48 (slightly higher in women than in men).

The p value was p>0.05 for both comparisons, indicating that sex had no effect on the degree of improvement in the results. The entire analysis is presented in Table 7.

Comparison by age

No statistically significant relationship was found based on the assessment of a correlation between the results for age and the VAS scores before treatment and a change in results after treatment in the entire group as well as when assessed separately for each subgroup.

The entire statistical analysis is presented in Table 8 and the results were compared using Spearman's rank

Table 6. Comparison of baseline VAS and Laitinen scores between women and men in both treatment groups

Group	Sex	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Physiotherapy + massage + kinesiotherapy	VAS										
	Men	8	6.88	0.83	6	6	7	7.5	8	0.752	0.452
	Women	7	6.43	0.79	5	6	7	7	7		
	Laitinen scale										
	Men	8	8.75	2.71	5	6.5	9	11	12	1.099	0.272
	Women	7	7.14	1.95	4	6	7	9	9		
Massage + kinesiotherapy	VAS										
	Men	8	6.63	1.06	5	6	6.5	7.5	8	-0.752	0.452
	Women	7	7.14	1.35	5	6	7	8	9		
	Laitinen scale										
	Men	8	7.88	2.80	4	5.5	8	10.5	11	-0.347	0.728
	Women	7	8.57	3.31	5	6	7	12	13		

Mann-Whitney U test

Source: Own materials

Table 7. Descriptive and statistical analysis for the comparison of results with respect to pain severity in the VAS and the Laitinen scale for the difference achieved after treatment between women and men – group undergoing massage + kinesiotherapy

Sex	N		SD	Min	Q1	Me	Q3	Max	Test result	p value
Difference for VAS										
Men	8	-3.50	0.93	-4	-4	-4	-3	-2	-0.289	0.772
Women	7	-3.43	0.98	-5	-4	-3	-3	-2		
Difference for Laitinen scale										
Men	8	-4.38	2.33	-8	-6	-4.5	-2.5	-1	0.347	0.728
Women	7	-4.86	1.68	-7	-7	-5	-3	-3		

Mann-Whitney U test

Source: Own materials

Table 8. Analysis of correlation between age and baseline VAS scores and differences in pain severity in the VAS – analysis for the entire group, including patients by groups

Correlation between age and VAS parameters	Number N	Correlation coefficient R	Test result t(N-2)	p value
VAS – results before treatment				
Entire group	30	0.370	2.104	0.054
Physiotherapy + massage + kinesiotherapy	15	0.317	1.206	0.249
Massage + kinesiotherapy	15	0.387	1.511	0.155
Differences achieved after treatment for VAS				
Entire group	30	-0.051	-0.268	0.791
Physiotherapy + massage + kinesiotherapy	15	-0.410	-1.622	0.129
Massage + kinesiotherapy	15	0.183	0.671	0.514

Spearman's rank correlation test

Source: Own materials

Table 9. Analysis of correlation between age and baseline results in the Laitinen scale and differences in symptom severity in the Laitinen scale – analysis for the entire group, including patients by groups

Correlation between age and Laitinen scale parameters	Number N	Correlation coefficient R	Test result t(N-2)	p value
Laitinen scale – results before treatment				
Entire group	30	0.544	3.431	0.002
Physiotherapy + massage + kinesiotherapy	15	0.531	2.257	0.042
Massage + kinesiotherapy	15	0.547	2.355	0.035
Differences achieved after treatment for Laitinen scale				
Entire group	30	-0.425	-2.483	0.019
Physiotherapy + massage + kinesiotherapy	15	-0.594	-2.662	0.020
Massage + kinesiotherapy	15	-0.451	-1.821	0.042

Spearman's rank correlation test *Source: Own materials*

Table 10. Analysis of correlation between BMI values and baseline VAS scores and differences in pain severity in the VAS – analysis for the entire group, including patients by groups

Correlation between BMI and VAS parameters	Number N	Correlation coefficient R	Test result t(N-2)	p value
VAS – results before treatment				
Entire group	30	0.149	0.800	0.430
Physiotherapy + massage + kinesiotherapy	15	0.144	0.525	0.608
Massage + kinesiotherapy	15	0.143	0.522	0.610
Differences achieved after treatment for VAS				
Entire group	30	0.037	0.198	0.844
Physiotherapy + massage + kinesiotherapy	15	-0.017	-0.061	0.952
Massage + kinesiotherapy	15	0.059	0.212	0.836

Spearman's rank correlation test *Source: Own materials*

correlation test. There is a certain tendency between the age and increased pain values in the VAS before treatment.

Table 9 presents comparisons for age with respect to the baseline values from the Laitinen scale and the degree of differences for the Laitinen scale that were achieved after treatment. An assessment of the baseline values shows that the symptom scores increase with age for the entire group, for the physiotherapy + massage group, and only in the group that underwent massage (r=0.544 for the entire group, r=0.531 for physiotherapy + massage + kinesiotherapy, and r=0.547 for massage + kinesiotherapy).

In contrast to the VAS results, a statistically significant correlation was observed between age and both the baseline Laitinen scores and the differences achieved after treatment. A correlation analysis performed for the changes that occurred after treatment also indicates a statistically significant correlation. The correlation results are inversely proportional. This means that as the age increased, the decrease in the results was higher. All correlation results indicate the presence of a moderate and low correlation.

Comparison by BMI

The subsection below includes correlation analyses with respect to the BMI. Table 10 presents comparisons for the baseline VAS scores and the differences achieved after treatment for the VAS. A statistical analysis performed for the entire group and separately for the group undergoing physiotherapy + massage + kinesiotherapy and the group undergoing massage + kinesiotherapy does not indicate any significant correlation in any of the comparisons.

A similar analysis performed for the baseline values and the differences achieved after treatment in the Laitinen scale with respect to the BMI also did not indicate any statistical relationship between the results in any of the comparisons. The p value was $p>0.05$, and the r value was close to 0.

Table 11. Analysis of correlation between BMI values and baseline results in the Laitinen scale and differences in symptom severity in the Laitinen scale – analysis for the entire group, including patients by groups

Correlation between BMI and Laitinen scale parameters	Number N	Correlation coefficient R	Test result t(N-2)	p value
Laitinen scale – results before treatment				
Entire group	30	0.284	1.568	0.128
Physiotherapy + massage + kinesiotherapy	15	0.186	0.683	0.507
Massage + kinesiotherapy	15	0.302	1.143	0.274
Differences achieved after treatment for Laitinen scale				
Entire group	30	-0.243	-1.327	0.195
Physiotherapy + massage + kinesiotherapy	15	-0.210	-0.773	0.454
Massage + kinesiotherapy	15	-0.243	-0.905	0.382

Spearman's rank correlation test

The entire statistical analysis for the analyses performed is presented in Table 11.

DISCUSSION

The positive results seen in this study, which show the efficacy of physiotherapy procedures in the treatment of back pain, confirm the findings reported by J. Sienicka and others. According to those authors, back pain treatment is based on appropriately selected kinesiotherapy, which, when combined with physiotherapy procedures, massage, patient education, and psychotherapy, produces the best therapeutic outcomes [12].

In their paper reporting the findings from a pilot study that assessed the efficacy of ultrasound therapy in the treatment of chronic lumbosacral pain syndromes, Magdalena Weber-Rajek et al. [according to 12] described reduced pain severity in the VAS and increased physical activity in the Laitinen scale after ultrasound therapy. The present study also demonstrates a statistically significant improvement in terms of reduced pain severity in the VAS as well as reduced physical activity limitation in the Laitinen scale. The study patients differed in terms of age, type of work, and level of physical activity; however, all experienced considerable limitations in their daily life and at work due to pain associated with lumbosacral discopathy. A remarkable improvement in their condition was seen after treatment in both Group I and Group II.

In view of the high frequency of lumbosacral pain and the global burden of this condition for society, it seems necessary to introduce and regularly update a system of principles of diagnostic and therapeutic management for patients with spinal pain syndromes. This study demonstrated that the treatment used in the patients contributed to a reduction in pain, but a significantly higher improvement was seen in Group I, and the severity and frequency of pain significantly decreased in Group I as compared to Group II.

Physical therapy and rehabilitation are a fundamental part of treatment in patients with spinal pain syndromes.

CONCLUSIONS

Spinal pain syndromes constitute an important clinical and social problem.

The applied treatment contributed to pain reduction in both study groups; however, significantly greater improvement was observed in the group receiving physiotherapy combined with massage and kinesiotherapy.

These findings suggest that combining physiotherapy procedures with massage and kinesiotherapy may enhance therapeutic outcomes in patients with lumbosacral pain syndromes.

Comprehensive physiotherapy and rehabilitation interventions may therefore play an important role in reducing pain and improving physical activity in patients with spinal pain syndromes.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 20.11.2025
ACCEPTED: 06.01.2026

ORIGINAL ARTICLE

Accelerating the adaptation of first-year students to university studies by means of motor activity

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ABSTRACT

Aim: The aim is to investigate the influence of motor activity (as exemplified by basketball training sessions) on the indicators of first-year students' adaptation to higher education.

Materials and Methods: The research involved 85 young men in their first year of study. An experimental group (EG, n = 42) was formed, which included students who were engaged in the club of sports games (basketball), and a control group (CG, n = 43), which included students who were involved in other types of motor activity (strength fitness, powerlifting, CrossFit).

Results: It has been found that the indicator of students' adaptive potential correlates with the indicator of dynamic endurance (r = -0.40), general endurance (r = 0.57), agility (r = 0.39), speed-strength endurance (r = -0.44), coordination-strength endurance (r = -0.40); the indicator of stress resilience correlates with the indicator of dynamic endurance (r = -0.30), general endurance (r = 0.51), agility (r = 0.30), speed-strength endurance (r = -0.35), coordination-strength endurance (r = -0.34). The effectiveness of basketball in accelerating students' adaptation has been proven by a significant improvement in adaptive potential and stress resilience, as well as by statistically significant positive dynamics in the level of prognostically significant motor indicators among students.

Conclusions: The prognostically significant motor indicators for first-year students have been identified: agility, general endurance, dynamic endurance, speed-strength endurance, and coordination-strength endurance. It has been found that students with a high level of stress resilience and a more enduring and agile approach are the most adapted to academic activities.

KEYWORDS: psychological adaptation, psychological resilience, physical fitness, basketball, students

Acta Balneol. 2026;68(1):14-19 doi: 10.36740/ABAL202601102

INTRODUCTION

The effective realization of their own needs, potential opportunities, establishment of social contacts with other participants in the educational process, and learning productivity depend on the course of adaptation of first-year students. Students with a high level of academic stress and educational maladjustment may experience cognitive impairment, decreased volitional activity, behavioral changes, psychosomatic or neurotic disorders [1]. The ability to adapt to new, unusual conditions of life, activity, and behavior, social functions of the educational process not only underlie academic success and professional development, but also ensure the preservation of the mental and physical health of higher education students [2, 3]. The study of students' bodies as an integral dynamic system under the influence of stressors involves examining the relationships between individual indicators of body and mental development, which enable them to maintain optimal performance and adapt physiologically and mentally to challenging environmental conditions. The course of adaptation is determined by the level of psychophysical readiness of students for education, which in turn determines their ability to maintain optimal physical and mental performance, the economical use of functional resources, and resistance to psychological and emotional overload. Therefore, stress resilience and adaptability are essential soft skills as general competencies of a future specialist.

The current understanding of the importance of implementing physical education in higher educational institutions is to fully realize the motor potential, develop volitional and personality qualities, and preserve the physical health and mental well-being of young people [4]. Despite the biological nature of the benefits of physical exercise, it is evident that motor activity is not the primary way to facilitate the academic adaptation of first-year students. Still, it can significantly expand the possibilities of pedagogical influence on increasing the level of psychophysiological adaptation of the body and social adaptation of the individual to the stressors of the educational environment. It can help reduce mental and somatic signs of stress [5]. For example, researchers have noted [6] that students with a high level of motor activity are more socially oriented, have emotional stability and volitional activity, and have better health and mood.

The authors [7, 8, 9] show that one of the most popular and effective sports cultivated in educational institutions

is sports games, in particular basketball, which is characterized by high dynamism and emotionality, a large arsenal of motor actions and variability of their application, accessibility for people of different levels of game readiness, and simplicity of conditions for organizing training sessions both indoors and outdoors.

The issue of students' academic adaptation is one of the leading areas in research on personality formation. However, the study of the impact of sports games, in particular basketball, on students' adaptation to the educational environment is currently fragmented and based on isolated practical developments. This requires separate interdisciplinary research to study the scientific prerequisites and peculiarities of the academic adaptation of first-year students during their basketball training sessions.

AIM

The aim is to investigate the influence of motor activity (as exemplified by basketball training sessions) on the indicators of first-year students' adaptation to higher education.

MATERIALS AND METHODS

The research had an experimental design and was conducted from September to June of the 2023-2024 academic year. The experiment involved 85 first-year male students from Ukrainian State Drahomanov University (Kyiv, Ukraine), from whom the experimental (EG) and the control (CG) groups were formed. The EG included 42 students who were engaged in the sports games club (basketball). In comparison, the CG included 43 students who were involved in other types of motor activities (strength fitness, powerlifting, CrossFit). The formation of groups of students was based on their own choice of the kinds of motor activity (inclusion criterion). The level of physical fitness of students, their morphofunctional state, and health level were not inclusion criteria and were not taken into account. At the same time, the initial examination of these indicators revealed that they are significantly ($p > 0.05$) the same in the EG and the CG. The experiment was open, and the students were informed about its purpose and objectives. The students of both groups had the opportunity to withdraw from the experiment at any time of their own free will (exclusion criterion). Training sessions in the EG and the CG were held twice a week, each lasting 2 hours.

Methods included: analysis and generalization of literary sources; R. Baievskyi's method for assessment of functional adaptive potential of cardiovascular system; Boston test-questionnaire for determination of personality stress resilience level; testing was carried out with the purpose of studying students' physical fitness level, in particular the following motor tests were used: 100 m (s) run to assess the level of speed; standing long jump (cm) and throwing a small ball at a distance (m) to evaluate the level of speed-strength abilities; pull-ups (number of times) to determine the level of strength abilities; 4x9 m (s) shuttle run to assess the level of agility; 1500 m (min) run to evaluate the level of general endurance; test of trunk raising from the supine position into a sitting position for 1 minute (number of times) to evaluate the level of dynamic endurance; Burpee test for 10 seconds (number of times) to assess coordination-strength endurance; jumping rope for 1 minute (times) to evaluate speed-strength endurance.

R. Baievskyi's method provided for the determination of the length and weight of the body, pulse rate per minute, systolic and diastolic blood pressure in students. Herewith, the indicator of adaptive potential was calculated by the formula: $AP = 0.011 \times HR + 0.014 \times SP + 0.008 \times DP + 0.014 \times$(age, years)$+ 0.009 \times$(weight, kg)$- 0.009 \times$(height, cm)$- 0.27$, where: AP – adaptive potential (c. u.); HR – heart rate per 1 min; SP – systolic pressure, mmHg; DP – diastolic pressure, mmHg.

To diagnose the individual level of stress resilience in first-year students, it was planned to use the Boston Method of self-assessment of personality stress resilience. The questionnaire, designed for this purpose, contains 20 questions, the answers to which are evaluated on a 5-point scale, and the result is reported on the corresponding scale. Herewith, the lower the score, the higher the level of stress resilience.

To process digital data, mathematical statistics methods were employed, specifically the sampling method using Student's criterion and linear correlation analysis using Pearson's criterion, to investigate the relationship between the level of academic adaptability (in terms of functional adaptive potential and stress resilience) and the level of physical fitness among students. The research implementation followed the requirements of scientific ethics. The research was approved by the Commission on Academic Ethics of Ukrainian State Dragomanov University. Also, this research followed the regulations of the World Medical Association Declaration of Helsinki.

RESULTS

Academic adaptability is a model that describes the mutual influence of students' skills and abilities on maintaining emotional, cognitive processes, and optimal physical performance during academic activities. The study of students' bodies under the influence of stressors in the learning environment involves examining the relationships between individual indicators of body and psychological development, which enable physiological and mental adaptation to complex environmental conditions. Based on the analysis of these relationships, it is possible to identify prognostically significant indicators that influence the formation of students' academic adaptation.

To study the relationships between academic adaptability (in terms of functional adaptive potential and stress resilience) and the level of physical fitness of first-year students, a correlation analysis was performed using Pearson's criterion. Motor parameters significantly associated with academic adaptability were identified, suggesting that their development through rationally organized motor

activity may contribute to improved adaptation to university study conditions.

It was found that the indicator of adaptive potential of students' organism correlates with the indicator of dynamic endurance (r = -0.40), general endurance (r = 0.57), agility (r = 0.39), speed-strength endurance (r = -0.44), and coordination-strength endurance (r = -0.40) (Table 1).

A correlation was observed between the indicator of stress resilience and dynamic endurance (r = -0.30), general endurance (r = 0.51), agility (r = 0.30), speed-strength endurance (r = -0.35), and coordination-strength endurance (r = -0.34) (Table 2).

One of the primary tasks of physical education is to maintain and preserve health, enhance physical performance, and mitigate the adverse effects of educational activities on first-year students. The choice of motor activities is based on the interests and needs of young people, as well as the importance of applied value, particularly the possibility of influencing prognostically significant motor indicators to accelerate students' adaptation to university conditions.

Considering the numerous functions performed by rationally organized motor activity and pedagogical tasks faced by physical education instructors in the educational process, basketball training sessions can have various directions of influence and, accordingly, health, educational, developmental, and recreational effects. Thus, the health benefits of basketball training sessions include increasing the functional capabilities of the cardiorespiratory system, enhancing metabolic processes, improving body resistance to adverse environmental factors, and enhancing muscle tone, hormonal levels, and psycho-emotional state. To achieve a health-improving effect, activities that focus on aerobic exercise, strength training, coordination, and games are primarily utilized. The educational impact of basketball training sessions is evident in the opportunities for forming motor experiences, learning new movements, and improving techniques and motor actions. To teach basketball techniques, we used preparatory, leading, and basic exercises. The developmental effect during basketball training sessions is achieved through a targeted impact on the development of students' motor abilities, including various types of strength, endurance, speed, coordination, and flexibility. Depending on the quality to be developed through basketball, general developmental and specifically developmental exercises were used, guided by general methodological provisions for the development of motor skills. At the same time, we employed continuous, interval, repeated, game, and competitive methods, as well as the circuit training method.

When planning motor loads, the most excellent attention was paid to the development of prognostically significant motor indicators, in particular, various types of endurance and agility, using techniques and game combinations, running and jumping exercises in pairs, exercises with passes, catching, handling, and throwing the ball with different ways of organizing students: current, group, circuit, etc. The content of the training sessions included high-intensity exercises with short rest periods, paired exercises, and exercises utilizing bodyweight and external weights (dumbbells, elastic bands, and weighted balls) to develop strength and endurance. Group and team game combinations, relay races, and outdoor games were used to enhance cohesion and psychological comfort within the student team, provide psycho-emotional relief, and foster the development of social and communication soft skills.

Checking the presence of changes in physical fitness and improvement of psycho-emotional state at the end of the pedagogical experiment as a result of the use of such exercises allowed us to obtain the following results (Table 3).

At the end of the academic year, the students in both the EG and the CG improved their results in all the studied indicators; however, more pronounced and statistically significant changes occurred only in the EG ($p \leq 0.05$). Thus, the indicator of adaptive potential in the EG improved by 0.34 c. u., stress resilience – by 2.2 points, results in trunk raising from the supine position into a sitting position for 1 minute (dynamic endurance) – by 4.9 times; in 1500 m run (general endurance) – by 41 seconds, in 4x9 m shuttle run (agility) – by 0.4 seconds; in jumping rope for 1 minute (speed-strength endurance) – by 9.7 times; in Burpee test (coordination-strength endurance) – by 1.2 times.

It is essential to note that at the beginning of the experiment, there was no significant difference between the EG and the CG in all studied indicators ($p > 0.05$). Following the experiment, all indicators of the EG were superior to those of the CG. At the same time, in terms of indicators of adaptive potential, including general endurance, coordination-strength endurance, the difference between the EG and the CG is significant ($p \leq 0.05$). This indicates the advantage of basketball training sessions compared to other types of motor activity, such as strength fitness, powerlifting, and CrossFit, in terms of accelerating the adaptation of first-year students to the conditions of studying in a higher educational institution.

DISCUSSION

The organization of motor activity in higher educational institutions is based on different conceptual approaches, but one of the leading ones is the focus on students' health. One of the ways to preserve students' health is to ensure a favorable psycho-emotional state and psychological climate in the learning environment, in particular, to increase the psychophysiological adaptability of the body and social adaptability of the individual to the stressors of the educational environment to achieve optimal performance and maximum productivity in learning [10, 11, 12].

The student age is characterized by crisis saturation, and one of the age crises of this stage is the first-year crisis related to adapting to higher education. The ability to adjust to challenging conditions within the educational process, i.e., to maintain optimal physical and mental performance, to respond adequately to the stressors of the learning environment, and to utilize the body's functional and mental reserves economically, determines the success of implementing higher education tasks. The process

Table 1. Relationship between students' adaptive potential and indicators of their physical fitness (r_{xy}, young men, n = 85)

Indicators of physical fitness	Indicator of adaptive potential
Dynamic endurance	-0.40
General endurance	0.57
Agility	0.39
Speed-strength endurance	-0.44
Coordination-strength endurance	-0.40

Note: r – Pearson's correlation coefficient

Source: Own materials

Table 2. Relationship between students' stress resilience and indicators of their physical fitness (r, young men, n = 85)

Indicators of physical fitness	Indicator of stress resilience
Dynamic endurance	-0.30
General endurance	0.51
Agility	0.30
Speed-strength endurance	-0.35
Coordination-strength endurance	-0.34

Note: r – Pearson's correlation coefficient

Source: Own materials

Table 3. Dynamics of indicators of physical fitness and psycho-emotional state of first-year students in the conditions of pedagogical experiment (Mean ± m, EG, n = 42, CG, n = 43)

Indicators	Groups	Before the experiment	After the experiment	The difference	t	p
Adaptation potential, c. u.	EG	3.05±0.11	2.71±0.08*	0.34	2.50	p≤0.05
	CG	3.02±0.10	2.94±0.09	0.08	0.59	p>0.05
Stress resilience, points	EG	30.3±0.72	28.1±0.81	2.2	2.05	p≤0.05
	CG	30.4±0.75	29.8±0.79	0.6	0.55	p>0.05
Dynamic endurance, times	EG	36.4±1.5	41.3±1.8	4.9	2.09	p≤0.05
	CG	36.3±1.6	38.7±1.7	2.4	1.03	p>0.05
General endurance, min, s	EG	8.48±0.12	8.07±0.09*	0.41	2.73	p≤0.05
	CG	8.41±0.11	8.35±0.10	0.06	0.40	p>0.05
Agility, s	EG	10.8±0.11	10.4±0.09	0.4	2.81	p≤0.05
	CG	10.7±0.13	10.5±0.11	0.2	1.17	p>0.05
Speed-strength endurance, times	EG	90.1±2.96	99.8±2.98	9.7	2.31	p≤0.05
	CG	92.2±2.89	94.3±2.91	2.1	0.51	p>0.05
Coordination-strength endurance, times	EG	5.1±0.41	6.3±0.37*	1.2	2.17	p≤0.05
	CG	5.0±0.39	5.2±0.38	0.2	0.37	p>0.05

Note: Mean – arithmetic mean; m – standard error; n – sample size; t – value of Student's t-test between the indicators of each groups before and after the experiment; * – statistically significant differences between the indicators of the EG and CG at the levels of p≤0.05: p – level of statistical significance of differences.

Source: Own materials

of students' adaptation to studying in higher educational institutions provokes changes in the motivational, cognitive, emotional, and volitional spheres of personality, as well as habitual motor mode. It can occur relatively calmly and evenly, or have a complex course under conditions of permanent stress [13].

Academic activity is characterized by several stressors, including intensive intellectual activity, excessive static load with limited physical activity, disruption of the usual life routine, increased mobilization of cognitive and volitional functions, and exacerbation of emotional experiences [14]. The prerequisites for successful adaptation to learning include the pre-adaptation level of knowledge, skills, and abilities, cognitive processes, level of volitional manifestations, individual psychological characteristics, personal traits, properties of the nervous system, and the psycho-emotional and physical condition of students. The current realities of life associated with the post-pandemic period, martial law, and other stressors of today's unstable world are accompanied by a decline in health indicators and an increase in the level of stress among young people who are potential applicants to higher educational institutions, so students' psychophysical readiness to study may be insufficient. This also leads to problems with academic adaptation, which can manifest in psychological, physiological, and behavioral ways [15, 16].

Basketball training sessions promote active recreation, foster interpersonal relationships within the team, develop flexible social and communication skills, enhance mental and physical health, increase volitional activity, and ultimately create opportunities for improving psychological and physiological mechanisms of adaptation to the educational process [8, 9, 17, 18]. However, the issue of forming students' academic adaptation through physical education is interdisciplinary in nature. It requires the study of individual indicators of body development and personality traits of students that determine their level of adaptation to the educational process. At the same time, the heterogeneity of the student contingent in terms of morphofunctional status, motor fitness, psychotype, level of stress and stress resilience requires planning a rational motor regimen and compliance with scientifically based parameters of motor loads, taking into account the individual characteristics of the development of the student's body, interests and needs of students, and the characteristics of future professional activities. Modern theory and practice have accumulated experience in using sports games for health purposes, including stress management and improving academic adaptation. However, such developments are fragmentary, and the data are generalized; there is no scientifically based technology for the formation of academic adaptation of students in the process of playing sports games, based on a comprehensive increase in the psychological and functional resources of the body in the process of physical education in a stressful educational environment.

CONCLUSIONS

It has been found that students' adaptation can be assessed by indicators of adaptive potential and stress resilience, the level of which characterizes the ability to preserve the psycho-functional resources of the body in stressful conditions of the educational environment. The study of interrelations between students' academic adaptability and indicators of their physical fitness shows that the indicator of adaptive potential of students' organism correlates with the indicator of dynamic endurance ($r = -0.40$), general endurance ($r = 0.57$), agility ($r = 0.39$), speed-strength endurance ($r = -0.44$), coordination-strength endurance ($r = -0.40$); stress resilience indicator correlates with dynamic endurance ($r = -0.30$), general endurance ($r = 0.51$), agility ($r = 0.30$), speed-strength endurance ($r = -0.35$), coordination-strength endurance ($r = -0.34$). It is assumed that the dynamic, variable nature and complex influences on the development of motor qualities in sports games substantiate the rationality of their use in accelerating students' adaptation to new learning conditions. The effectiveness of basketball in increasing students' academic adaptability has been demonstrated in this study by significant improvements in adaptive potential and stress resilience, as well as statistically significant improvements in motor indicators associated with academic adaptability.

The relationship between the indicators of academic adaptability (in terms of adaptive potential and stress resilience) and the physical fitness of first-year students has been established. The following prognostically significant motor indicators have been identified: agility, general endurance, dynamic endurance, speed-strength endurance, and coordination-strength endurance. It has been found that students most adapted to educational activities are those who are more enduring and agile, with high stress resilience. It has been established that basketball training sessions, as part of physical education, contribute to the improvement of students' academic adaptability in both functional and psychological aspects.

Prospects for further research will focus on examining the impact of various types of motor activity on accelerating the adaptation of first-year female students to university conditions during wartime.

LIMITATIONS

This study has certain limitations that should be acknowledged. The allocation of participants based on voluntary choice of motor activity and the absence of randomization may have introduced selection bias and uncontrolled confounding factors. Moreover, the study was conducted in a single institution and included only male students, which may limit the generalizability of the findings to broader and more diverse student populations.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 05.11.2025
ACCEPTED: 14.01.2026

ORIGINAL ARTICLE

Effect of diaphragmatic breathing exercise on stress management among professional chess players

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ABSTRACT

Aim: Study of the effectiveness of diaphragmatic breathing exercise on reducing stress levels among professional chess players.

Materials and Methods: 52 professional chess players aged 18-30 without prior experience in diaphragmatic breathing exercises had been recruited and randomly assigned into two groups. The blunders made by each player was documented (using stockfish engine). The participants baseline stress were assessed using Depression Anxiety Stress Scales (DASS-21) scale and heart rate. The players in experimental group (n=26) practiced diaphragmatic breathing exercise in the time intervals between each game during practice session daily. Whereas the players in control group (n=26) continued with their usual chess practice routines without any additional stress reduction interventions.

Results: The results within the group showed that the diaphragmatic breathing exercise has a significant effect ($p \leq 0.0001$) on stress reduction among chess players in experimental group from 29.38±2.25 to 26.46±2.96. In addition, blunders were reduced significantly ($p = 0.003$) from 10.42±1.72 to 9.38±2.30. However, there is no significant (p-value = 0.064) change in heart rate was reported. The players in control group showed no significant changes ($p > 0.05$). Between the groups results showed reduced stress ($p \leq 0.0001$) and blunders ($p = 0.013$) among players in diaphragmatic breathing exercise group compared with control group.

Conclusions: The findings suggest that short-duration diaphragmatic breathing exercises can be a useful exercise for chess players to manage stress during competitions, potentially improving their well-being and performance by reducing the blunders. This technique could be a simple yet effective way to gain a attention in high-pressure games like chess.

KEYWORDS: psychological stress, heart rate, breathing exercises, psychomotor performance, relaxation

Acta Balneol. 2026;68(1):20-25. doi: 10.36740/ABAL202601103

INTRODUCTION

Chess is more than just a game – it's a powerful workout for the brain. It improves memory, focus, problem-solving, and strategic thinking by constantly challenging players to plan ahead and adapt. Playing chess activates key areas of the brain, especially the prefrontal cortex, which handles decision-making and planning.

Regularly playing chess strengthens mental skills, boosts creativity, and can help maintain brain health as we age. It exercises both logical and creative thinking, encourages mental flexibility, and may even reduce the risk of cognitive decline, including dementia and Alzheimer's. Overall, chess keeps the mind sharp by promoting neuroplasticity and lifelong learning [1].

Chess has been shown to support brain health, especially in relation to neurodegenerative diseases like Alzheimer's and Parkinson's. Regular mental stimulation from playing chess may help build what's known as "cognitive reserve" – the brain's ability to adapt and stay functional despite age-related changes or damage. People with higher cognitive reserve tend to show symptoms of these conditions later, as their brains can better cope with deterioration.

Beyond its cognitive benefits, chess also supports emotional well-being. It teaches patience, focus, and how to manage stress, whether during intense games or in daily life. The game provides a safe, structured environment for practicing problem-solving and decision-making, which can help strengthen mental functioning and reduce symptoms [2,3].

Stress is brought on by an existing „stressor," which in response generates depression. When stress and other psychological components combine, it can be detrimental and disrupt with daily activities. The subjective perception of stressors can result in poor quality of life, diminished self-esteem that lowers self-confidence, and a diminished capacity to deal with day-to-day challenges [4,5].

Stress can lead to repeated spikes in blood pressure by triggering the release of hormones that cause blood vessels to constrict. Factors like job stress, competitive sports, social pressure, and mental strain can all contribute. While stress may not directly cause hypertension, it can worsen it when combined with other risk factors. Research shows that non-drug stress management techniques can effectively help lower blood pressure [6,7].

Breathing is vital for survival, with humans typically taking 20–22 breaths per minute. Slow, deep breathing increases oxygen intake and removes more carbon dioxide, benefiting both the body and brain. It supports brain function by improving oxygen flow, which enhances mental clarity and overall health. Deep breathing has physiological effects that activate the vagus nerve, enhancing vagal tone in line with polyvagal theory by promoting parasympathetic nervous system activity, which supports overall well-being. Breathing practices are considered contemplative exercises that, according to cognitive neu-

roscience research, can lead to structural brain changes and improve the well-being of those who engage in them [8]. One effective method is diaphragmatic, or „belly" breathing, which uses the diaphragm to draw in more air. Unlike shallow breathing linked to stress, this technique maximizes lung capacity, boosts oxygen exchange, and improves blood circulation. With regular practice, it can reduce anxiety, sharpen focus, and strengthen emotional well-being [9,10].

Deep, slow breathing activates the parasympathetic nervous system (PNS), which helps the body relax and balances the stress-driven sympathetic nervous system (SNS). This calming response can lower heart rate, reduce blood pressure, and support heart health. Diaphragmatic breathing also benefits mental well-being, especially in stressful situations. For example, a study on nursing students found that those who practiced this technique experienced less stress, likely due to the soothing effects of PNS activation, which helps manage emotional and physical reactions to stress [11,12].

AIM

Study of the effectiveness of diaphragmatic breathing exercise on reducing stress levels among professional chess players.

MATERIALS AND METHODS

The participant recruitment for this study was conducted in two phases. In Phase 1, a sample size of 385 was estimated [13], and players from various clubs in Chennai, India were invited to participate. A Google link was shared from June 2024 first week until the end of the month, and 342 players responded. However, in phase two baseline screening was conducted from August 2024 and the post intervention measurements were conducted in September 2024. Only 52 professional chess players aged 18-30 who met the inclusion criteria and had no prior experience with diaphragmatic breathing exercises were recruited and randomly assigned to two groups. The participant's baseline (week 1 first day) and post-activity (week 4 last day) stress levels were assessed using the Depression Anxiety Stress Scales (DASS-21) and heart rate measurements. The experimental group (n=26) practiced diaphragmatic breathing exercises for 3 minutes, 3 sets per day, during practice sessions, while the control group (n=26) continued with their usual chess practice routines without any additional stress reduction interventions. Informed consent forms were obtained from all participants, and the study procedure was explained to them. In addition, the participants valid FIDE or AICF ID were verified. The study was approved by the Institutional Scientific Ethical Committee (ISRB/SCPT02/008/2023) prior to participant enrollment.

The blunders made by each player were documented using the Stockfish engine before and after the interventions after 4 weeks. Conversely, individuals were excluded from the study if they exhibit poor cognition or perception, making them unable to understand instructions required for assessment and treatment. Additionally, those with cardiopulmonary, neurological, or musculoskeletal disorders, as well as uncooperative individuals, were excluded.

The players in the diaphragmatic breathing exercise group were instructed to inhale slowly and deeply through nose, focus on expanding the abdomen, allowing it to rise. Chest should remain relatively still. Continue to inhale until the lung capacity is comfortably full, but not overinflated. They were instructed to exhale slowly and completely through mouth. During exhalation, they were advised to maintain the abdomen movement fall naturally.

The participants' stress levels and the heart rate is measured using a pulse oximeter following their practice sessions during the first week. It is essential that each subject is seated comfortably in a chair with a backrest to ensure proper posture and stability during the measurement. However, to obtain a more accurate representation of their physiological response to stress, participants should not be relaxed before the measurement.

Prior to taking the heart rate measurement, players were instructed to engage themselves in their practice session to elevate their arousal levels. This approach mimics real-life scenarios where individuals may experience stress immediately after a demanding activity. The pulse oximeter will then capture heart rate data under these conditions, providing valuable insights into how their bodies respond to stress following practice.

Additionally, it is crucial to instruct participants to keep their hands still and their breathing normal during the measurement process. This help players to minimize any external factors that could affect the accuracy of the readings. By implementing these guidelines, the study aims to establish a reliable baseline for heart rate measurements in relation to perceived stress levels, facilitating a more comprehensive understanding of the participants' physiological responses.

Average blunders: In the study of chess performance, the average number of blunders made by players is recorded using Stockfish engine, one of the most powerful and widely used chess engines. Stockfish evaluates the moves of the players by comparing each move against the optimal moves determined by its advanced algorithms [14]. A blunder is typically defined as a move that significantly worsens a player's position, often resulting in a large loss of material or a decisive strategic disadvantage.

To quantify blunders of participants, the games played by the participants are analysed move by move. Stockfish assigns a numerical evaluation to each position, and when a player's move causes a drastic drop in this evaluation (typically by more than 2.0 points in engine terms), it is flagged as a blunder. The average number of blunders per game is then calculated for each player by analysing a series of games, offering insights into their decision-making patterns and areas of weakness.

The outcome measure for each of the 7 stress items is scored on a scale from 0 to 3 and the total value is multiplied by 2 resulting in a maximum score of 42. The DASS-

21 scale become a standard tool for assessing self-rated stress. The scoring categories are as follows: 0-14 Normal, 15-18 Mild, 19-25 Moderate, 26-33 severe, 34+ extremely severe [15]. The outcome measures of within group values are calculated using Paired t-test and between group values are calculated using Unpaired t-test. The significance value was set as $p<0.05$.

RESULTS

The mean age of participants in the control group was 21.96 years with a standard deviation of 2.41, while the experimental group had a mean age of 21.50 years with a standard deviation of 2.23. The age range for both groups was between 18 and 28 years. There was no statistically significant difference in age between the two groups, as indicated by a T-value of 0.28 and a P-value of 0.7817. In terms of gender distribution, the control group comprised 57.69% males and 42.31% females, whereas the experimental group consisted of 65.38% males and 34.62% females. With regard to hand dominance, 84.62% of participants in the control group and 88.46% in the experimental group were right-handed, while 15.38% and 11.54% were left-handed, respectively (Table 1).

The results within the group showed that the diaphragmatic breathing exercise has a significant effect ($p<0.0001$) on stress reduction among chess players in experimental group from 29.38 ±2.25 to 26.46 ±2.96. In addition, blunders were reduced significantly ($p= 0.003$) from 10.42 ±1.72 to 9.38 ±2.30. However, there is no significant (p--value = 0.064) change in heart rate was reported. The players in control group showed no significant changes ($p> 0.05$) in all the outcome variables (Table 2). Between the groups results showed reduced stress ($p< 0.0001$) and blunders ($p= 0.013$) among players in diaphragmatic breathing exercise group compared with control group players (Table 3. Fig.1).

DISCUSSION

This study aims to evaluate the impact of diaphragmatic breathing on professional chess players' ability to manage stress. Competitive chess is a mental sport that demands a high degree of cognitive function, mental endurance, and emotional stability. Chess players often engage in hours-long matches where they must maintain unwavering focus, make complex calculations, and anticipate their opponent's moves. In this high-pressure environment, even a slight increase in stress and anxiety can have detrimental effects on a player's performance. Stress is the body's irrational reaction to any need for adaptation, whether such adaptation results in enjoyment or suffering. Stress is a symptom of anxiety when a person's capacity for coping is exceeded. Stress has an impact on mental health in addition to being a physical one. Also, it is a psychological problem. Because stress can act as both a strengthening and a driving force, it is a complex phenomenon [16]. This study's findings offered valuable

Table 1. Demographic Characteristics of control group and experimental group

Variable		Control group	Experimental group	T value	P value
Age		21.96 (2.41)	21.50 (2.23)	0.28	0.7817
Age range		18-28	18-28	-	
Gender	Male	57.69 %	65.38 %	-	
	Female	42.31 %	34.62 %	-	
Dominant side	Right	84.62	88.46	-	
	Left	15.38	11.54	-	

Source: Own materials

Table 2. Presents within group effects of outcome measures (DASS-21, Heart rate, Average blunders)

Outcome	Group	Mean± SD		T-value	P-value
		Pre-test	Post-test		
DASS 21	Control group	30±2.19	30.38±2.53	1.547	0.134
	Experimental group	29.38±2.25	26.46±2.96	6.347	<0.0001
Heart rate	Control group	79.85±6.29	80.23±5.31	0.585	0.563
	Experimental group	78.81±5.72	77.62±5.44	1.938	0.064
Average blunders	Control group	9.31±2.66	9.12±2.57	0.667	0.510
	Experimental group	10.42±1.72	9.38±2.30	3.235	0.003

Source: Own materials

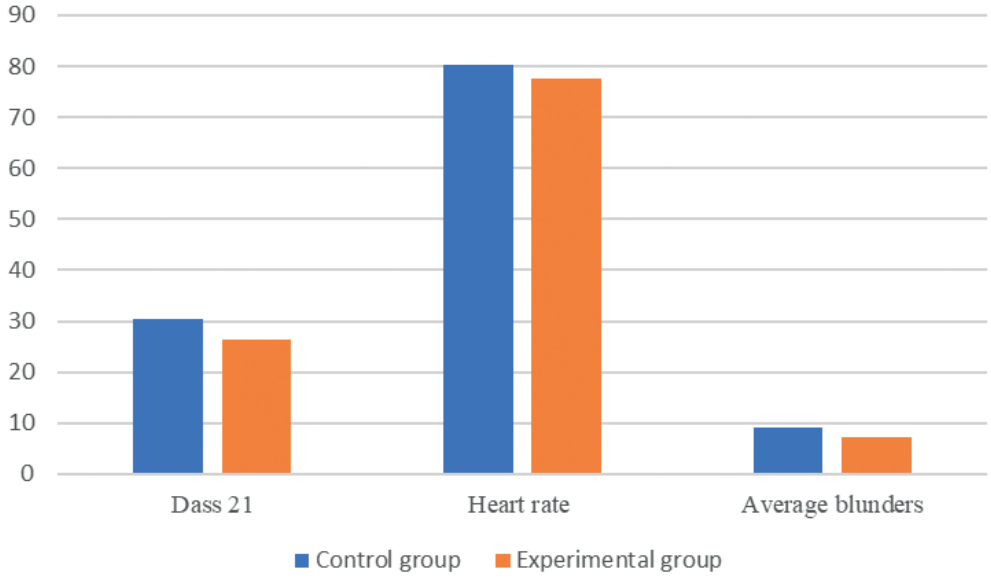

Fig. 1. Presents between group effects of outcome measures (DASS-21, Heart rate, Average blunders)

Source: Own materials

Table 3. Presents between group effects of outcome measures (DASS-21, Heart rate, Average blunders)

Outcome	Post test	Mean± SD	T Value	P value
DASS-21	Control group	30.38±2.53	5.1332	<0.0001
	Experimental group	26.46±2.96		
Heart rate	Control group	80.23±5.31	1.7507	0.085
	Experimental group	77.62±5.44		
Average blunders	Control group	9.12±2.57	2.5725	0.013
	Experimental group	9.38±2.30		

Source: Own materials

coping strategies for stress management, which includes diaphragmatic breathing. Long-term stress can have a number of detrimental effects on health, including weakened immune systems, heart problems, and psychological disorders including anxiety and depression, according to studies. Furthermore, financial status and social support are two psychological variables that have an impact on health outcomes, and stress can amplify their effects [17]. Stress is caused by an underlying „stressor," which in turn causes depression. Combining stress with other psychological elements might have negative effects and interfere with day-to-day tasks. Subjective stress perception has been linked to a decreased quality of life, a decline in self-worth that undermines confidence, and a reduced ability to handle daily obstacles. Stress has an effect on chronic conditions like diabetes, cancer, coronary artery disease [18]. These research findings show the negative effects of high stress levels which affects the cognitive ability of a person. In the context of mental sports like chess, where the demand for cognitive precision is paramount, understanding and managing stress is crucial. Unchecked stress can cloud judgment, slow reaction times, and lead to poor decision-making, all of which can undermine a player's ability to perform at their best [19].

An investigation of how stress relaxation training has an effect on automotive workers' self-perceived workplace stress. In which the stress levels were measured both before and after the session using the validated short form of the Depression Anxiety Stress Scales (DASS-21). The DASS-21 is a widely recognized tool used to assess depression, anxiety, and stress, offering a comprehensive evaluation of an individual's mental health status through self-reporting [20]. In this study, the effectiveness of the DASS-21 scale was shown to be highly valuable in quantifying stress levels and the results highlighted significant improvements following the deep breathing training.

Sunil Naik et al. (2018) concluded that a wide variety of breathing exercises and yogic asanas have long been utilized as effective tools to significantly reduce stress brought on by the demands of a hectic and imbalanced lifestyle. Their research highlights the beneficial impact of these practices in promoting relaxation and enhan-

cing mental well-being without causing any notable side effects [21]. The assessment of diaphragmatic mobility demonstrated moderate to good levels of reliability across different forms of measurement. Furthermore, the studies reviewed showed a low risk of bias, indicating that the results are likely to be valid and consistent. Both inter-rater and intra-rater reliability were found to be satisfactory, supporting the use of these assessment methods in clinical and research settings [22]. In particular, the study found that participants who engaged in modified slow breathing exercises experienced no adverse effects and demonstrated good compliance, indicating the feasibility and accessibility of these techniques for a wide audience. A key focus of the study was on the practice of deep breathing, which plays a crucial role in stress management. Deep breathing, often referred to as deep belly breathing, activates the parasympathetic nervous system, promoting relaxation and reducing the body's stress response. The study demonstrated that incorporating this form of breathing into daily routines can lead to significant physiological and psychological benefits, such as lowering heart rate, reducing anxiety levels, and enhancing overall emotional stability. Furthermore, the findings underscore the importance of deep breathing in improving lung function and increasing oxygen intake, which, in turn, positively influences cognitive performance and emotional resilience. The absence of side effects and the ease of integrating these exercises into daily life make deep breathing an accessible and effective intervention for managing the harmful effects of stress, especially in individuals who struggle with the pressures of a modern, fast-paced lifestyle. This research emphasizes the growing relevance of non-pharmacological approaches like yogic practices in fostering long-term health and well-being [23].

According to a study, diaphragmatic breathing has several advantages for healthy adults, especially for improving cognitive performance and lessening the detrimental physiological and psychological impacts of stress [24]. The research aimed to explore how this specific form of breathing, which emphasizes deep, controlled breaths from the diaphragm, could influence both mental and physical well-being. The study revealed that regular practice of diaphragmatic breathing led to improvements in various cognitive functions. These benefits are likely attributed to the practice's ability to reduce stress and anxiety, which are known to impair mental performance. By activating the parasympathetic nervous system, diaphragmatic breathing promotes relaxation and lowers the body's stress response, leading to a calmer mind and enhanced cognitive clarity. Diaphragmatic breathing not only improves cognitive function but also plays a vital role in mitigating the detrimental effects of stress, such as increased heart rate, elevated cortisol levels, and subjective feelings of tension and anxiety. Participants in the study who practiced diaphragmatic breathing reported feeling less stressed and more focused, indicating that this technique can have both immediate and long-term benefits for mental sharpness and emotional well-being. Whereas our study reported that the diaphragmatic breathing exercise has a significant effect on stress reduction among professional chess players. A previous report finding from a clinical trial among healthy participants who trained for 8 weeks in diaphragmatic breathing exercise showed significant reduction in the heart rate [25].

However, our study found no significant change in heart rate of chess players in either the experimental or control group, possibly due to the time interval between measurement and the practice match.The study also had few limitations. The 4-week follow-up allowed evaluation of short-term efficacy in chess players but cannot be generalized to long-term remission. In addition, the lack of an active control group, limited participants age range, absence of heart rate variability (HRV) measurement, and single-center design may limit the generalizability of the findings.

CONCLUSIONS

The findings of the present study demonstrated that the players exposed to 3-mins diaphragmatic breathing have better relieve from stress compared with players those who are not exposed. This recommends the short duration breathing exercise can be used to reduce the stress level of chess players during the competition in enhancing well-being and performance. However, there is no significant effect on heart rate. As diaphragmatic breathing exercise reduces the stress level it improves the performance by reducing the average blunders.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 21.05.2025
ACCEPTED: 26.11.2025

ORIGINAL ARTICLE

Hippotherapy as a form of supporting social and life activity in children with autism spectrum disorders

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ABSTRACT

Aim: The aim of this study was to make a preliminary assessment of the effectiveness of hippotherapy as a therapeutic method in improving the social and daily functioning of children with autism spectrum disorders. An important aspect of the study was also to determine the extent to which the duration of therapy influences therapeutic outcomes in selected areas. Although hippotherapy was developed in the second half of the 20th century, it meets modern medical standards in terms of both effectiveness and safety. The study also aimed to identify key factors influencing the effectiveness of this method and to present the therapeutic outcomes achieved. The ICF classification was used in the study as a universal research and diagnostic tool, which allowed for increased reproducibility of the results and emphasized the importance of using standardized questionnaires in evaluating the effects of hippotherapy.

Materials and Methods: The study involved 45 children diagnosed with autism spectrum disorder. A proprietary questionnaire was used, developed based on the criteria of the ICF classification, assessing selected mental functions as well as areas of activity and participation. The results were analyzed within three timeframes: up to 1 year of hippotherapy, from 1 to 2 years, and over 2 years.

Results: Preliminary findings indicate positive changes in activity and social participation, particularly in the group of children who underwent hippotherapy for more than two years.

Conclusion: Hippotherapy may be an effective supportive method in the therapy of children with autism spectrum disorders, with the duration of the therapy appearing to be a significant factor influencing therapeutic outcomes.

KEYWORDS: Autism Spectrum Disorder, Equine-Assisted Therapy, ICF (International Classification of Functioning), hippotherapy

Acta Balneol. 2026;68(1):26-34. doi: 10.36740/ABAL202601104

INTRODUCTION

Autism is a developmental disorder with an as yet unclear etiology, which complicates both the diagnostic and therapeutic processes. Today, autism is understood as a pervasive developmental disorder that lasts a lifetime, and its causes remain unknown. The symptoms of autism in children primarily include impairments in social interaction, verbal and non-verbal communication, and restricted activities and interests. Children with autism often do not reciprocate the emotions and behaviors typical of their neurotypical peers, tend to withdraw from social relationships, and retreat into their own world [1, 2].

Comprehensive therapeutic approaches are essential in the treatment of autism spectrum disorder. Among these, hippotherapy – a neurophysiological form of therapy involving a horse – plays an important supportive role. Due to its multifaceted effects, this therapy positively influences children's motor, psychological, sensory, and emotional functioning. By affecting bodily functions and structures, hippotherapy also contributes to increased activity and participation in everyday life, aligning with the modern biopsychosocial model of rehabilitation [3].

Conducting therapy in children during their developmental years presents limitations in terms of available therapeutic interventions but simultaneously offers greater regenerative and educational potential due to the plasticity of the developing organism. In children, conservative methods are most often used, based on natural forms of movement and stimulation. In the case of neurologically based disorders, it is crucial to apply techniques that support the development of the nervous system and its functions.

Children with autism spectrum disorder often participate in rehabilitation camps or special therapeutic day camps. These types of support can be considered alternative therapy methods, resembling a "resort" model – instead of short, regular visits to a therapist's office, the child spends several days or weeks in a new environment, fully engaged in intensive therapeutic, physical, and social activities. Constant presence in a therapeutically supportive environment enables not only systematic work on skill development but also the opportunity to learn how to adapt to new conditions and interact with other children on the spectrum.

Due to difficulties in maintaining attention and motivating children to engage in therapeutic activities, many methods incorporate elements of play, such as obstacle courses, water exercises, engaging equipment, music, and modified forms of popular games and activities. These approaches serve as a supplement to traditional therapies and aim to improve communication and social skills.

Hippotherapy, by leveraging the child's interaction with an animal, becomes an attractive form of therapy that fosters motivation and engagement. The presence of a horse, as a herd animal, can also play a therapeutic role – particu-

larly important for children with autism, who struggle with communication and social interaction. Contact with a horse can naturally stimulate these developmental areas [4–6].

AIM

The aim of this study was to make a preliminary assessment of the effectiveness of hippotherapy as a therapeutic method in improving the social and daily functioning of children with autism spectrum disorder. An important aspect of the study was also to determine the extent to which the duration of therapy influences therapeutic outcomes in selected areas. Although hippotherapy was developed in the second half of the 20th century, it meets modern medical standards in terms of both effectiveness and safety.

The study also aimed to identify key factors influencing the effectiveness of this method and to present the therapeutic outcomes achieved. The ICF classification was used as a universal research and diagnostic tool, which allowed for increased reproducibility of the results and emphasized the importance of standardized questionnaires in evaluating the effects of hippotherapy. Further research will allow for a more precise determination of the mechanisms of equine therapy and its impact on various aspects of the physical and mental health of therapy participants.

MATERIALS AND METHODS

The study involved 45 children aged 3 to 15 years, all diagnosed with autism spectrum disorder and participating in hippotherapy sessions. The study group included 35 boys and 10 girls, with a mean age of 8 years. The children were divided into three groups based on the duration of their participation in hippotherapy:

- Group I – children participating in hippotherapy for less than 1 year (n = 16),
- Group II – children participating in hippotherapy for 1 to 2 years (n = 10),
- Group III – children participating in hippotherapy for more than 2 years (n = 19).

The research was conducted in the following therapeutic centers:

- Fundacja Hipoterapia na Rzecz Rehabilitacji Dzieci Niepełnosprawnych in Kraków,
- Ognisko TKKF "Przyjaciel Konika" in Kraków,
- Hucul Horse Stud in Rzeszotary (Recreation and Equine Rehabilitation Center "TABUN"),
- Ośrodek Jazdy Konnej "Bór" in Toporzysko (Jordanów),
- Riding School "Tęcza" in Libiąż.

Hippotherapy sessions were typically conducted once a week and lasted approximately 30 minutes.

The research tool was a questionnaire developed based on the ICF and ICF-CY classifications. It was addressed to parents of children attending hippotherapy and consisted of two parts: 9 questions related to general data and 15 questions regarding the child's body functions, activities, and participation, in accordance with the ICF chapters.

The assessment covered the child's functioning prior to therapy and changes observed as a result of participation in hippotherapy, depending on therapy duration: up to 1 year, from 1 to 2 years, and more than 2 years [7].

SCOPE OF SOCIAL FUNCTIONING ASSESSMENT IN CHILDREN

The study focused on selected areas of social activity in children with autism spectrum disorder, in accordance with the ICF and ICF-CY classifications. The following domains were analyzed:

Communication: receiving spoken messages – assessing the child's ability to understand simple verbal instructions from parents, such as "we're going home" or "let's go for a walk."

General interpersonal interactions – evaluating emotional and behavioral regulation in social contacts and the ability to initiate physical contact with a parent during emotional situations (e.g., hugging during sadness).

Community life – assessing the child's level of participation in group games and activities in the presence of other children.

To evaluate the effects of hippotherapy, functions, activity, and participation were assessed using the ICF scale:

0 – No difficulty or impairment (none, absent, negligible) – 0–4%
1 – Mild difficulty or impairment (slight, small) – 5–24%
2 – Moderate difficulty or impairment (medium, considerable) – 25–49%
3 – Severe difficulty or impairment (great, strong) – 50–95%
4 – Complete difficulty or impairment (total) – 96–100%
8 – Not specified
9 – Not applicable

RESULTS

The data presented in Figure 1 indicate that 56% of the children showed improvement in communication, specifically in understanding spoken messages, as a result of participating in hippotherapy, regardless of its duration. No significant changes were observed in this area in 44% of the children.

The data presented in Figure 2 show that in the first group of 16 children, hippotherapy had a positive impact on 13 children (29% of the total number of participants) in their ability to understand spoken messages. The most significant progress was observed in 4 children whose difficulties improved from severe to slight. Moreover, one child showed improvement from slight difficulties to none. Another child improved from severe to moderate difficulties, and one from severe to significant difficulties. Two children improved from significant to slight difficulties. Additionally, one child improved from significant to moderate difficulties, and three children showed a reduction in difficulties from moderate to slight.

The data in Figure 3 indicate that in the second group of 10 children, hippotherapy had a positive impact on 4 children (9% of the total sample). The most significant improvement was observed in one child whose difficulties were reduced from severe to slight. One child showed

improvement from slight difficulties to none. Another improved from significant to slight difficulties, and one from moderate to slight difficulties.

According to the data in Figure 4, in the third group of 19 children, hippotherapy had a positive impact on 8 children (18% of the total sample). The greatest improvement was observed in one child who improved from severe difficulties to no difficulties. Another child improved from moderate to no difficulties. One child improved from severe to slight difficulties. One child progressed from significant to moderate difficulties, while four others improved from moderate to slight difficulties.

In summary, the analyses indicate that the most substantial positive changes in understanding spoken messages were observed in the group of children participating in therapy for up to 1 year, accounting for 29% of the total group.

The data in Figure 5 show that 80% of the children exhibited improvement in behavioral control in mutual interactions following hippotherapy, regardless of its duration. The remaining 20% showed no changes in this area.

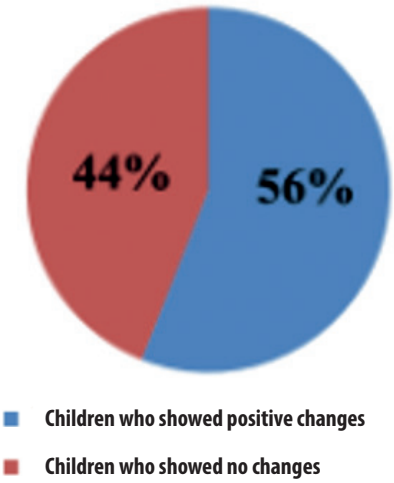


Fig. 1. Percentage distribution of changes in communication – understanding spoken messages observed in children after starting hippotherapy, regardless of therapy duration.

Source: Own materials

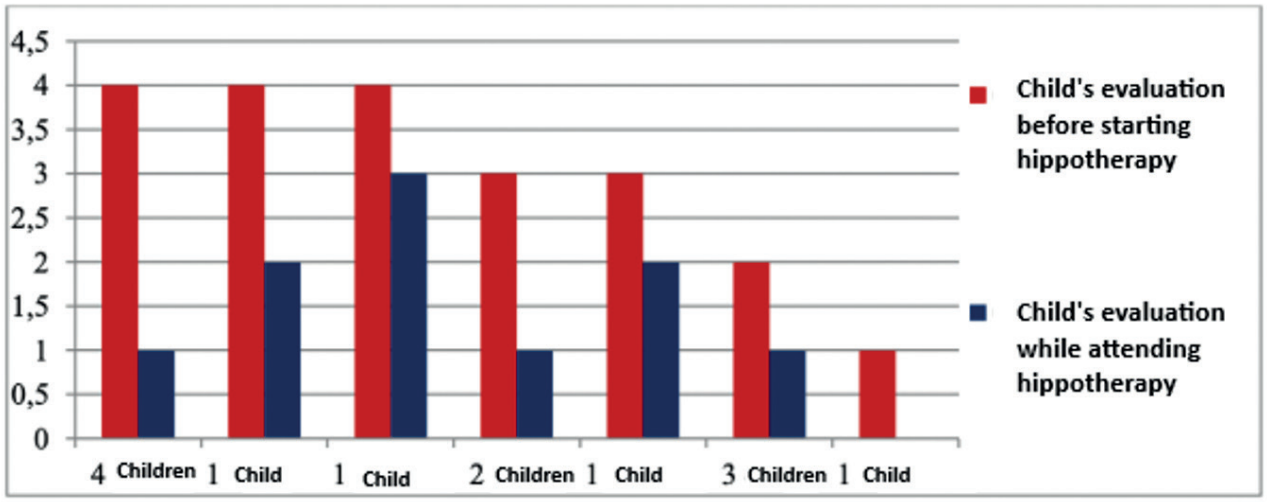


Fig. 2. Changes in the category of communication – understanding spoken messages, expressed on the ICF scale in children before starting hippotherapy compared to those attending hippotherapy for one year or less.

Source: Own materials

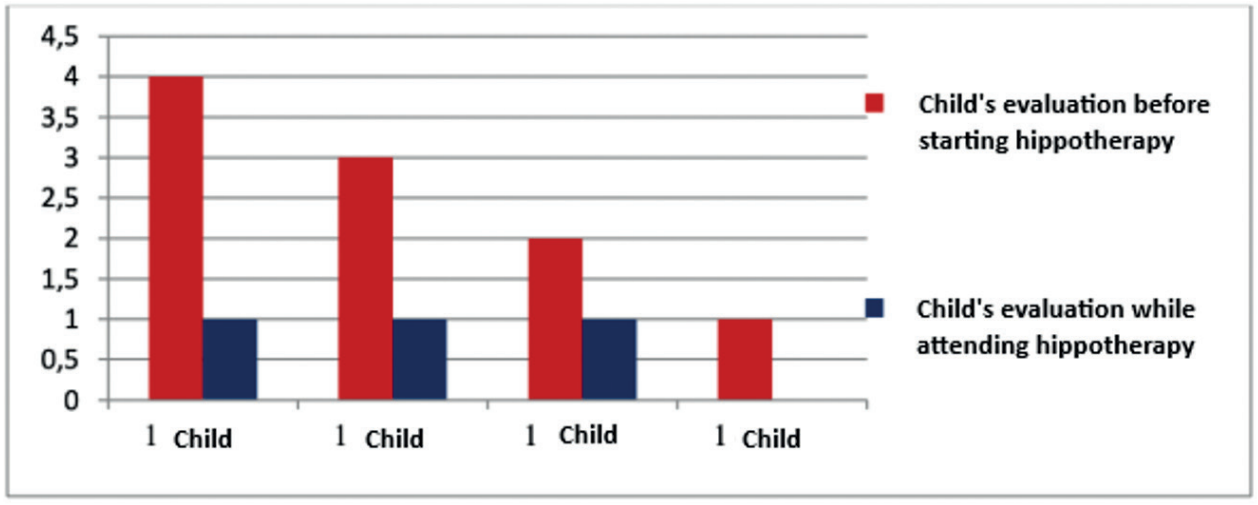


Fig. 3. Changes in the category of communication – understanding spoken messages, expressed on the ICF scale in children before starting hippotherapy compared to those attending hippotherapy for more than one year up to two years.

Source: Own materials

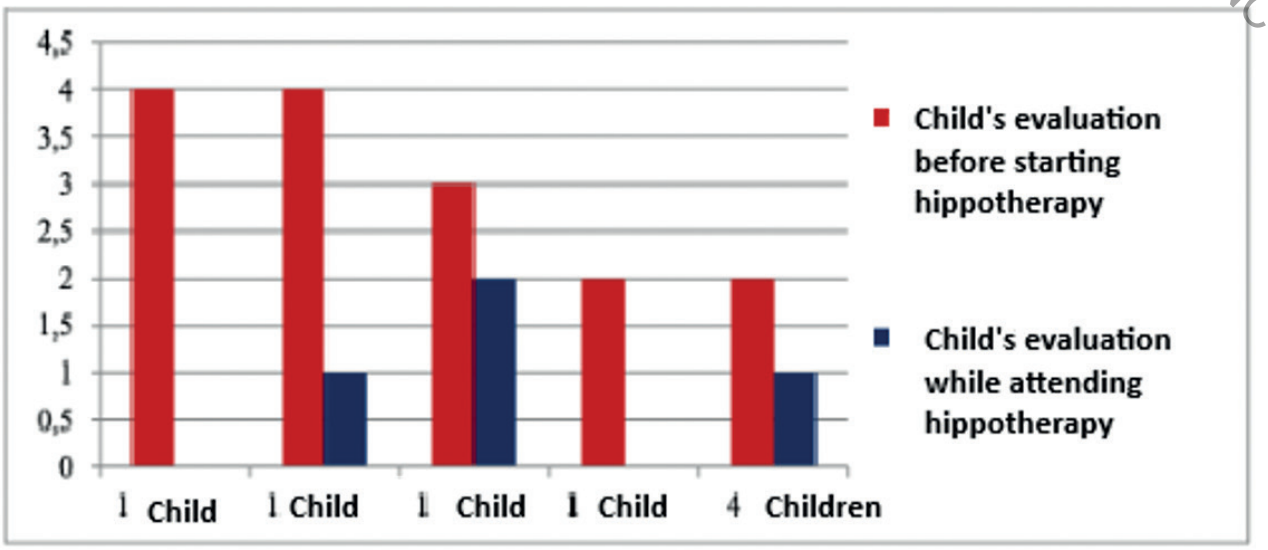
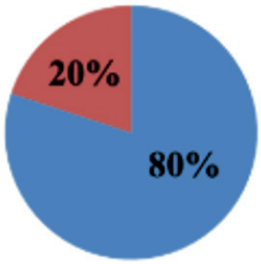


Fig. 4. Changes in the category of communication – understanding spoken messages, expressed on the ICF scale in children before starting hippotherapy compared to those attending hippotherapy for more than two years.

Source: Own materials



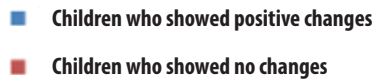


Fig. 5. Percentage distribution of changes in behavioral control in mutual interactions observed in children after starting hippotherapy, regardless of therapy duration.

Source: Own materials

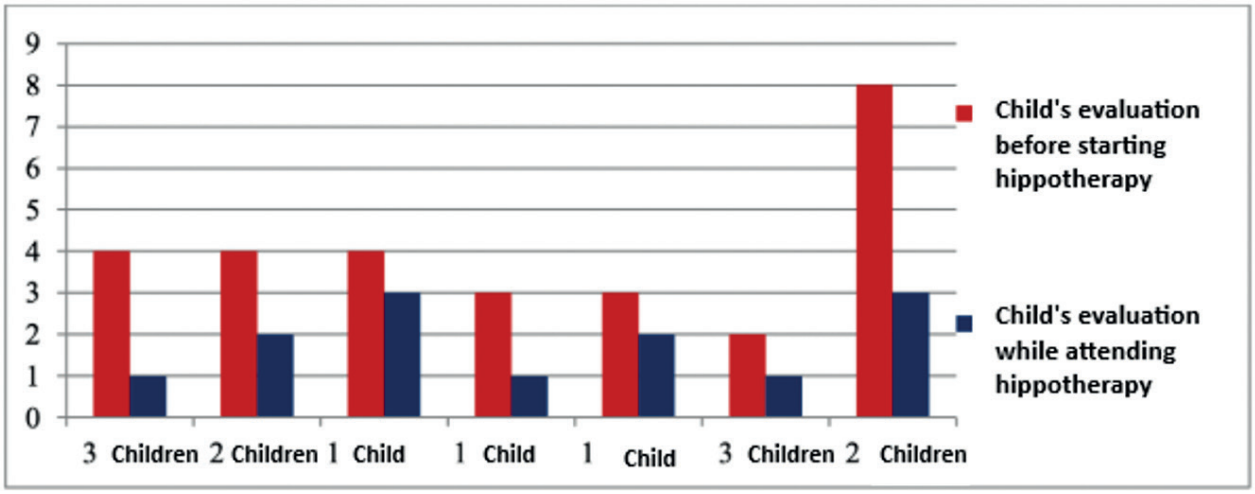


Fig. 6. Changes in the category of behavioral control in mutual interactions, expressed on the ICF scale in children before starting hippotherapy compared to those attending for one year or less.

Source: Own materials

According to Figure 6, among the 16 children in the first group, 13 (29% of all study participants) experienced positive effects of hippotherapy on behavioral control. The greatest improvement occurred in three children whose difficulties decreased from severe to slight. Two children improved from severe to moderate, one from severe to significant, one from significant to slight, and one from significant to moderate. Three children improved from moderate to slight difficulties, and two children showed a change from an unspecified level to significant difficulties.

As shown in Figure 7, of the 10 children in the second group, 8 (18% of the total participants) demonstrated improvement. One child improved from severe to slight difficulties, another from severe to significant, and one from significant to moderate. Five children improved from moderate to slight difficulties.

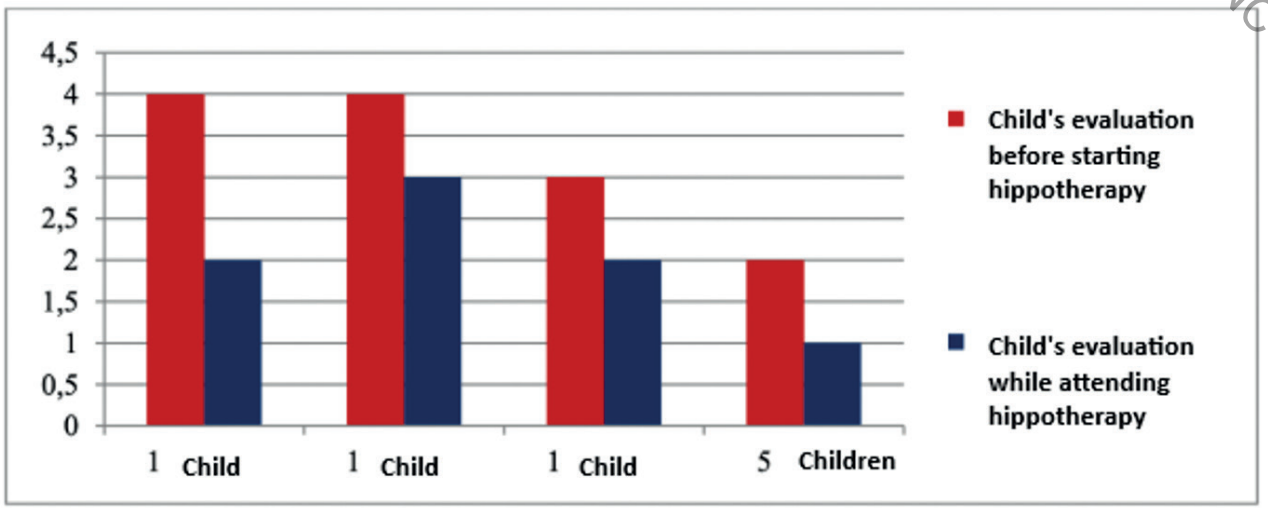


Fig. 7. Changes in the category of behavioral control in mutual interactions, expressed on the ICF scale in children before starting hippotherapy compared to those attending for more than one year up to two years.
Source: Own materials

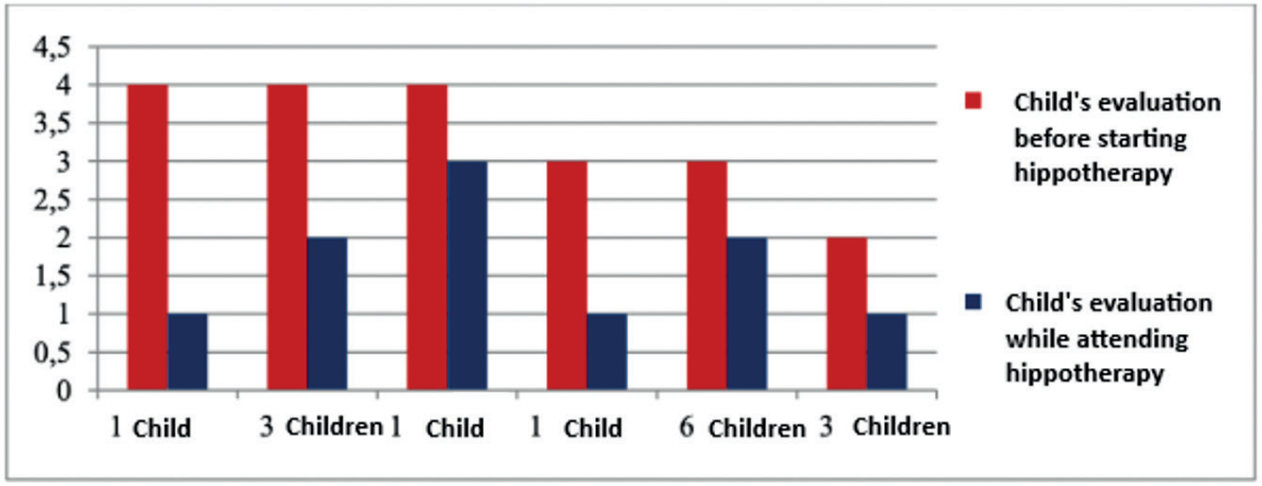


Fig. 8. Changes in the category of behavioral control in mutual interactions, expressed on the ICF scale in children before starting hippotherapy compared to those attending for more than two years.
Source: Own materials

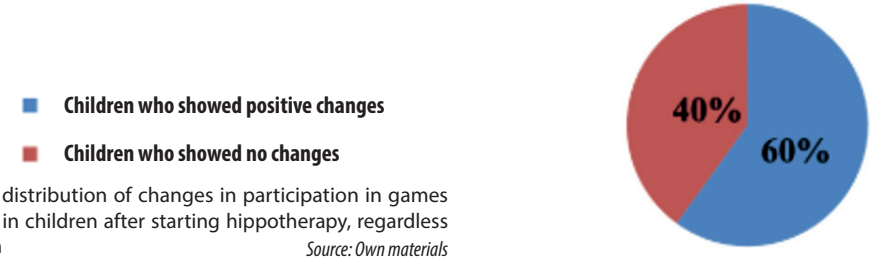


Fig. 9. Percentage distribution of changes in participation in games and play observed in children after starting hippotherapy, regardless of therapy duration
Source: Own materials

According to Figure 8, among the 19 children in the third group, 15 (33% of the total participants) showed improvement. One child progressed from severe to slight difficulties, and one from significant to none. Three children improved from severe to moderate, and one from severe to significant. Six children improved from significant to moderate, while three others improved from moderate to slight.

In summary, the greatest improvements in behavioral control were observed in the group attending hippotherapy for more than two years, accounting for 33% of the total participants.

The data presented in Figure 9 indicate that 60% of the children demonstrated improvement in participation in games and play following hippotherapy, regardless of its duration. No significant changes were observed in this area in the remaining 40%.

As shown in Figure 10, out of 16 children in the first group, 12 (27% of all participants) demonstrated improvement in participation in games and play. The greatest

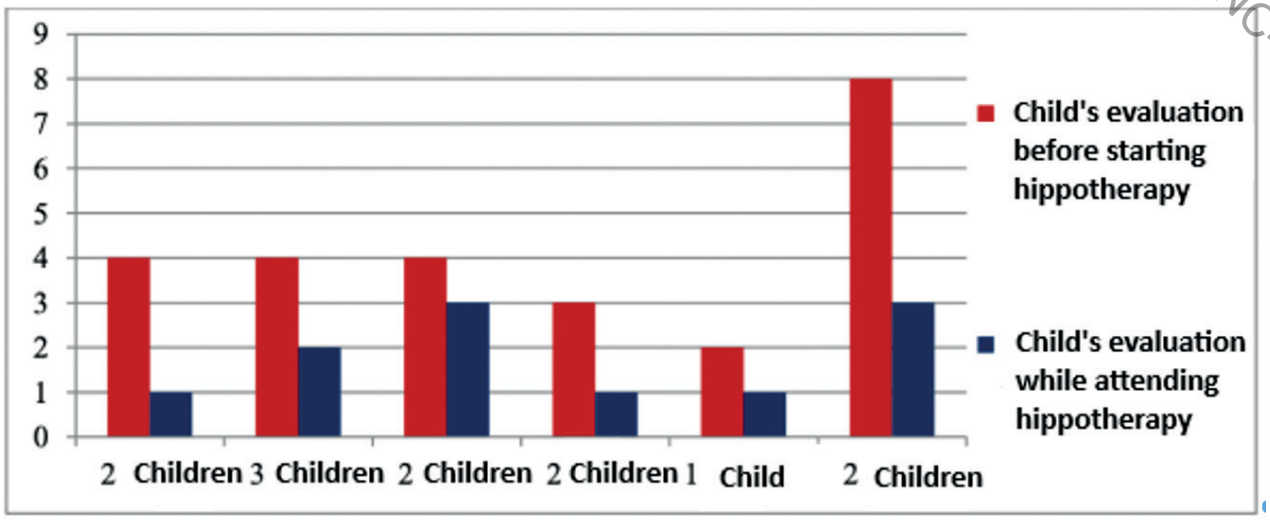


Fig. 10. Changes in the category of participation in games and play, expressed on the ICF scale in children before starting hippotherapy compared to those attending for one year or less.

Source: Own materials

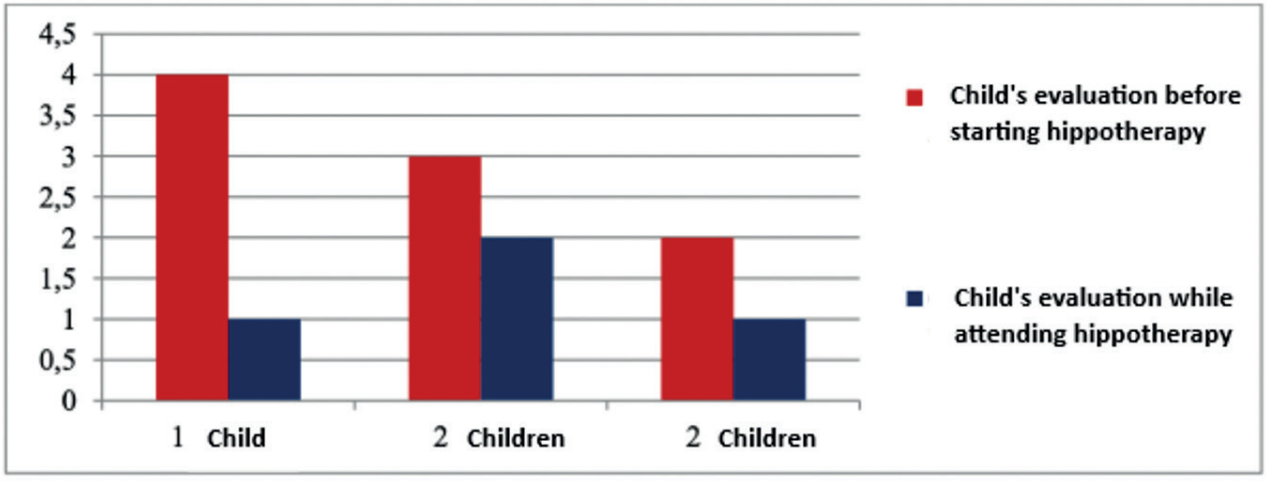


Fig. 11. Changes in the category of participation in games and play, expressed on the ICF scale in children before starting hippotherapy compared to those attending hippotherapy for more than one year up to two years.

Source: Own materials

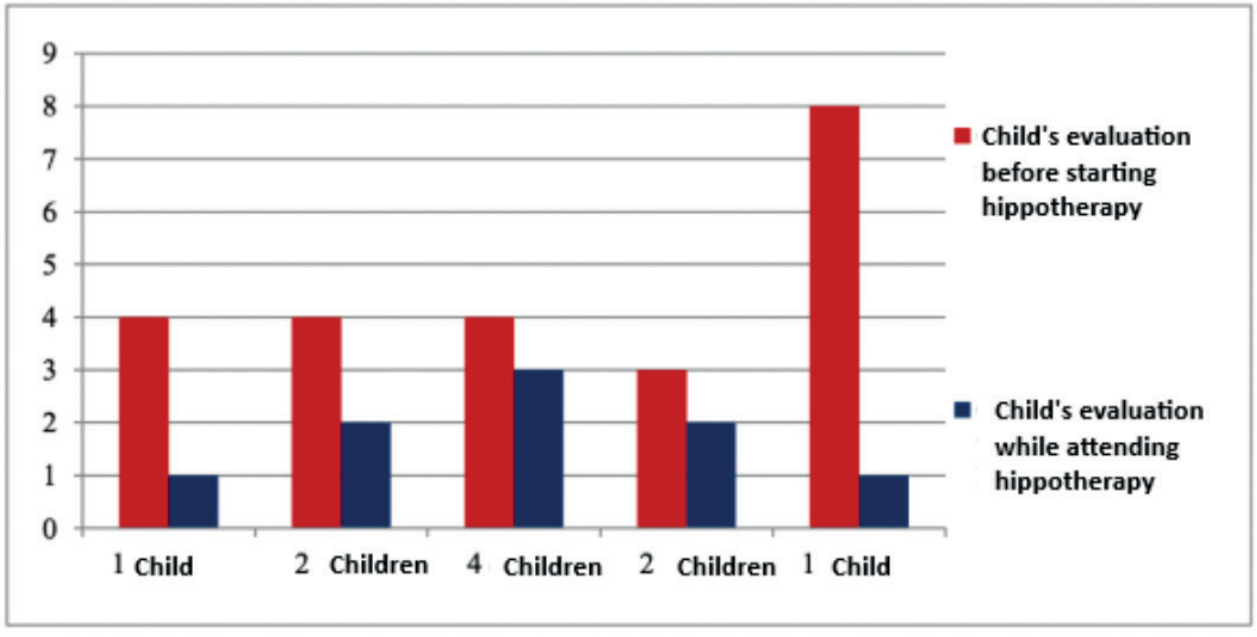


Fig. 12. Changes in the category of participation in games and play, expressed on the ICF scale in children before starting hippotherapy compared to those attending hippotherapy for more than two years.

Source: Own materials

progress was observed in two children who improved from severe to slight difficulties. Three children improved from severe to moderate, and two from severe to significant. Two others improved from significant to slight, and one from moderate to slight difficulties. Additionally, two children moved from an unspecified difficulty level to moderate.

The data presented in Figure 11 indicate that among the 10 children in the second group, 5 (11% of all participants) showed a positive impact of hippotherapy on participation in games and play. The greatest improvement was observed in one child who improved from severe to slight difficulties. Two participants improved from significant to moderate difficulties, and two children from moderate to slight difficulties.

The data presented in Figure 12 indicate that among the 19 children in the third group, 10 (22% of all participants) experienced a positive effect of hippotherapy on participation in games and play. The greatest improvement was observed in one child who progressed from severe to slight difficulties. Two children improved from severe to moderate, four from severe to significant, two from significant to moderate, and one from an unspecified level to slight difficulty.

DISCUSSION

Autism, as a clinical condition, poses challenges in terms of its etiology and therapeutic approach. Early diagnosis increases the chances of improving the patient's quality of life, but only if appropriate therapy is implemented. A holistic approach and interdisciplinary collaboration between specialists from various fields are also of great importance to ensure that the patient receives comprehensive care.

Currently, there are numerous treatment approaches aimed at reducing symptoms and improving the functioning of individuals with autism. Early behavioral intervention in young children, implemented immediately after diagnosis, plays a particularly important role. Such interventions have a positive impact on speech development, cognitive functions, and the development of social skills [8]. The medical literature emphasizes the necessity of a comprehensive therapeutic approach; thus, the use of various treatment methods is recommended [9]. To enhance standard therapeutic practices, alternative methods are also applied, the effectiveness of which is increasingly supported by scientific research. One such approach is animal-assisted therapy, which has shown beneficial effects in neurological disorders [10].

Hippotherapy, in particular, has yielded promising results, especially in children with autism, highlighting the need for further research in this area [11]. As a form of rehabilitation, hippotherapy has a positive impact on emotional, social, and motor functioning [12]. Animal-assisted therapies also contribute to improved psychological well-being, for example by enhancing self-esteem, which has been observed in individuals with cerebral palsy (CP), as well as in other groups facing motor and social limitations, such as individuals with Down syndrome, developmental delays, or older adults [13].

Hippotherapy is used in both children and adults. The most common disorders for which it is chosen as a therapeutic method are cerebral palsy and autism. It influences sensory functions, coordination, and balance, thereby affecting both motor and psychological aspects. Hippotherapy involves several interacting factors, which makes it difficult to isolate specific mechanisms of its action. The presence of and contact with the horse, its temperament and disposition, and its influence on the individual play a significant role. The physical and psychological effects of contact with the horse depend largely on the patient's characteristics; therefore, appropriate selection of both the animal and the therapist is essential. The mechanics of the horse's movement and its influence on the rider must also be considered. Imitation of the horse's movement is often used in other therapeutic methods and exercises, attempting to replicate its positive effects on the human muscular and nervous systems. It is important to consider the essence of the therapy, which involves the use of another living organism. It should be noted that it is impossible to perfectly recreate the conditions of each hippotherapy session or to introduce strictly standardized parameters. The horse, as a living being, cannot be programmed like a machine, which complicates research methodology. As in other fields, one must also consider the subjectivity and influence of the individuals conducting the therapy. However, what constitutes a challenge in research may also be an advantage in therapy, as the influence of another living being can have a positive impact on the patient. Contact with the horse is also utilized in animal-assisted psychotherapy, which can be considered a branch of hippotherapy. The essence of hippotherapy combines elements of movement therapy using horseback riding and psychotherapy initiated through contact with an animal. It is crucial to consider the influence of the animal on a developing individual. Contact with an animal under the supervision of trained caregivers teaches the child empathy and responsibility and stimulates important areas of the developing brain. For a child in a world that often seems not to understand them, contact with an animal can have significant therapeutic value, helping the child express emotions beyond purely verbal communication [4,14–16].

Despite the positive effects of hippotherapy in various disorders, including autism spectrum disorder, there are still relatively few publications confirming its effectiveness in autism. The nature of autism itself complicates the conduct of such studies and the establishment of an optimal comparison group for research purposes. Current therapies are complementary, and despite promising therapeutic outcomes associated with hippotherapy, it should not be implemented as the sole method of treatment. Further research is needed to determine the precise role and significance of this therapeutic method in autism [16].

This paper refers to the recommendations and standards of the ICF from a diagnostic perspective, which provide a standardized method accessible to all specia-

lists. However, it must be acknowledged that, like any questionnaire-based study, there is an increased risk of error and results that depend on the person conducting the assessment. Therefore, the ICF diagnostic method can be considered a useful screening and preliminary assessment tool, as well as a means of facilitating communication between members of interdisciplinary teams.

Hippotherapy brings positive therapeutic effects in various neurological disorders; however, it should be implemented with consideration of potential contraindications and limitations, such as allergies to horse hair, fear of horses, limited availability due to geographic location, and high therapy costs.

CONCLUSIONS

Hippotherapy has a positive effect on improving various aspects of functioning in children with autism spectrum disorder, including communication (particularly in the reception of spoken messages), behavior control, participation in games and play, as well as selected psychological functions such as sustained and divided attention, emotion regulation, and perceptual functions (auditory and visual-spatial perception). Most children showed significant improvement after beginning the therapy. Among the studied functions, emotion regulation and visual-spatial perception showed the greatest changes under the influence of hippotherapy.

The most notable positive changes in communication, behavior control, and participation in games and play were observed in children who participated in hippotherapy for up to one year. This suggests that children may benefit the most during the initial phase of therapy, and that hippotherapy appears to be particularly effective in the early stages of treatment.

The duration of hippotherapy differentiates the results obtained in the assessment of functions, activities, and participation using the ICF scale. Although improvements were also observed in children who participated in therapy for one to two years and more than two years, the changes in the main social domains were generally less pronounced compared to the first year of therapy.

At the same time, during hippotherapy lasting more than two years, changes were observed in areas such as divided attention, visual-spatial perception, emotion regulation, reception of messages, communication, non-verbal message creation, and control of behaviors in interpersonal interactions. This suggests significant potential for improvement and achieving positive therapeutic effects depending on the continuity of this form of therapy in the long term.

The research results highlight the value of hippotherapy as an effective supportive method in the development and therapy of children with autism spectrum disorder. Further research is recommended to better determine the optimal duration of therapy and its impact on various aspects of child development.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 07.05.2025
ACCEPTED: 14.01.2026

ORIGINAL ARTICLE

Correlation between diastasis recti abdominis (DRA) and pelvic floor muscle dysfunction (PFMD) in women with a history of at least one childbirth

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ABSTRACT

Aim: The aim of this study was to assess the correlation between diastasis recti abdominis (DRA) and pelvic floor muscle dysfunction (PFMD) in women with a history of at least one vaginal childbirth.

Materials and Methods: The study involved 165 women aged 22–47 years who had undergone at least one vaginal delivery. Participants were divided into two groups based on the presence or absence of palpable DRA (≥2 finger-widths). Data were collected via clinical interviews, physical assessments (including palpation of the linea alba and breathing patterns), and functional testing. Statistical analysis was conducted using the Spearman correlation test.

Results: No significant correlation was found between the presence of DRA and the number of reported pelvic floor dysfunction symptoms. However, higher BMI and greater parity were positively associated with an increased number of PFMD symptoms. A shift toward less dynamic forms of physical activity was observed postpartum. Additionally, 18% of women diagnosed with DRA or PFMD did not seek any form of treatment.

Conclusion: Although DRA and PFMD may occur independently, a holistic therapeutic and preventive approach remains valuable, especially in older populations. Clear interdisciplinary guidelines and consistent patient education are essential. Emphasizing early prevention, healthy daily habits, and accessible physiotherapy may reduce the long-term impact of these dysfunctions.

KEYWORDS: childbirth, diastasis recti abdominis, pelvic floor disorders, body mass index, parity

Acta Balneol. 2026;68(1):35-41. doi: 10.36740/ABAL202601105

INTRODUCTION

The female body undergoes numerous physiological changes during pregnancy and childbirth. During pregnancy, alterations in body posture and a shift in the center of gravity occur, accompanied by an increase in anterior pelvic tilt and lumbar lordosis. These adaptations result in a characteristic gait and increased loading of the lumbar spine. The pelvic floor muscles, which support the pelvic organs in place, experience significant strain. The uterus grows, and with it the entire abdomen, and the internal organs are compressed. As the abdomen grows, not only the muscles stretch, but also the linea alba – a fibrous structure extending from the pubic symphysis to the xiphoid process. During the pelvic floor muscles are subjected to substantial overload, and depending on the course of labor, perineal trauma such as episiotomy or spontaneous tearing may occur [1].

Pelvic floor muscle disorders have a huge impact on the lives of patients. First of all, their dysfunctions can cause lowering or even prolapse of the pelvic organs. Weakened or excessively tense, they cause urinary and/or fecal incontinence. They affect sexual sensations – their absence or pain during intercourse. Diastasis recti abdominis (DRA) – the separation of the rectus abdominis muscle – is considered physiological to a certain extent. A separation width of approximately two fingers (around 2 cm) is generally regarded as the clinical threshold. Excessive separation may lead to abdominal wall herniation, weakening of the muscle corset, and compromised posture and spinal support [2]. DRA persists beyond the postpartum period in approximately 36% of women, while pelvic floor-related complaints such as urinary incontinence affect about 31% of postpartum women [3]. Physical activity, both antepartum and postpartum, plays a crucial role in the development and resolution of these conditions. However, appropriate exercise selection and intensity require awareness of physiological changes and adherence to clinical guidelines. Despite this, studies show that only around 50% of postpartum women have ever engaged in pelvic floor muscle training [4].

Pelvic floor dysfunction is defined as impaired function of the pelvic floor muscles and associated structures, and it can severely affect a woman's quality of life. Clinical manifestations include urinary incontinence (stress, urge, or mixed), fecal incontinence, pelvic organ prolapse, sexual dysfunction, pelvic girdle pain, and chronic pelvic pain syndromes [5]. According to the Interna-

tional Continence Society (ICS), urinary incontinence is defined as „non-voluntary leakage of urine that is a social or hygienic problem" [6]. The ICS classifies urinary incontinence as follows [7]:

- stress- urinary incontinence – leakage of urine during physical exertion, sneezing, coughing,
- urge urinary incontinence – leakage of urine preceded by a feeling of urgency (sudden, uncontrollable need to urinate),
- mixed urinary incontinence – involuntary leakage associated with both exertion and urgency.

Pelvic organ prolapse refers to the descent of pelvic organs due to weakening or damage to the supportive structures of the pelvic floor. Organs potentially involved include:

- the vagina,
- the uterus – which may descend partially or entirely into the vaginal canal and potentially drag the bladder downward,
- the rectum – which may prolapse through the anal canal, with either only mucosal or full-thickness involvement.

In the case of sexual disorders, the most common symptoms may present: reduced sensation of intimate areas, pain during intercourse, inability to engage in intercourse, a feeling of "looseness" or heaviness in the vagina, weak or no sexual sensations (lack of orgasm). Other, often less recognized consequences of weakened or increased tension of the pelvic floor muscles may include: back pain, especially in the lumbar section, menstrual disorders, pain in the pelvis and hip joints, or unexplained pain in the lower abdomen [8].

Diastasis recti abdominis (DRA) is a condition characterized by the separation of the left and right rectus abdominis muscles, accompanied by widening of the linea alba and anterior abdominal wall bulging. While DRA may predispose to herniation, it is not considered a hernia itself. It affects both women and men. In women, it is most often associated with pregnancy. Nearly all pregnant women experience some degree of separation, typically beginning around the 35th week of gestation. This is thought to be an adaptive mechanism that facilitates expansion of the anterior abdominal wall to accommodate the growing uterus. DRA is present in 27% of women in the second trimester, 66% in the third trimester, and 53% immediately postpartum, with persistent separation in 36% beyond the postpartum period [9].

Risk factors and contributing causes of DRA include: obesity, weak or overly tense abdominal musculature, multiparity, maternal age >35 years, polyhydramnios, macrosomia, short interpregnancy interval, inappropriate physical training, poor posture, improper body mechanics, straining during defecation, lifting heavy objects, and genetic predisposition. While DRA is common after childbirth and may be perceived as inevitable due to mechanical strain from the growing fetus, it is also influenced by tissue quality and long-term postural and functional habits. Many contributing factors are associated not only with abdominal distension but also with elevated intra-abdominal pressure and imbalanced abdominal muscle tension [10].

AIM

The aim of this study was to assess the correlation between diastasis recti abdominis (DRA) and pelvic floor muscle dysfunction (PFMD) in women following at least one vaginal childbirth.

MATERIALS AND METHODS

The study included a group of 165 women who had given birth 1-6 times. The age of the subjects ranged from 22 to 47 years, with an average age of 34.47 ± 4.83 years. The participants ranged in height from 152 to 187 cm (mean: 168.34 ± 5.84 cm) and weighed 44 to 104 kilograms with an average of 67.05 ± 11.94 kg. Their BMI was 16.92 to 35.93 m2/kg with an average of 23.63 ± 3.85 m2/kg. The patients were divided into two groups:

- women who palpated rectus abdominis muscle separation measuring at least 2 fingers in width in at least one of the three examined locations: above the pubic symphysis, around the umbilicus, below the xiphoid process – 87 participants,
- women who did not palpate rectus abdominis muscle separation or it was narrower than 2 fingers in width in all three examined locations: above the pubic symphysis, around the umbilicus, below the xiphoid process – 78 participants.

The clinical interview included questions on: number and course of deliveries; self-reported pelvic floor dysfunctions; type and frequency of physical activity both before and after pregnancy; daily lifestyle habits; and self-declared knowledge concerning rectus abdominis muscle separation and pelvic floor dysfunctions (e.g., awareness of their nature, exercise strategies, and information sources). The treatment history was also recorded.

The following functional tests were performed:

- Pelvic stabilization assessment – lower limb elevation test. The participant was asked to elevate the lower limb with flexion at the hip and knee joints to a low height. The test was performed twice for each limb. Pelvic rotation and asymmetry were assessed. A positive test indicated signs of altered lumbopelvic stabilization and possible anterior abdominal wall weakness.
- Breathing assessment in a corrected sitting position. The participant assumed a relaxed seated posture. The therapist then guided her into a corrected position: pelvis in neutral, spine aligned, shoulders relaxed, head corrected. The test was considered positive if the participant experienced any difficulty breathing in the corrected position, indicating possible imbalance in soft tissue tension (including diaphragm, abdominal, spinal, and pelvic floor muscles).
- Breathing assessment in a supine position. The participant breathed freely while lying on her back. The breathing pattern was observed: upper thoracic, lower rib, or abdominal.
- Linea alba under tension assessment. In the supine position, with knees bent, the participant was instructed to lift the upper body as in a partial abdominal crunch. Palpation was conducted along the linea alba from the

xiphoid process to the pubic symphysis, with emphasis on three points: just below the xiphoid process, at the umbilicus, and approximately 3 cm below it.

Microsoft Excel from Microsoft Office 2020 and Statistica v. 13.1. (Statsoft, Poland) were used for statistical analysis of the results. The Shapiro-Wilk normality test was applied to assess the normality of the distribution. As the data did not follow a normal distribution, the Spearman rank correlation test was used. The strength of the correlation was interpreted according to the following guidelines: $|rs|<0.2$ – no linear relationship; $0.2\leq|rs|<0.4$ – weak correlation; $0.4\leq|rs|<0.7$ – moderate correlation; $0.7\leq|rs|<0.9$ – strong correlation; $|rs|\geq0.9$ – very strong correlation. The significance level p-value = 0.05 was assumed.

RESULTS

In the breathing pattern assessment, it was observed that 63 women (38.2%) used abdominal breathing, 62 (37.6%) demonstrated upper rib breathing, and 40 (24.2%) exhibited lower rib breathing.

Regarding the course of vaginal delivery, 87 women (52.7%) reported having an episiotomy, and 21 (12.7%) experienced a perineal tear. Labor was induced in 18 participants (10.9%), and instrumental delivery (forceps or vacuum) was used in 8 participants (4.8%). A total of 39 women (23.6%) reported no complications during labor. Additionally, 55 women (33.3%) experienced two complications, 18 (10.9%) experienced three, and 2 (1.2%) experienced four.

Reported pelvic floor and pelvic region disorders included: lumbar back pain – 89 (53.9%), urinary incontinence – 69 (42.8%), hemorrhoids – 57 (34.5%), reduced or absent sexual sensation/orgasm – 50 (30.3%), painful menstruation – 42 (25.5%), urgency – 36 (21.8%), dyspareunia – 35 (21.2%), pelvic organ prolapse – 28 (17%), pelvic pain – 25 (15.2%), other (e.g., endometriosis, umbilical pain) – 11 (6.7%), absent or irregular menstruation – 7 (4.2%), and fecal incontinence – 2 (1%). Only one symptom was reported by 29 women (17.6%), whereas 120 (72.7%) reported two or more co-occurring complaints.

Before pregnancy, physical activity frequency was as follows: 43 women (26.1%) did not exercise, 16 (9.7%) exercised occasionally (<1/week), 46 (27.9%) 1-2 times/week, 43 (26.1%) 3-4 times/week, 15 (9.1%) 5-6 times/week, and 2 (1.2%) daily. After childbirth, 41 women (24.8%) did not exercise, 22 (13.3%) exercised occasionally, 48 (29.1%) 1-2 times/week, 39 (23.6%) 3-4 times/week, 13 (7.9%) 5-6 times/week, and 2 (1.2%) daily.

Changes in exercise frequency included: a 1.2% decrease in those not exercising, a 3.6% increase in occasional exercisers, a 1.2% increase in the 1-2 times/week group, a 2.4% decrease in the 3-4 times/week group, a 1.2% decrease in the 5-6 times/week group, and no change in the daily group.

Exercise frequency remained unchanged in 69 women (41.8%), decreased in 50 (30.3%), and increased in 46 (27.9%).

Before pregnancy, the most commonly practiced sport was aerobics/cardio (57 women, 34.6%), followed by cycling/rollerblading – 48 (29.1%), long walks – 38 (23%), running – 36 (21.8%), yoga/Pilates – 27 (16.4%), swimming – 27 (16.4%), gym training – 23 (13.9%), pelvic floor/deep muscle training – 13 (7.9%), team sports – 7 (4.2%), tennis/squash – 6 (3.6%), Nordic walking – 5 (3%), martial arts – 2 (1.2%), trampoline classes – 2 (1.2%), and CrossFit, pole fitness, skiing – 1 each (0.6%).

After childbirth, aerobics/cardio remained most popular (47 responses, 28.5%), followed by long walks – 37 (22.4%), deep muscle/pelvic floor exercises – 28 (17%), yoga/Pilates – 28 (17%), cycling/rollerblading – 28 (17%), gym – 23 (13.9%), running – 18 (10.9%), swimming – 10 (6%), postnatal exercises – 8 (4.8%), Nordic walking – 6 (3.6%), horse riding, PelviFly, trampoline classes – 2 (1.2%) each. Pole fitness, skiing, team sports, and martial arts were reported by 0.6% each.

Reasons for discontinuing exercise included: lack of time – 99 (60%), concern about abdominal muscle separation – 23 (13.9%), concern about pelvic floor weakness – 16 (9.7%), and other reasons (e.g., lack of motivation, back pain) – 9 (5.5%).

99 women (60%) reported rolling to the side and pushing up, 48 (29.1%) performed a forward sit-up, 16 (9.7%) used momentum with leg lifting, and 2 (1.2%) turned onto their stomach and rose from a quadruped position.

Sneezing responses included: slight forward bend – 57 (34.5%), twisting the torso – 46 (27.9%), holding the nose – 41 (24.8%), crossing the legs – 18 (10.9%), and other conscious actions (e.g., pelvic floor muscle activation) – 3 (1.8%).

Toilet posture during defecation: foot position: toes on floor with heels elevated – 61 (37%), feet on a platform – 60 (36.4%), feet flat on the floor – 44 (26.7%); torso position: slightly leaned with rounded back – 133 (80.6%), upright – 17 (10.3%), significantly leaned forward with compressed abdomen – 15 (9.1%).

Infant-carrying methods included: resting child on the abdomen/hip with trunk tilt – 140 (84.8%), using a sling/carrier – 61 (37%), carrying with proper posture using arm strength – 37 (22.4%), high shoulder hold – 21 (12.7%), and front-facing carrier – 3 (1.8%).

The most frequently used postnatal abdominal exercises were: front plank – 58 (35.2%), standard crunches – 30 (18.2%), oblique crunches – 22 (13.3%), other exercises (e.g., balance, ball, resistance band) – 19 (11.5%), and side plank – 16 (9.7%). A total of 20 women (12.1%) did not engage in abdominal exercises post-delivery.

Awareness of rectus abdominis separation prior to pregnancy was split: 83 women (50.3%) were unaware, while 82 (49.7%) were aware.

Regarding pelvic floor therapy, 95 women undertook no treatment. Of these, 65 (39.4%) did not perceive a need, while 30 (18.2%) acknowledged the need but did not pursue therapy. Among those who sought evaluation, 49 (29.7%) were assessed by a pelvic floor physiotherapist, 4 (2.4%) by a physician, 4 (2.4%) by another specialist, and 1 (0.6%) self-diagnosed using online resources. In 2 cases (1.2%), physiotherapists referred the patient to another specialist; in 1 case (0.6%), a physician referred the patient to a physiotherapist.

Pelvic floor therapy was conducted exclusively by a physiotherapist in 34 cases (20.6%), by a doctor/other specialist in 4 (2.4%), with home devices only (e.g., PelviFly, PeriFit) in 2 (1.2%), and through multidisciplinary cooperation in 1 case (0.6%).

For rectus abdominis separation therapy, 96 women did not pursue any intervention; 66 (40%) saw no need, and 30 (18.2%) did not act despite perceiving a need. Among those who pursued assessment, 37 (22.4%) were evaluated by a pelvic physiotherapist, 9 (5.5%) by another specialist, 5 (3%) by a doctor, and 2 (1.2%) self-diagnosed via online platforms. Four women (2.4%) were referred to a physiotherapist by a physician, and three (1.8%) to another specialist. No physiotherapists referred patients to doctors.

Therapy was conducted exclusively by a physiotherapist in 33 cases (20%), by a doctor/other specialist in 5 (3%), and through multidisciplinary cooperation in 2 (1.2%).

The test for rectus abdominis separation was considered positive when the inter-rectus distance at any of the three tested locations was at least two finger-widths. Based on this criterion, 87 women (53.7%) had a positive result, and 78 (47.3%) either had no separation or less than two finger-widths at all three sites (Table 1).

Based on the Spearman test, a correlation was shown between (Table 2.):

- BMI and the number of pelvic floor muscle dysfunctions – with an increase in BMI, the number of pelvic floor muscle dysfunctions increases;
- the number of deliveries and the number of pelvic floor muscle dysfunctions – with an increase in the number of deliveries, the number of pelvic floor muscle dysfunctions increases

DISCUSSION

Based on the results of this study, the main hypothesis – assuming a correlation between DRA and pelvic floor muscle dysfunctions in women following at least one childbirth – was rejected.

This finding is consistent with the results of a study by K. Bø [11], who conducted a longitudinal assessment at 6 weeks, 6 months, and 12 months postpartum in a cohort of 179 women. Similar conclusions were drawn

Table 1. Analysis of the test for separation of the rectus abdominis muscle.

Distance between the bands of the rectus abdominis muscle	Above the pubic symphysis	Around the navel	Under the sternum
0	89 (53,9%)	42 (25,5%)	81 (49,1%)
0,5	4 (2,4%)	3 (1,8%)	4 (2,4%)
1	45 (27,3%)	31 (18,8%)	44 (26,7%)
1,5	2 (1,2%)	8 (4,8%)	4 (2,4%)
2	18 (10,9%)	52 (31,5%)	26 (15,8%)
2,5	1 (0,6%)	8 (4,8%)	1 (0,6%)
3	4 (2,4%)	17 (10,3%)	5 (3,0%)
4	2 (1,2%)	4 (2,4%)	0 (0,0%)

Source: Own materials

Table. 2. The results of correlation of the examined features.

Correlated data		R	p-value	interpretation
diastasis recti abdominis	number of pelvic floor muscle dysfunctions	0	0.8181	no correlation
BMI	diastasis recti abdominis	-0.1	0.0994	no correlation
	number of pelvic floor muscle dysfunctions	0.2	0.0235	* statistically significant weak positive correlation
number of deliveries	diastasis recti abdominis	0.1	0.1369	no correlation
	number of pelvic floor muscle dysfunctions	0.2	0.0404	*statistically significant weak positive correlation
good exercise habits	diastasis recti abdominis	-0.1	0.1315	no correlation
	number of pelvic floor muscle dysfunctions	-0.1	0.1663	no correlation
breathing pattern	diastasis recti abdominis	0.0	0.9115	no correlation
	number of pelvic floor muscle dysfunctions	0.1	0.4525	no correlation

Source: Own materials

by Q. Wang [12], who evaluated 310 women 6–8 weeks postpartum, and by A. Braga [13], whose study focused specifically on younger mothers (up to 6 months postpartum) and excluded women over 45 years of age.

A study by V. Eisenberg [14] also failed to establish a correlation between DRA and pelvic floor muscle strength measured via vaginal device. However, it did report a link between DRA and urinary incontinence, suggesting that the overall condition of the abdominal wall – not just linea alba separation – may influence pelvic floor symptoms.

Other studies, including those by T.M. Spitznagle [15] and B. Harada [16], suggest a cumulative effect of DRA over time, particularly in older or postmenopausal women. The discrepancy between findings may relate to differences in age groups, methodologies, and whether the studies assessed absolute separation versus changes from pre-pregnancy baseline, as highlighted by K. Bowman [17].

Based on the conducted study, the hypothesis about the relationship between BMI and the number of deliveries and rectus abdominis muscle separation was rejected. As in the case of the main hypothesis, here too, one can find divergent studies on the effect of BMI on rectus abdominis muscle separation in women after childbirth. The study conducted by P. Gonçalves Fernadez de Mota [9] shows no statistically significant relationship between BMI and rectus abdominis muscle separation, while L. Wu [18] in a study on 644 women proves that BMI is one of the factors predisposing to rectus abdominis muscle separation, but only in the case of older women. Moreover, in the study by Q. Wang [12], women with a lower BMI had DRA more often after childbirth than those with a higher BMI, however, in this study the index value before childbirth was taken into account, not after it, and the study included women 6-8 weeks after childbirth. Taking into account the results of the studies in this paper and those mentioned above, it can be assumed that BMI may have an impact on the separation of the rectus abdominis muscle, but only in combination with other factors, which could be confirmed by a study focused on these relationships.

It seems intuitive that repeated pregnancies would increase the risk of abdominal wall weakening and separation, the current study did not confirm this association. This contrasts with most literature, indicating a need for further studies comparing parity with additional variables such as age or connective tissue quality.

In contrast, the study did support a significant correlation between higher BMI and greater parity with the number of PFMDs, consistent with previous research [6, 10]. Incorrect advice given to patients – such as voluntarily urinating every two hours or practicing pelvic floor exercises during urination – was also reported and reflects a need for better education.

Although most participants demonstrated proper habits, the expected relationship between daily routines and reduced dysfunction was not confirmed. This may be due to the fact that many adopted these habits only after symptoms appeared, limiting their preventive effect.

The hypothesis connecting breathing patterns and pelvic floor dysfunction was not confirmed. While the coordination of the diaphragm, abdominal wall, and pelvic floor is well-documented, the chosen assessment methods may not have adequately captured this relationship. Future studies should consider more specific diagnostic tools, such as osteopathic respiratory assessments [6].

Participants' approach to physical activity changed postpartum, with a shift from dynamic sports (e.g., running, cycling) to gentler forms (e.g., walking, yoga, pelvic floor exercises). The change was influenced by concerns about pelvic floor integrity and DRA, as well as time constraints.

Despite good awareness, 18% of women with known PFMD or DRA did not seek treatment. Urinary incontinence remains stigmatized, though growing awareness – fueled by social media and women's health campaigns – may change this. A follow-up study could reassess patient awareness and treatment-seeking behavior in coming years.

Physiotherapy remains the cornerstone of conservative management for PFMD and DRA. Methods such as Kegel exercises, electromyostimulation, and biofeedback are widely usekd. Proper guidance is essential to avoid compensatory muscle activation, especially of the hip adductors. In the field of balneology, cold water splashing and warm sitz baths are used. In the field of reflexology, these include connective tissue massage, foot reflex therapy or hot rolling used in the dermatome. Their therapeutic value is demonstrated primarily by improving blood supply and regulating muscle tension, because muscle efficiency depends not only on their strength, but also on blood supply and tissue trophism [6,19,20].

Technologies like perineometers and sEMG provide objective assessment and can be used at home through apps (e.g., PelviFly®). Other tools include vaginal cones or behavioral training based on methods like the BeBo® concept, which integrates awareness, mobilization, and strengthening of the pelvic floor into daily function [21].

Correct daily habits also support therapy. These include: proper posture during defecation (feet elevated, back rounded), side-lying transitions when rising, avoiding tight clothing, and coughing with torso rotation to reduce pelvic pressure [6].

In most women, DRA resolves spontaneously. If persistent, physical therapy is the primary treatment. Although promising techniques exist (e.g., Tupler, Noble), no standardized protocol has been universally accepted [22]. Manual therapy, combined with myofascial release and corrective exercises, may improve outcomes.

When conservative therapy fails or hernias are present, surgical repair – either open or laparoscopic – is indicated. Prevention strategies include proper movement, avoiding intra-abdominal pressure peaks, and early education on body mechanics [23].

CONCLUSIONS

The results of this study suggest that, due to the lack of a direct correlation between Diastasis Recti Abdominis

(DRA) and pelvic floor muscle dysfunctions (PFMD), there is no clinical necessity to combine treatment strategies solely based on the co-occurrence of these conditions. However, given the observed association of higher BMI and greater parity with an increased number of PFMD symptoms, a holistic and preventive approach may still be beneficial. Such an approach aligns with current therapeutic paradigms that emphasize synergy and integration to optimize outcomes.

A postpartum shift in the type of physical activity practiced was observed.

It is essential to establish consistent therapeutic protocols across specialties and to promote interdisciplinary collaboration. Patients should receive uniform, evidence-based information, minimizing contradictory advice and maximizing treatment adherence.

Patient education should underline the importance of prevention and early intervention. Encouraging the adoption of healthy daily habits and guiding patients along structured treatment pathways may significantly improve long-term outcomes and reduce the progression of dysfunction.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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RECEIVED: 30.04.2025
ACCEPTED: 21.06.2025

ORIGINAL ARTICLE

Effectiveness of silicone brush oro-motor stimulation on breastfeeding performance and weight gain in early preterm infants: a pilot study

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ABSTRACT

Aim: Preterm infants often struggle to coordinate sucking, swallowing, and breathing-skills essential for effective breastfeeding. These difficulties may delay discharge, increase healthcare costs, and affect developmental outcomes. Oro-motor stimulation, especially using silicone brushes, has been proposed to improve oral feeding efficiency. To evaluate the effectiveness of silicone brush oro-motor stimulation on feeding performance and weight gain in early preterm infants compared to standard manual stimulation.

Materials and Methods: This pilot study enrolled 20 early preterm infants randomized into two groups. The intervention group (10) received silicone brush oro-motor stimulation prior to feeding, while the control group (10) received manual stimulation. Both interventions were administered for four weeks, twice daily for three minutes. Feeding performance was measured using the Infant Breastfeeding Assessment Tool (IBFAT), and weight gain was tracked weekly.

Results: Infants in the silicone brush group showed a significant weight increase from 945 g (SD = 85.7) to 1184.9 g (SD = 38.5), compared to the manual group which gained from 953.4 g to 1095.1 g. IBFAT scores were significantly higher in the silicone brush group (10.6 ± 1.17) versus the control group (6.4 ± 0.97), with both outcomes reaching statistical significance ($p < 0.0001$).

Conclusions: Silicone brush oro-motor stimulation significantly enhances feeding performance and promotes weight gain in early preterm infants. This technique may serve as a valuable adjunct in neonatal care.

KEYWORDS: weight gain, neonatal care, feeding efficiency, Preterm infants, oro-motor stimulation, silicone brush

Acta Balneol. 2026;68(1):42-47. doi: 10.36740/ABAL202601106

INTRODUCTION

Feeding difficulties are a frequent challenge among preterm newborns admitted to neonatal intensive care units (NICUs), often delaying hospital discharge and impacting growth and development [1]. The establishment of adequate oral feeding skills is a critical milestone for discharge, yet preterm infants commonly experience delayed development in sucking, swallowing, and breathing coordination. These difficulties are not only prevalent during hospitalization but may persist into early childhood, with preterm infants exhibiting more feeding-related challenges than their term counterparts. Persistent oro-motor dysfunction can lead to feeding difficulties and growth delays. Additionally, excessive drooling or poor oral control can cause secondary complications, including aspiration, respiratory infections, and impaired social development. For instance, children with cerebral palsy often suffer from significant oral motor impairments, which complicate feeding and increase the risk of pneumonia and malnutrition [2-6].

Globally, approximately 15 million infants are born preterm each year, defined as birth occurring before 37 weeks of gestation [7, 8]. Among these, nearly 6% are classified as extremely preterm (born before 28 weeks of gestation) [9]. Preterm birth is associated with a range of complications that extend beyond the neonatal period, including increased risks of respiratory, neurological, and cardiovascular disorders [10–13].

While full-term infants generally transition to oral feeding without significant difficulty, oral feeding challenges are reported in 25–45% of typically developing infants and up to 80% of developmentally delayed children, including those born prematurely [14]. Despite the clinical importance of this issue, research on infant oral feeding remains limited. Awareness of the impact of feeding dysfunction has grown, especially with improved survival rates of preterm infants, many of whom struggle with the transition from tube to oral feeding, prolonging hospitalization and delaying maternal-infant bonding [15].

Oro-motor stimulation (OMS), which involves manipulating the lips, jaw, tongue, and soft palate-either with or without non-nutritive sucking (NNS)-is aimed at improving oral feeding skills in preterm infants. This approach was first introduced in 2008 by Dr. Brenda Knoll Lessen as a therapeutic intervention for preterm newborns [16]. Techniques such as OMS and kinesthetic stimulation, often

grouped under developmental care or sensory-motor interventions, have shown potential in supporting the respiratory, neuromuscular, and feeding development of preterm infants. However, the empirical evidence for their effectiveness, particularly from randomized controlled trials (RCTs), remains insufficient [17]. NNS has been widely used to encourage oral feeding readiness and is known to support the development of oral motor patterns in preterm neonates [18, 19].

While oral stimulation and NNS programs can support oral feeding readiness, they often do not directly address pharyngeal swallowing deficits, and they differ physiologically from nutritive sucking [20-22].

Effective oral feeding is not only a functional milestone but also a neuroprotective intervention, as it supports brain development and sensory integration in preterm infants. Nurses play a critical role in implementing oral feeding strategies that are aligned with the infant's maturity and developmental needs [20]. Promoting feeding autonomy is a key requirement for hospital discharge in preterm infants and should be supported by evidence-based interventions such as oro-motor stimulation [23, 24].

Previous studies [20-25] have emphasized the importance of early interventions in supporting breastfeeding and improving neonatal outcomes.

AIM

The aim of this pilot study was to evaluate the effectiveness of silicone brush oro-motor stimulation on breastfeeding performance and weight gain in early preterm infants.

MATERIALS AND METHODS

This pilot experimental study was conducted at Saveetha Medical College and Hospital, Chennai, following approval from the Institutional Scientific Review Board of Saveetha College of Physiotherapy, SIMATS (Approval No: 042/10/2024/ISRB/UGSR/SCPT). A total of 20 early preterm infants were recruited. Inclusion criteria were hemodynamic stability, exclusive gavage feeding, gestational age <32 weeks, and birth weight between 1000 g and 1500 g. Infants with congenital anomalies, perinatal infections, jaundice, or born to mothers with significant infections or a history of recurrent pregnancy loss were excluded [26, 27]. Written informed consent was obtained from parents.

Participants were randomly assigned to either the intervention group (n=10) or the control group (n=10). The intervention group received oro-motor stimulation using a soft silicone brush [27-30], while the control group received traditional manual stimulation without a brush. Both groups received the same structured stimulation sequence consisting of perioral stimulation (lips, cheeks, jawline), intraoral stimulation (tongue, gums, palate), and non-nutritive sucking practice using the therapist's gloved little finger (Figure 1). Each session lasted 3 minutes, including 10-second rest intervals between each step, and was administered twice daily for 4 weeks. Infants were swaddled and positioned in a semi-upright posture in a low-stimulation environment to optimize neuromotor engagement. Clinical safety and tolerance were continuously monitored by a neonatologist. All procedures were performed by a trained neonatal physiotherapist with experience in oro-motor intervention. A standardized training checklist and competency validation were used to ensure intervention fidelity. A detailed stimulation protocol is presented in Table 1.

Fig. 1. Manual oro-motor stimulation
Source: Own materials

Outcomes were assessed using the Infant Breastfeeding Assessment Tool (IBFAT) and a calibrated digital infant weighing scale. IBFAT scores and body weight were recorded at baseline and at the end of week three. The IBFAT is a validated and reliable tool for evaluating infant feeding behavior, with inter-rater reliability ranging from 0.77 to 0.85 and internal consistency from 0.75 to 0.85 [31].

RESULTS

Data were analyzed using SPSS version 27.0.1.0. Descriptive statistics including mean and standard deviation (SD) were used to summarize the data. Paired t-tests were used to assess within-group differences (pre- and post-intervention), while independent t-tests were used to compare post-intervention values between groups. Statistical significance was set at $p < 0.0001$.

Both groups showed statistically significant improvements in IBFAT scores and weight following the intervention. In the silicone brush oro-motor stimulation group, the mean IBFAT score increased from 4.10 ± 0.876 to 10.60 ± 1.174 ($t = -14.337$, $p < 0.0001$), while the manual stimulation group improved from 3.70 ± 0.949 to 6.40 ± 0.966 ($t = -5.014$, $p < 0.0001$). Weight gain also showed significant improvement in both groups. The silicone brush group's mean weight increased from 945.50 ± 85.69 g to 1184.90 ± 38.48 g ($t = -7.891$, $p < 0.0001$), and the manual group improved from 953.40 ± 49.79 g to 1095.10 ± 67.07 g ($t = -12.386$, $p < 0.0001$) (Table 2, Table 3).

Table 1. Intervention Protocol

METHOD	PROCEDURE		TOTAL DURATION	SESSION DURATION
Silicone brush Oro-motor stimulation	perioral: lips, cheeks, jaws	Perioral – 1 minute	3 minutes (including 10 seconds break after every treatment procedure)	2 – sessions per day
		Break –10 seconds		
	intraoral: tongue and gums	Intraoral – 1 minutes		
		Break – 10 seconds		
	pacifier (little finger)	Pacifier – 30 seconds		
		Break –10 seconds		
Manual Oro-motor stimulation	perioral: lips, cheeks, jaws	Perioral – 1 minute	3 minutes (including 10 seconds break after every treatment procedure)	2 – sessions per day
		Break –10 seconds		
	intraoral: tongue and gums	Intraoral – 1 minutes		
		Break – 10 seconds		
	pacifier (little finger)	Pacifier – 30 seconds		
		Break –10 seconds		

Table 2. Pre and Post-test values of silicone brush Oro-motor stimulation and manual stimulation using IBFAT

GROUP	TEST	MEAN	SD	t value	p value
SILICONE BRUSH OROMOTOR STIMULATION	Pre test	4.10	0.876	- 14.337	<0.0001
	Post test	10.60	1.174		
MANUAL STIMULATION	Pre test	3.70	0.949	-5.014	<0.0001
	Post test	6.40	0.966		

Table 3. Pre and Post-test values of silicone brush Oro-motor stimulation and manual stimulation using weighing scale

GROUP	TEST	MEAN	SD	t value	p value
SILICONE BRUSH OROMOTOR STIMULATION	Pre test	945.50	85.694	- 7.891	<0.0001
	Post test	1184.90	38.478		
MANUAL STIMULATION	Pre test	953.40	49.789	- 12.386	<0.0001
	Post test	1095.10	67.066		

Table 4. Post-test values of silicone brush Oro-motor stimulation and manual stimulation using IBFAT and weighing scale

SCALE	GROUP	TEST	MEAN	SD	t value	p value
IBFAT	SILICONE BRUSH OROMOTOR STIMULATION	Post test	10.60	1.174	8.737	<0.0001
		Post test	6.40	0.966		
WEIGHING SCALE	MANUAL STIMULATION	Post test	1184.90	38.478	3.673	
		Post test	1095.10	67.066		

Between-group comparisons of post-test values revealed statistically significant differences favoring the silicone brush group. The IBFAT score was significantly higher in the silicone group (10.60 ± 1.174) compared to the manual group (6.40 ± 0.966), with $t = 8.737$, $p < 0.0001$. Similarly, post-test weight was higher in the silicone group (1184.90 ± 38.48 g) than in the manual group (1095.10 ± 67.07 g), with $t = 3.673$, $p < 0.0001$ (Table 4).

These results suggest that silicone brush oro-motor stimulation is significantly more effective than manual stimulation in improving feeding performance and promoting weight gain in early premature infants.

DISCUSSION

This pilot study examined the impact of silicone brush oro-motor stimulation on feeding abilities and weight gain in early premature infants, a population often challenged by immature coordination of sucking, swallowing, and breathing. The study compared two groups-one receiving stimulation with a silicone brush and the other receiving traditional manual oro-motor stimulation. Both interventions were administered for three minutes, twice daily, over four weeks. Feeding effectiveness was assessed using the Infant Breastfeeding Assessment Tool (IBFAT), and weight was monitored throughout the study.

The group receiving silicone brush stimulation demonstrated a notable improvement in weight from a pre-test mean of 945.50 g (SD = 85.694) to a post-test mean of 1184.90 g (SD = 38.478). In contrast, the manual stimulation group showed weight gain from 953.40 g to 1095.10 g. The IBFAT scores also reflected better feeding efficiency in the silicone brush group, suggesting that structured oro-motor stimulation using a silicone brush may accelerate the development of feeding skills in preterm infants.

These findings are supported by Thakkar PA et al. (2018) [32], who found that structured oral stimulation significantly improved feeding efficiency and led to quicker transitions to independent oral feeding. Sasmal S et al. (2020) [17] also reported that prefeeding oro-motor stimulation improved feeding performance and increased breastfeeding rates at discharge and one-month corrected age, though it did not significantly affect weight gain. Similarly, Arora K et al. (2018) [33] demonstrated that premature infants receiving structured stimulation achieved oral feeding milestones earlier and showed better weight gain.

The present results align with Bala et al. (2016) [34], who observed earlier initiation of spoon feeding and direct breastfeeding in infants who received oral stimulation. Moreover, Muñoz-Gómez et al. (2024) [35] emphasized that unimodal sensorimotor interventions, like oral stimulation with non-nutritive sucking (NNS), improved feeding outcomes though weight gain remained unaffected, suggesting the benefits may be primarily neuromuscular rather than metabolic.

Arvedson et al. (2010) [36] noted inconsistencies in outcomes from prefeeding stimulation but supported the role of NNS and oral/perioral interventions in enhancing feeding transition. Likewise, Tian and Xu (2015) [37] reported improved feeding efficiency and shortened hospital stay following oral motor interventions, even though weight gain benefits were inconsistent across studies.

However, despite the positive outcomes, Arvedson et al. (2010) [38] highlighted that the evidence base for oral motor interventions is still limited and inconsistent, especially regarding long-term effects and pulmonary outcomes. The effectiveness of silicone brush oro-motor stimulation may vary based on factors such as gestational age, stimulation techniques, and adherence to intervention protocols. While the results are promising, further research is required to determine the optimal stimulation parameters, including frequency, duration, and timing relative to feeding. Additionally, feeding outcomes are influenced by other factors such as the infant's overall health status and nutritional support.

CONCLUSIONS

This pilot study evaluated the effectiveness of silicone brush oro-motor stimulation on breastfeeding performance and weight gain in early preterm infants. The findings indicate that this intervention significantly enhances feeding performance as measured by IBFAT scores and is associated with greater weight gain, compared to manual stimulation. Infants who received silicone brush stimulation demonstrated higher post-intervention IBFAT scores and greater increases in body weight than those in the control group.

These results underscore the clinical value of consistent and structured oro-motor stimulation in promoting feeding readiness and supporting early growth and development in preterm infants. However, given the small sample size and pilot design, these findings should be interpreted with caution.

To strengthen the evidence base, future research should focus on larger-scale, randomized controlled trials to confirm these findings, standardize stimulation protocols, and investigate the long-term developmental and neurobehavioral outcomes associated with silicone brush oro-motor stimulation.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 15.05.2025
ACCEPTED: 14.01.2026

REVIEW ARTICLE

Modern post-stroke rehabilitation: from conventional therapy to virtual reality and artificial intelligence

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ABSTRACT

Aim: To evaluate whether technologies such as virtual reality (VR) and artificial intelligence (AI) offer advantages over traditional rehabilitation in post-stroke patients and to compare these approaches in the context of modern neurological rehabilitation.
Materials and Methods: This review includes clinical studies conducted in post-stroke patients using both traditional rehabilitation methods and VR- and AI-based approaches. The analysis was based on publications from 2020–2025 retrieved from scientific databases in order to present an overview of recent research from the last five years.
Conclusions: Traditional post-stroke rehabilitation remains a well-established and non-invasive therapeutic approach supported by extensive clinical experience. Virtual reality offers an accessible tool that may enhance motor and cognitive training through interactive and task-oriented environments, although it does not replace comprehensive rehabilitation when used alone. Artificial intelligence enables more precise assessment and personalization of therapy, but its implementation may be limited by high costs and technological requirements. Current evidence suggests that integrating modern technologies such as VR and AI with conventional rehabilitation may provide additional therapeutic benefits compared with single-method approaches. Continued development of these technologies may further support individualized rehabilitation strategies for post-stroke patients.

KEYWORDS: stroke, rehabilitation, virtual reality, artificial intelligence, neurorehabilitation

Acta Balneol. 2026;68(1):48-53. doi: 10.36740/ABAL202601107

INTRODUCTION

Stroke is a cerebrovascular disease. Cerebral circulation stops, which is leading to tissue hypoxia, tissue damage and loss of brain function. It is usually caused by fracture or obstruction of a vessel [1]. Stroke is associated with a high risk of permanent disability. The most common clinical implications include hemiplegia, loss of ability to care for yourself, speech impairment or loss of mobility. Difficulty in walking occurs in about 80% of patients after strokes [2]. Starting rehabilitation as early as possible and with a properly tailored schedule of treatment to the patient, especially in patients with milder symptom severity, increases the chances of even a full return to social and occupational activity. Current classical therapeutic regimens are based on the combined use of pharmacological treatment and physical improvement. The effect of these measures largely depends on the regularity of the patient and often the involvement of the family and medical team in monitoring the treatment process [3]. A variety of therapeutic interventions are used in the recovery process after a stroke. An important role is played by exercise, which promotes recovery by improving the function of weakened muscles and overall physical fitness, allowing patients to gradually return to daily activities. Regular physical activity is also important in the prevention of secondary post-stroke complications. It contributes to reducing the risk of recurrent cardiovascular diseases and lowering mortality [4]. Rehabilitation is a fundamental component of post-stroke care and technological advances are fostering the development of new solutions to support the improvement process [3]. Training methods that go beyond traditional therapeutic protocols facilitate the use of alternative forms of rehabilitation, including approaches aimed at assessing and improving motor function. Developments in artificial intelligence (AI) and virtual reality (VR) technologies have led to the creation of interactive therapeutic systems that allow for more engaging and individually tailored rehabilitation environments. These solutions address some of the limitations of traditional rehabilitation, such as repetitive exercises, limited feedback and insufficient focus of therapy on functional tasks [5]. The dynamic development of modern technologies creates new opportunities to complement classical methods of neurological rehabilitation and prompts analysis of their potential importance in the treatment of post-stroke patients.

AIM

The purpose of this article is to present modern neurological rehabilitation after stroke. This study describes not only traditional methods of post-stroke rehabilitation, but

also discusses the role of technologies such as VR and AI as tools supporting the neurological rehabilitation process. Comparing these approaches may help determine which methods provide the best results. This work aims to indicate potential directions for the development of therapy for post-stroke patients.

MATERIALS AND METHODS

We focused on the effects of different rehabilitation methods in post-stroke patients. We included randomized clinical trials comparing traditional rehabilitation methods and the use of VR and AI. The analysis was based on publications from 2020–2025 retrieved from scientific databases. We also used definitions of neurological diseases from articles published between 1997 and 2025.

REVIEW

TRADITIONAL REHABILITATION

Traditional post-stroke rehabilitation is a multi-stage therapeutic process. It includes physiotherapy focused on movement improvement, speech therapy addressing speech, swallowing and cognitive functions, and occupational therapy focused on daily activities. The goal of these interventions is to regain mobility, improve mobility and increase the patient's independence by stimulating brain neuroplasticity. Rehabilitation typically begins as soon as the patient's health has stabilized.

Around 20 percent of patients have impaired expression and comprehension of language after a stroke. Speech therapy can be a solution for them to help enhance communication skills, treat speech disorders (aphasia, dysarthria, apraxia) and dysphagia. The biggest impact is seen in more intense therapy from 40 to 100 hours; the best results have patients whose stroke occurred less than six months previously [6]. Oropharyngeal dysphagia following acute stroke is evident occurring in about 50% of patients. The rehabilitation suggested to those patients is thermal tactile application (TTA) that involves rubbing the anterior cheek arches with a chilled laryngeal mirror or ice pack. Five movements are made along each arch, followed by swallowing a small amount of fluid or saliva. It is recommended to perform this exercise three to four times daily for five to ten minutes [7].

The acute stage of stroke includes the first 24 h to 1 week following the onset of the stroke. Acute stroke patients are typified by a trouble in the ability to adapt to changes in body position. Research shows that the Bobath and Vojta methods are likewise impactful to help with that issue. Both rely on transferring acquired skills from one motor task to another. The Bobath method relies on initial training in sitting and standing gait. A repetition-based approach is increasingly being used in posture and gait rehabilitation: to memorize a movement, the exercise must be repeated as often as possible. [8, 9] The Vojta method triggers involuntary motor responses through pressure, significantly correcting posture, trunk control, and motor function. In the randomised controlled trial, patients were assigned to Vojta therapy or standard physiotherapy within 72 h after stroke onset. Patients treated with the Vojta method achieved bigger improvement in the MESUPES scale than patients in the control group (20% *vs.* 10%, p = 0.006) [9].

The first week after the stroke, 78-90% of patients are dependent on ADL. At six months 40-62% and at one year 33-59% stay dependent. Motor recovery is the most rapid in first weeks and tends to plateau after eight to twelve weeks. Momentous recovery can occur up to six months, sometimes up to two years or more after stroke [10]. Depending on the patient's level of physical health, therapists can begin teaching single handed techniques for feeding, dressing in the first week after the stroke. These exercises prevent immobilization complications and improve ADL skills early on, maximizing the use of the healthy side of the body. They are divided into passive range-of-motion exercises and active joint-by-joint exercises. In passive range-of-motion exercises, the therapist passively moves the joints through their entire range of motion, which prevents contractures. In active ones, the patient actively moves the joints. These exercises are isotonic or isometric [10, 11].

The subacute phase lasts from 1 week to 3–6 months after stroke. More intensive rehabilitation therapies are used during this phase. Occupational therapy utilizes techniques such as Constrained Movement Therapy (CIMT) and dual--modality training. Proprioceptive training is also incorporated to improve the patient's sense of body position, coordination, and movement [11].

The chronic stage of stroke commences 6 months after the initial event and continues indefinitely. During this phase, long-term rehabilitation and treatment of any residual disability are paramount. The goal is to further improve functional abilities. Adding mirror therapy can be used to create the illusion of movement in the affected limb and reduce phantom pain. Cognitive rehabilitation interventions aim to improve memory, attention, and problem-solving skills. Aerobic exercise and hydrotherapy are used to improve cardiovascular health [11] .

Different studies show that 56–95% of patients undergoing inpatient stroke rehabilitation experience medical complications. These complications negatively impact prognosis and extend hospital stays. The most common complications include pressure ulcers, deep vein thrombosis, shoulder pain, and contractures [10].

Factors contributing to a good prognosis include: a supportive family, higher social, financial and educational levels, early diagnosis and initiation of rehabilitation, the center's experience in post-stroke rehabilitation. Access to traditional rehabilitation methods remains a significant challenge in stroke care due to geographic and financial disparities, particularly in rural areas, often with limited access to specialized rehabilitation centers and qualified medical personnel [10, 11].

VIRTUAL REALITY

The definition of VR has been disputed, although it is generally defined as the use of computer hardware and software to create interactive simulations providing users with environments mimicking and feel-similar to real-world

objects and events. In stroke rehabilitation, users typically explore their virtual environment while having to hold, move or touch objects, with the help of visual, auditory and haptic feedback. Depending on the VR application selected, virtual rehabilitation intervention may be modified from relatively inactive, where patients may only need to use hand movements, to highly active, where full body movements are necessary [12].

VR systems are classified by their level of immersion and sensory integration. Non-immersive VR involves interaction with a computer screen or television, typically using standard input devices (e.g. mouse, keyboard, or motion sensors). Non-immersive VR is widely accessible and relatively inexpensive but provides limited sensory feedback and a low sense of presence in the virtual environment. Fully immersive VR employs head-mounted displays (HMDs), dome environments or projection systems that visually and auditorily isolate the user from the physical world, creating a strong sense of "being inside" the virtual environment. Haptic feedback may be incorporated and less commonly olfactory cues (e.g. scents released during specific virtual moments) to further immerse the user. Rehabilitation specific platforms are custom designed to create targeted therapeutic exercises, adapt difficulty and provide real time performance feedback. Often, these platforms support repetitive, task-specific practice and neuroplasticity curated to aid patients during their rehabilitation. Commercial gaming systems are primarily designed for entertainment and fitness but have been repurposed for rehabilitation due to their affordability and ease of use. Rehabilitation specific VR systems are engineered to address clinical goals, allowing for individualized therapy through adjustments of parameters, integration of advanced sensory modalities and tailored feedback [13-15]. The department of Veterans Affairs guideline emphasizes that although immersive systems are more costly, they provide superior engagement and therapeutic benefit in comparison to their non-immersive counterparts, which are more accessible and feasible [14].

VR rehabilitation shows modest benefits for upper limb function after stroke when used alone, but demonstrates great and more sustained improvements in motor function, manual dexterity and activities of daily living (ADL) when combined with conventional therapy or delivered in immersive formats. Evidence also favors immersive over non-immersive VR for ADL outcomes [12, 16-19]. For lower extremity and balance rehabilitation, VR produces meaningful improvements in balance, gait parameters and activity limitations, especially when integrated with standard rehabilitation and in chronic stroke. Although, evidence for gait speed remains mixed, suggesting that VR may be more effective for balance than velocity training, with certainty ranging from moderate to very low depending on the outcome [12-14, 20, 21].

Optimal dosing and timing of VR-assisted therapy demonstrates a meaningful impact. Greater improvements in balance and mobility were seen with 20 sessions of VR rehabilitation or more. Further, VR therapy >6 months post-stroke demonstrates sustained benefits [13]. Interventions exceeding 6 weeks elicit improved results and initiation of VR within 6 months post-stroke optimizes outcomes [11]. Optimal improvements are observed with hybrid VR sessions of 31-59 minutes daily [16]. Interestingly, variability of stroke type also changed the impact of VR therapy. Subacute stroke survivors exhibit the most significant gains in ADL, compared to chronic or acute patients [19]. Age may also factor into rehabilitation results, with younger patients appearing to benefit more from VR protocols compared to older patients [22].

VR rehabilitation provides engaging, task-specific and repetitive practice that enhances neuroplasticity, motivation and motor learning through immersive environments, real-time feedback and personalized difficulty adjustment, with evidence linking these neural changes to improved functional outcomes [13, 23]. In stroke rehabilitation, VR demonstrates a generally favorable safety profile with mostly mild, transient adverse effects. However, current evidence is limited by low-to-moderate quality, heterogeneous interventions, small samples, uncertain long-term benefits, mixed effects on participation and quality of life. Additionally, practical barriers include cost, accessibility and suitability for patients with cognitive and visual impairments [12, 14, 18, 19].

ARTIFICIAL INTELLIGENCE

Incorporation of AI has transformed stroke rehabilitation from traditional therapist dependent approaches to data driven, objective assessment and intervention systems that can operate across clinical and home settings. A scoping review of 704 studies identified four common themes in AI stroke rehabilitation research: impairment assessment, assisted intervention, prediction and imaging and neuroscience applications. AI-driven tools provide objective, reproducible evaluation of motor and cognitive deficits, which significantly reduces clinician subjectivity in stroke assessment [24] AI-enhanced assessment systems offer quantitative and continuous measurements that capture subtle changes in motor performance not detectable by conventional scales, allowing accurate assessment of upper limb function, gait and balance through automated movement analysis using computer vision and wearable sensors [24, 25].

AI pose estimation and wearable inertial measurement units (IMUs) enable accurate, continuous tracking of movement kinematics using consumer devices, providing reliable assessment of gait, mobility and functional recovery beyond conventional clinical scales [24,26]. When combined with real-time performance monitoring and automated feedback, computer-vision-based home rehabilitation platforms support adaptive, personalized therapy, improve joint kinematics and balance control and enable clinicians to evaluate rehabilitation progress remotely [27]. In contrast, multimodal machine learning models integrating clinical, sensor and neuroimaging data show good predictive performance for motor impairment and recovery [24].

The effectiveness of AI-driven rehabilitation has been supported by systematic reviews and meta-analyses de-

monstrating modest but significant improvements in upper extremity motor function compared with conventional therapy [28]. Comparative analyses indicate that different AI-enabled modalities confer complementary benefits, with robot-assisted and VR-based therapies favoring motor recovery, while brain computer interface (BCI) and digital cognitive interventions show particular advantages for ADL and cognitive outcomes [29,30]. Randomized controlled trials further suggest that self-guided AI-based telerehabilitation can achieve outcomes comparable to therapist-supervised care, with high patient satisfaction and no increase in adverse events [24].

Robotic rehabilitation (RR) and BCI represent advanced AI-driven modalities exhibiting potential for motor rehabilitation post-stroke by delivering intensive, repetitive and task-specific training that stimulates neuroplasticity. Feasibility studies suggest that BCI-driven robotic assistance can produce motor outcomes comparable to conventional therapy, even in patients with severe upper limb impairment, while maintaining acceptable usability and cognitive workload. When integrated with other technologies such as VR, functional electrical stimulation and non-invasive brain stimulation, these approaches demonstrate synergistic neuroplastic effects through mechanisms such as long term potentiation, mirror neuron activation and cerebellar modulation [31].

Despite the promising potential of AI in stroke rehabilitation, several challenges and barriers limit widespread clinical implementation. Current challenges include small and homogeneous datasets with poor external validation and explainability, high cost and resource demands, limited clinical training, regulatory and reimbursement barriers and ongoing concerns regarding data security, bias, transparency and the need for continued clinician oversight [32, 33].

Machine learning has developed from a research tool into a transformative force in stroke care, enabling precise and individualized prediction and monitoring across the entire post-stroke trajectory [5]. In stroke prevention, these tools facilitate scalable monitoring of cardiometabolic and stroke-specific risk factors for early impairment detection and personalized recovery outside specialized centers [24]. Future efforts in stroke-specific AI must prioritize prospective validation, standardized reporting and seamless integration into clinical workflows to realize the full potential of AI for precision medicine [5]. The development of consensus-based guidelines and standards for transparency of data diversity in health datasets has emerged as a priority to address fundamental challenges related to bias and generalizability [33]. The continual emergence of AI-enabled, consumer-based technologies signals a paradigm shift toward accessible, individualized and data driven stroke prevention and management [5]. While most of these innovations remain in early development, they represent a future of distributed precision stroke care, with AI-driven stroke management using multimodal sensor data enabling continuous monitoring and intervention across the full spectrum of stroke care [24].

DISCUSSION

Strokes are becoming increasingly common among many patients, requiring treatment and thereafter rehabilitation to allow the patient to return to efficient functionality. The effects of stroke up to 50% of patients include oropharyngeal dysphagia, which is treated with TTA [1]. The acute phase of stroke is a condition in which patients have difficulty adapting to changes in body position. The Bobath and Vojta method help with such affliction. The Bobath method focuses on improving basic movements while eliminating improper ones. The Vojta technique aims to rebuild movement patterns by applying pressure to selected parts [3,5]. Based on the patient's health and physical fitness, the therapists align appropriates exercises to improve performing everyday doings while making maximum use of the health side of the body. Repeating the same motion helps to relearn motor skills [4,6]. The subacute phase is characterized by more intensive rehabilitation such as CIMT, dual-modality training and proprioceptive training which helps patients feel the body and its position. In the chronic stage mirror therapy is used to help reduce phantom pain while being non-invasive. Other methods include aerobic exercise and hydrotherapy, which improve cardiovascular health [6]. The positive aspect of traditional rehabilitation is direct contact with the therapist, which allows precise development of exercises that will enable a return to fitness. It also allows patients to find out more about their own health and body needs, increasing their self-awareness. Traditional rehabilitation includes the methods that have been practiced for a long time which also contributes to the greater experience of the therapists. In most cases, traditional rehabilitation is non-invasive and safe for patients. The disadvantage of conventional rehabilitation is often the long waiting period for such services, which becomes a significant obstacle for patients in need. In certain conditions, standard therapy is not sufficient. Limiting the use of modern technologies may also contribute to prolonging the patient's recuperation.

Another type of after-stroke rehabilitation is VR. It involves the use of electrical devices that stimulate an environment similar to reality. The aim is to improve the patient's mobility while reducing pain [1].

Research has shown that post-stroke patients can asset from VR-based cognitive rehabilitation exercises that imitate errands, resulting in significant improvements in cognitive performance. [34] Although this non-immersive method is relatively inexpensive, it does not provide a full immersive experience in the virtual world contrary to the immersive method [1-3]. Although non-immersive methods are easier and cheaper to use, immersive techniques have an advantage in terms of therapeutic benefits, which is emphasized by the department of Veterans Affairs guideline [3]. Hybrid VR combined with conventional therapy has been found to significantly improve motor function and manual dexterity compared to conventional therapy alone [4]. In patients with chronic stroke, it has been observed that the use of VR can have a positive effect on attention, spatial awareness and depressed mood when using Adaptive Cognitive Training (ACCT) in VR. [34] Additionally, VR therapy significantly improves Berg Balance Scale scores,

timed Up and Go test performance, and step length [2]. VR interventions induce improved interhemispheric balance, enhanced cortical connectivity, increased cortical mapping of the affected limb muscles, and activation of the mirror neuron system. Immersive VR increases patient motivation and curiosity, as well as their willingness to perform this kind of exercise equating to traditional rehabilitation methods [3, 7]. The VR technique has many positive aspects. It allows to adjust the level of difficulty to the individual needs. In contrast, its long-term effectiveness is unknown. It has limitations such as it should not be used by people with cognitive and visual dysfunction. This method is also more expensive compared to conventional therapy [3].

Using AI in treating strokes allows working in the clinical circumstances but also the home ones. Traditional clinical assessments rely on ordinal scales. In contrast, AI-enhanced assessment systems offer quantitative and continuous measurements that capture subtle changes in motor performance not detectable by conventional scales [13]. RR based on AI allows the reorganization of the neurons while stimulating neuroplasticity [20]. The advantage of this method is the high precision of movements and the safety of the patients' possible injuries. AI and VR form adaptive rehabilitation systems that gustily adapt therapy difficulty, offer personalized feedback. Studies have reported accuracies exceeding 90% in automatically evaluating rehabilitation performance [35]. VR methods allow increased precision, but also earlier detection of abnormalities compared to traditional methods, which allows faster treatment. Although the use of AI in stroke rehabilitation has many advantages, it can also lead to many complications. Some of the obstacles are high costs, limited sources, and the technological capabilities of facilities [22]. Excessive use of AI-based stroke rehabilitation methods may lead to a shortage of specialists, leading to entrusting patients' health under the control of AI by itself.

CONCLUSIONS

Stroke is a disorder with a complex recovery process. Survivors of stroke are often left with numerous complications. Rehabilitation provides patients with an opportunity to regain functional abilities and reduce disability. To achieve optimal outcomes, different therapeutic approaches should be combined, integrating traditional rehabilitation methods supported by long clinical experience with emerging technologies such as VR and AI. These technologies offer new, engaging therapeutic possibilities and broaden the scope of rehabilitation strategies. However, due to the still limited body of evidence, they should currently be considered supportive rather than primary therapeutic approaches.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 02.01.2026
ACCEPTED: 28.02.2026

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

REVIEW ARTICLE

Acupuncture as a concomitant treatment in chronic low-back pain in the elderly

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ABSTRACT

Aim: To evaluate the role of acupuncture in the treatment of chronic lumbosacral spine pain syndromes in older adults and to define its place within comprehensive management including physiotherapy and pharmacotherapy.

Materials and methods: A narrative review of the scientific literature was performed, including randomized clinical trials, meta-analyses, systematic reviews, and European and American clinical guidelines addressing chronic low back pain in the elderly. Publications concerning epidemiology, pharmacologic and nonpharmacologic treatment, physiotherapy, and the neurologic, neurohumoral, and psychological mechanisms of acupuncture analgesia were analyzed. Data on the safety and effectiveness of combining acupuncture with physiotherapy and limited pharmacotherapy were included. The reviewed literature indicates that acupuncture may provide clinically meaningful pain reduction in patients with chronic lumbosacral spine disorders and may contribute to improvements in functional status and quality of life when used as an adjunct to physiotherapy and conservative management. Reported adverse effects were generally minimal, and integration of acupuncture into multidisciplinary treatment approaches may reduce reliance on long-term pharmacotherapy in selected patients.

Conclusions: Acupuncture may be an effective and safe complementary method in the management of chronic lumbosacral spine pain syndromes in older adults. Its integration into comprehensive treatment strategies may reduce pharmacologic burden and offer clinical and economic benefits in aging populations.

KEYWORDS: acupuncture, low back pain, aged, chronic pain, complementary therapies

Acta Balneol. 2026;68(1):54-57. doi: 10.36740/ABAL202601108

INTRODUCTION

Low back pain in adults constitutes a global pandemic and has become the leading reported complaint among all diseases [1–4]. It is particularly burdensome in the elderly, often necessitating the use of multiple analgesic medications in patients already treated for multimorbidity [5–7]. Chronic pharmacologic pain management is not neutral to overall health, especially with respect to parenchymal organs (kidneys, liver), which are frequently already compromised by metabolic syndrome, type 2 diabetes or age-related decline in renal function [5, 8, 9]. The coexistence of these diseases represents an unfavorable general health condition.

Therefore, internationally recognized research groups have undertaken efforts to assess the health status of individuals with chronic lumbosacral pain, focusing on the use of minimally invasive treatment approaches [5,10–12]. Global and national epidemics of chronic painful dysfunctions of the lumbosacral region generate measurable societal costs and impose a substantial burden on health care systems [1, 10, 13].

Despite advances in imaging techniques and targeted interventional surgical treatments – both extensive and minimally invasive – the effectiveness of such procedures often fails to meet patient expectations [14–16]. Chronic pain syndromes following surgical treatment of discopathy and/or critical neural stenosis frequently recur despite rehabilitation therapy, and repeated surgical interventions typically do not result in long-term improvement [14, 15]. he search for complementary methods to alleviate symptoms in older adults treated by neurologists, orthopedists, neurosurgeons, and rehabilitation specialists – at least for temporary relief of low back pain – has led to increasing interest in acupuncture as an adjunctive therapy [5, 17–21].

AIM

The objective of this study was to present the role of acupuncture in the treatment of chronic lumbosacral spine pain syndromes in older adults and to discuss its place within comprehensive therapy that includes physiotherapy and pharmacotherapy [5, 7, 9]. The analgesic mechanisms of acupuncture and its clinical effectiveness compared with traditional pain treatment methods were also analyzed [17, 20, 21].

MATERIALS AND METHODS

A narrative literature review was conducted to evaluate the role of acupuncture in the management of chronic lumbosacral spine pain in older adults. Electronic databases including PubMed/MEDLINE, Scopus, and Web of Science were searched for relevant publications between January 2000 and January 2025. The search strategy combined the following keywords and Medical Subject Headings (MeSH):

"acupuncture", "low back pain", "lumbosacral pain", "chronic pain", "aged", "rehabilitation", and "physiotherapy" [1, 5, 9, 17–19, 22]. Randomized controlled trials, meta-analyses, systematic reviews, and clinical guidelines published in English were considered eligible for inclusion [5, 9, 11, 17–19, 22]. Studies involving adult or elderly populations with chronic spinal pain were included, whereas publications unrelated to musculoskeletal pain, non-clinical reports, and duplicate records were excluded [10, 22]. Titles and abstracts were screened for relevance, followed by full-text evaluation of selected articles. The final qualitative synthesis incorporated evidence addressing epidemiology, pharmacological and non-pharmacological treatment, physiotherapy approaches, and neurophysiological mechanisms of acupuncture analgesia [5–9, 11, 16, 17–23]. Owing to the narrative nature of the review, no formal meta-analysis or quantitative pooling of data was performed.

REVIEW

Low back pain in older adults is among the most frequently reported complaints in advanced age [10,13,24]. Its source may involve all structures of motion segments (Junghans), most notably degenerated facet joints and intervertebral discs undergoing atrophy and pathological displacement [10,13]. Short intersegmental muscles – particularly their overloaded and structurally impaired attachments – may also be sources of pain [10].

Thus, chronic lumbosacral pain in older adults most often results from overload of altered motion segments, degenerative facet joint changes, pathologically altered intervertebral discs, and intersegmental muscles [10,13]. Fatigue osteoporotic vertebral body fractures may also be a source of chronic pain [24].

Clinical differentiation of lumbosacral pain syndromes allows classification into acute, subacute, and chronic forms [10, 25]. Conventionally, pain lasting up to 6 weeks is considered acute, up to 3 months subacute, and thereafter chronic [10]. However, causes of low back pain may extend beyond those described above [10, 22].

During history taking, attention should be paid to circumstances suggesting serious diagnoses such as infectious inflammation, malignancy, acute osteoporotic fractures, and neurologic syndromes [10, 22]. Early application of physiotherapy and kinesiotherapy improves range of motion and strengthens muscles without increasing pain [8, 14, 16]. Bed rest has analgesic effects but should be limited to the minimum necessary because of its adverse effects on the musculoskeletal and cardiovascular-respiratory systems [10, 25].

Pharmacotherapy (paracetamol, NSAIDs, opioids) is partially effective but associated with a risk of adverse effects and requires limitation of treatment duration [5,9]. Acupuncture may demonstrate a clinically significant analgesic effect that persists long-term and may exceed placebo effects [17–21].

Acute low back pain typically affects relatively younger individuals (30–40 years) [10, 25]; however, it occurs at all ages [1, 10]. In older adults (>60 years), it often becomes chronic over time and constitutes a significant clinical problem [10, 13, 24]. In addition to conventional treatment (analgesic and anti-inflammatory medications, rest, physiotherapeutic and physical treatments such as massage, TENS, and laser therapy), acupuncture may also be applied in such cases [5, 17–21].

Analgesic mechanisms of acupuncture include the gate control theory of Melzack and Wall [3], neurohumoral modulation (endorphin release; roles of serotonin, dopamine, and acetylcholine) [2, 6, 23], and psychological effects, including reduction of depression and improvement in quality of life [6, 21]. Acupuncture can be used chronically without significant adverse effects, which represents an advantage over pharmacotherapy in older adults [5, 9, 17].

Acute pain syndromes are most often associated with traumatic overload of a motion segment with disc disruption and herniation, most commonly causing conflict with the dural sac and compression of neural structures (nerve roots and spinal nerves) [10, 13]. The clinical presentation typically manifests as sciatica, usually with radiation to one lower limb and occasionally to both, depending on disc damage [10].

Because of pain, patients are often severely limited in activity and may be forced into antalgic positions, sometimes confined to bed [25]. Coughing and sneezing (or other increases in intra-abdominal pressure) exacerbate symptoms [10]. Treatment depends largely on the pathomorphology visualized on magnetic resonance imaging (usually without contrast) [13, 16].

In cases justified by the clinical picture (neurologic deficits such as foot drop or urinary retention), rapid surgical decompression of neural structures should be performed [13, 16]. In selected cases, this may be achieved as a minimally invasive procedure under local anesthesia in a day-surgery setting [14, 13]. In the absence of clear neurologic deficits, acupuncture may additionally be applied with beneficial effects [17–21].

Some research groups have explored electroacupuncture; however, comparative studies have not demonstrated superiority over traditional acupuncture [26]. Screening diagnosis typically involves radiographic examination, which may occasionally be definitive (eg. spondylolisthesis, osteoporotic compression fracture) but usually precedes detailed imaging with magnetic resonance [10,24].

It should be noted that hip joint pathologies – such as femoral head necrosis or hip osteoarthritis – may clinically mimic chronic lumbosacral spine pain [22, 24]. Early correct diagnosis may sometimes "save" the joint and prevent arthroplasty [22]. At the initial visit, blood tests for C-reactive protein, uric acid, and complete blood count are recommended. Normal results may help exclude important pathologies such as infection or bone marrow malignancy [10, 22].

DISCUSSION

The results of the literature analysis indicate that acupuncture may be a valuable complementary method in the treatment of chronic spinal pain syndromes in older adults [17–21]. When combined with physiotherapy and

limited pharmacotherapy, acupuncture may enable pain reduction, improved motor function, and enhanced quality of life [5, 14–16].

Beyond direct analgesic effects, patient education regarding lifestyle, sleep conditions, and minimization of bed rest is crucial [10, 25]. This includes weight reduction when indicated, appropriate sleep surfaces, and adherence to physiotherapy recommendations. Particular emphasis should be placed on early initiation of physiotherapy [8, 14, 16].

Kinesiotherapy is applied in the form of range-of-motion and muscle-strengthening exercises [14,8], which should not provoke pain. Therefore, these interventions may – and should – be combined, when possible, with TENS and acupuncture (in the absence of contraindications) [14, 17, 21]. The McKenzie method may also be applicable [16].

Scientific theories explaining acupuncture's effects relate to changes in neurologic, neurohormonal, and psychological domains [2, 3, 6, 23]. The first physiologic theory addressing acupuncture's analgesic effects was Melzack and Wall's gate control theory [3]. Other authors postulated effects via neural pathways to the thalamus, cutaneo-visceral reflexes, and diffuse noxious inhibitory controls [2, 6].

In summary, when comparing acupuncture with TENS regarding analgesic effects, both modalities likely act at segmental, intersegmental, spinal cord, midbrain, and thalamic levels [2,6]. The addition of electroacupuncture does not confer superiority over traditional acupuncture [26].

Neurohumoral mechanisms suggest involvement of endogenous endorphin release, including within cerebrospinal fluid [2, 6, 23]. Additional roles of serotonin, acetylcholine, and dopamine in modulating acupuncture's analgesic effects have been proposed [23]. Psychological aspects primarily relate to depression, which commonly affects patients with chronic pain [6].

Recent studies suggest that acupuncture exerts a clinically significant and long-lasting analgesic effect in chronic pain conditions [17–21]. Recommending acupuncture for patients with chronic pain is therefore a reasonable therapeutic choice [5,17,21]. In the context of an aging population, reducing the use of analgesics that burden renal and hepatic function is particularly important [5, 9]. Consequently, incorporating acupuncture into standard treatment may yield both clinical and economic benefits [1, 5, 24].

In recent years, Western medicine has shown a marked increase in interest in traditional Chinese medicine (TCM), including acupuncture [5, 26, 27]. Early reports describing acupuncture analgesia during surgical procedures were published in 1971 in a New York journal during the visit of President Nixon's delegation to mainland China [26]. Since that publication, TCM and acupuncture have gained recognition in the United States and many European countries [5, 26].

Confirmation of acupuncture's effectiveness in clinical practice by the World Health Organization occurred in 2003 with the publication of Acupuncture: Review and Analysis of Reports on Controlled Clinical Trials [27].

CONCLUSIONS

Acupuncture has become incorporated into various therapies, particularly in the treatment of acute and chronic low back pain, where its effectiveness has been supported by scientific evidence.

Early diagnosis and differentiation of spinal pain causes are crucial. The role of a thorough and detailed medical history should be emphasized, particularly with regard to serious causes of lumbosacral pain such as malignancy, infectious inflammatory disease, and mechanical conditions including spondylolisthesis and spondylolysis.

Acupuncture may represent an effective and safe method for treating chronic low back pain syndromes in older adults. Treatment should be comprehensive and include physiotherapy, kinesiotherapy, patient education, and limited pharmacotherapy.

Combining acupuncture with other therapeutic methods may reduce pain, improve motor function, and enhance patients' quality of life.

LIMITATIONS

This review is based on previously published studies and did not include a formal systematic review or meta-analysis. The heterogeneity of study designs, patient populations, and acupuncture protocols may limit direct comparison of reported outcomes. Additionally, the analysis was restricted to publications available in selected databases and published in English.

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CONFLICT OF INTEREST

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RECEIVED: 02.01.2026
ACCEPTED: 28.02.2026

REVIEW ARTICLE

Development of pediatric rehabilitation in a supracluster children's hospital in the Chernivtsi region

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ABSTRACT

Aim: To describe the experience of organizing and implementing multidisciplinary pediatric rehabilitation within a supracluster multi-profile children's hospital in the Chernivtsi region under martial law in Ukraine.

Materials and Methods: The study summarizes the organizational development and clinical activity of the rehabilitation department of the Regional Municipal Non-Profit Enterprise "Chernivtsi Regional Children's Clinical Hospital" during 2024–2025. Data from electronic medical records and institutional reports were analyzed in accordance with current Ukrainian legislation regulating rehabilitation care for children.

Conclusions: After obtaining supracluster status in 2023, the hospital established an inpatient rehabilitation department providing services for children with neurological, orthopedic, somatic, and neonatal conditions. In 2024, 554 children received rehabilitation care, including 113 children under 3 years of age. The department functions as a multidisciplinary center equipped with neurophysiological diagnostic facilities and provides individualized rehabilitation programs within a single institutional structure.The development of pediatric rehabilitation within a multidisciplinary supracluster hospital ensures continuity of care, coordinated multidisciplinary management, and improved organizational efficiency. The described institutional experience may serve as a practical model for further development of pediatric rehabilitation services in similar healthcare settings.

KEYWORDS: rehabilitation, child, patient care team, early intervention, continuity of patient care

Acta Balneol. 2026;68(1):58-61 doi: 10.36740/ABAL202601109

INTRODUCTION

During the Russian-Ukrainian war, rehabilitation as a branch of healthcare has gained particular importance in terms of development, technology, science, and innovation [1]. Ukrainian physicians are compelled to acquire extensive practical experience while providing care to military and civilian populations affected by war-related physical and psychological trauma. In many aspects, this experience has become highly relevant in the context of contemporary medical practice [2].

Over the past decade, the integration of rehabilitation services into comprehensive pediatric treatment has undergone significant transformations. An important factor in this process has been the systemic restructuring of the Ukrainian healthcare sector, including the formation of a capable network of medical institutions and the development of economic incentives aimed at expanding the range of medical services [3]. These changes have created prerequisites for continuity of care, infrastructure development, appropriate staffing, and scientific support.

Multidisciplinary hospitals, particularly those providing intensive treatment for complex and comorbid conditions, remain key settings for the implementation of comprehensive rehabilitation services [4]. In this context, the present report describes the institutional experience of organizing and implementing pediatric rehabilitation within a supracluster children's hospital in the Chernivtsi region under martial law.

AIM

To describe the institutional experience of organizing and implementing multidisciplinary pediatric rehabilitation within a supracluster multi-profile children's hospital in the Chernivtsi region under martial law in Ukraine.

MATERIALS AND METHODS

The Regional Municipal Non-Profit Enterprise "Chernivtsi Regional Children's Clinical Hospital" is a multi-profile intensive care hospital of the supracluster level [5]. It provides medical care to approximately 200,000 children of all age groups in the Chernivtsi region and adjacent territories across 35 medical specialties. The institution delivers outpatient services with an annual capacity of 60,000 consultative visits and more than 300,000 laboratory and instrumental diagnostic procedures. Each year, over 10,000 patients receive inpatient treatment.

The bed capacity includes neonatal, hematological, oncological, cardiorheumatological, gastroenterologi-

cal, endocrinological, immunological, neurological, pulmonological, allergological, palliative, and rehabilitation profiles. The hospital has 100 pediatric infectious disease beds, including beds for the treatment of HIV-infected patients. With two intensive care units (for newborns and older children), the institution functions as a specialized pediatric intensive care center in the Chernivtsi region [6].

This report summarizes the organizational development and clinical activity related to the establishment of pediatric rehabilitation services within the institution during 2024–2025.

REVIEW AND DISCUSSION

Despite organizational, structural, and financial barriers inherent in large medical institutions, multidisciplinarity and the ability to provide a wide range of medical services offer significant systemic advantages. Multidisciplinary children's hospitals bring together physicians of different specialties (pediatricians, rehabilitation specialists, neurologists, psychologists, etc.), allowing medical problems to be considered from multiple perspectives. Such an approach facilitates individualized, patient-centered care adapted to specific clinical needs and supported by extensive institutional resources. Electronic medical records and long-term health data improve information exchange and clinical decision-making. A comprehensive approach to treating patients with comorbid conditions within a single episode of care may also reduce financial and time costs while improving diagnostic and therapeutic accuracy.

The Resolution of the Cabinet of Ministers of Ukraine dated February 28, 2023 No. 174 "Some Issues of Organizing a Capable Network of Healthcare Institutions" [7] established minimum areas of medical care for supracluster-level institutions. After obtaining supracluster status in 2023 [7], the Regional Municipal Non-Profit Enterprise "Chernivtsi Regional Children's Clinical Hospital" expanded its medical services and introduced pediatric medical rehabilitation. At the organizational stage, preparatory measures included infrastructure development, staff training, licensing procedures, and compliance with the requirements of the National Health Service of Ukraine under the medical guarantees program [8]. Analysis of scientific sources [9] and practical experience indicate that a large proportion of patients in pediatric rehabilitation departments present with acquired or congenital nervous system disorders. Consequently, neurological beds were incorporated into the rehabilitation department, enabling early initiation of rehabilitation during the acute phase within a single structural unit. This organizational model allowed coordinated treatment planning and continuity of care [10].

The modernization of infrastructure and accessibility standards was carried out in accordance with current building regulations [11]. Special attention was given to early rehabilitation in infants born prematurely or with perinatal pathology [12–14]. The integration of habilitation and rehabilitation measures during the first years of life is particularly important for functional development.

The Law of Ukraine "On Rehabilitation in the Healthcare Sector" No. 1962-IX [15] defines key principles of rehabilitation, including patient-centeredness, timeliness, continuity, sequence, purposefulness, and functional orientation. These principles require coordinated multidisciplinary teamwork.

Modern rehabilitation practice distinguishes varying degrees of professional integration [16–18], including multidisciplinary, interdisciplinary, and transdisciplinary approaches. The highest level of transdisciplinary integration enables broader collaboration, including non-medical stakeholders, and creates opportunities for scaling rehabilitation services beyond the medical institution [19].

An example of transdisciplinary integration is the functioning of the educational space of the state institution "School of Superheroes" within the hospital [20], ensuring continuity of education and supporting psycho-emotional and cognitive development of hospitalized children.

CASE REPORT

A 7-month-old boy (M.) was admitted for inpatient rehabilitation with a diagnosis of anoxic brain damage and delayed psychomotor development.

Upon admission, the child presented with delayed motor development. According to the mother, he did not roll over, sit, bear weight on his feet, or reach for toys. The child had been treated since birth due to hypoxic-ischemic encephalopathy. He was born from the first pregnancy by urgent Caesarean section due to fetal hypoxia, with a birth weight of 1870 g and body length of 45 cm. He had previously received inpatient treatment in the post-intensive care and neonatal rehabilitation department.

Allergic and hereditary history were unremarkable. No recent epidemiological risk factors were identified.

On physical examination, body temperature was 36.6°C, heart rate 132/min, respiratory rate 38/min. The child did not sit, roll over, or crawl. Brachycephaly and asymmetry of the skull were noted. Increased muscle tone in the limbs and decreased tone in the back muscles were observed. Head control was insufficient when pulled to sit. The child visually tracked a toy but did not reach for it. Cardiopulmonary and abdominal examinations were unremarkable.

The patient underwent a structured rehabilitation program according to an individualized rehabilitation plan, including:

- 96129-00 Therapeutic exercises, whole body
- 96120-00 Therapeutic exercises, back or neck muscles
- 96126-00 Therapeutic exercises, lower leg muscles
- 96123-00 Therapeutic exercises, hand muscles and wrist joints
- 96130-00 Training of position and mobility skills
- 96131-00 Training of movement skills
- 96112-00 Training of sensory and sensorimotor function
- 96148-00 Play and recreational therapy
- 96102-00 Family therapy

At discharge, the patient's condition was satisfactory. The child demonstrated improved head control, short-term supported standing, better maintenance of the sitting position with support on hands, and improvement in

muscle tone of the back and lower extremities. Appetite and weight gain were adequate. The child tolerated the rehabilitation load well..

CONCLUSIONS

The establishment of pediatric rehabilitation within a multidisciplinary supracluster children's hospital required systematic organizational planning, infrastructure development, and the formation of a coordinated multidisciplinary team. The integration of neurological and rehabilitation services within a single institutional structure ensured continuity of care and individualized management of children with complex functional disorders.

The presented institutional experience, supported by the clinical illustration, demonstrates the feasibility of this organizational model and its potential applicability in comparable healthcare settings.

LIMITATIONS

This report presents the experience of a single institution and includes a limited clinical illustration. The findings cannot be directly generalized to other healthcare settings. The clinical outcomes were assessed primarily on the basis of routine clinical evaluation without standardized functional scales or long-term follow-up. Further multicenter studies are required to evaluate the effectiveness of the described organizational model.

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CONFLICT OF INTEREST

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RECEIVED: 29.05.2025
ACCEPTED: 26.11.2025

CASE STUDY

Physiotherapy interventions in a patient with degenerative spinal disorders: a case report

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ABSTRACT

Aim: To present a case of multilevel degenerative spinal disorder complicated by metabolic comorbidities and to evaluate the effects of a comprehensive conservative physiotherapy program.

Case presentation: A 54-year-old male with obesity, diabetes mellitus, and hypertension presented with progressive lower back pain, stiffness, and radicular symptoms. MRI revealed multilevel osteochondrosis, spondyloarthrosis, protrusions at Th11–Th12, L3–L5, and Schmorl's hernias at Th7–Th12. ENMG confirmed radiculopathy. A 14-day program combining pharmacotherapy with individualized physiotherapy, including massage, electrophoresis, HILT, kinesiotaping, spinal decompression, and structured exercise therapy, was implemented. Pain intensity assessed by VAS decreased from 8.5 cm to 3.1 cm. Functional disability measured by ODI improved from 46% to 25% after rehabilitation.

Conclusion: A multimodal conservative rehabilitation program may significantly reduce pain and improve function in patients with degenerative spinal disorders and metabolic comorbidities.

KEYWORDS: osteochondrosis, spondyloarthrosis, radiculopathy, physical therapy modalities, rehabilitation

Acta Balneol. 2026;68(1):62-64. doi: 10.36740/ABAL202601110

INTRODUCTION

Osteochondrosis and spondyloarthrosis are degenerative spinal disorders that frequently coexist, especially in older adults, contributing to chronic back pain and reduced mobility.

Osteochondrosis is a very common disease that affects the intervertebral discs and vertebrae. According to various sources, between 50% and 90% of the population suffer from osteochondrosis, with the incidence increasing with age. Osteochondrosis used to be considered a disease of the elderly, but it is now increasingly diagnosed in young people [1, 2].

The relevance of osteochondrosis of the spine is due to its high prevalence, especially in developed countries, affecting people of working age (30–60 years), often leading to complete or partial loss of working capacity, chronic disease course, and progression in the absence of adequate treatment and prevention. Osteochondrosis can lead to serious complications, such as herniated intervertebral discs; therefore, timely diagnosis, treatment, and rehabilitation measures are essential to improve patients' quality of life [3–5].

AIM

To present a case of multilevel degenerative spinal disorder complicated by metabolic comorbidities and to evaluate the effects of a comprehensive conservative physiotherapy program.

CASE PRESENTATION

We report a case of a 54-year-old male with a history of hypertension, diabetes mellitus, and obesity who presented with progressive lower back pain, stiffness, occasional radicular symptoms, fatigue, and reduced work capacity.

On physical examination, the following findings were noted: height – 175 cm, body weight – 134 kg, BMI – 41.3 kg/m^2, HR – 80/min, BP – 140/90 mm Hg, RR – 17/min.

Laboratory findings included: RBC – 5.0×10^{12}/L, Hb – 160 g/L, WBC – 4.7×10^9/L, lymphocytes – 22%, monocytes – 4%, platelets – 120×10^9/L, ESR – 4 mm/h, Ht – 45%, HbA1c – 8.05%, 25-hydroxyvitamin D – 21.2 ng/ml.

Instrumental investigations revealed the following findings: ECG – sinus rhythm, HR – 74/min, left ventricular hypertrophy; electroneuromyography (ENMG) – decreased amplitude of the M-response in both peroneal nerves by 55–60%, with preserved conduction velocity; MRI of the lumbosacral spine – signs of osteochondrosis and spondyloarthrosis, scoliotic deformation of the thoracic spine (grade I), wedge-shaped deformation of vertebral bodies Th7–Th10 (grade I), Schmorl's hernias at Th7–Th12, and left-sided foraminal protrusions at L3–L5 (5 mm).

Neurological consultation confirmed chronic vertebrogenic cervical-thoracic and lumbosacral radiculopathy on the background of osteochondrosis, spondylosis, and spondyloarthrosis, with intervertebral disc protrusions at Th11–Th12 and L3–L5 and Schmorl's hernias at Th7–Th12.

The treatment included non-steroidal anti-inflammatory drugs, B vitamins (B1, B6, B12), and muscle relaxants. A comprehensive physiotherapy program was implemented, consisting of therapeutic massage, ultrasound with electrophoresis, High-Intensity Laser Therapy (HILT), kinesiotaping, orthopedic corset therapy, acupuncture, spinal decompression therapy, and individualized exercise therapy. Examples of selected exercises included strengthening,

Fig. 1. Examples of exercises to reduce lower back pain
Source: Own materials

stretching, and flexibility training tailored to the patient's condition (Fig. 1).

Pain intensity assessed using the Visual Analogue Scale (VAS) decreased from 8.5 cm before rehabilitation to 3.1 cm after 14 days of treatment.

Functional limitation assessed using the Oswestry Disability Index (ODI) improved from 46% before treatment to 25% after two weeks.

Following rehabilitation therapy, the patient reported improved ability to bend forward and sideways, reduced discomfort during squatting, and easier walking.

DISCUSSION

Osteochondrosis and spondyloarthrosis are highly prevalent degenerative spinal disorders that often affect individuals of working age and may significantly impair functional capacity and quality of life [3–5]. If left untreated, osteochondrosis can lead to serious complications, including herniated intervertebral discs and chronic pain syndromes [6, 7].

Spondyloarthrosis represents a chronic degenerative process involving the facet joints and is frequently associated with spondylosis and osteochondrosis, forming the so-called orthopaedic triad "SOS" (spondyloarthrosis, osteochondrosis, spondylosis). The coexistence of these processes may intensify pain and functional limitation.

Schmorl's hernias are relatively common radiological findings, present in approximately 10–15% of the adult population, although only a minority become clinically significant [8, 9]. In the present case, multilevel degenerative changes were accompanied by radiculopathy confirmed by ENMG, indicating both structural and neurophysiological involvement.

Conservative management remains the primary approach in degenerative spinal disorders and includes pharmacotherapy and physiotherapeutic interventions. Drug therapy typically involves NSAIDs, muscle relaxants, B vitamins, and, in selected cases, local corticosteroid injections [10]. Physiotherapeutic modalities such as electrophoresis [11], massage therapy [12, 14], and structured exercise programs [15–20] aim to reduce pain, improve mobility, and strengthen the muscular support of the spine.

Traction therapy may reduce intradiscal pressure and nerve root compression by increasing intervertebral distance and decreasing muscle tension. Early and active rehabilitation is considered important, as prolonged pain may lead to kinesiophobia and maladaptive movement patterns, which complicate recovery.

In cases where conservative treatment is insufficient, interventional procedures such as radiofrequency denervation of the facet joints have been shown to be effective in selected patients with lumbar spondyloarthrosis [21]. However, in the present case, a multimodal conservative rehabilitation program resulted in significant short-term improvement in pain intensity and functional status.

CONCLUSIONS

This case illustrates the complex interplay between multilevel degenerative spinal pathology and systemic comorbidities such as obesity, diabetes mellitus, and hypertension in a 54-year-old male presenting with chronic back pain and radiculopathy. A comprehensive conservative management strategy combining pharmacological therapy with a structured, individualized physiotherapy program resulted in marked short-term reduction in pain intensity and improvement in functional capacity. The findings underscore the importance of multimodal physiotherapy as a key component of conservative management in patients with degenerative spinal disorders and significant metabolic comorbidities.

LIMITATIONS

This report describes a single clinical case with short-term follow-up limited to 14 days. The multimodal character of the intervention makes it impossible to determine the individual contribution of specific therapeutic modalities to the observed improvement. Long-term outcomes were not assessed, and the absence of a control group limits the generalizability of the findings.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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(A) – Work concept and design, (B) – Data collection and analysis, (C) – Responsibility for statistical analysis, (D) – Writing the article, (E) – Critical review, (F) – Final approval of the article

RECEIVED: 31.05.2025
ACCEPTED: 14.01.2026

VARIA

Professor Kazimiera Milanowska, Ph.D. (1926–2018). A tribute on the 100th anniversary of her birth

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ABSTRACT

In February 2026 it will be 100 years since the late Professor Kazimiera Milanowska, Ph.D., co-founder of the Polish school of rehabilitation, an unquestionable authority in the field of rehabilitation, was born. For many years she was a world-renowned specialist in medical rehabilitation, a World Health Organisation rehabilitation expert, co-author of curricula of medical rehabilitation programmes for doctors and physiotherapists in accordance with the recommendations of the World Confederation for Physical Therapy (WCPT). She was the author of numerous publications, including books and coursebooks that shaped generations of Polish physiotherapists. In her professional work she had an opinion of a valued and demanding teacher, at the same time a kind and warm-hearted person, liked and respected by her students and co-workers.

This tribute has been written with the goal of making sure that Professor's contribution is remembered, especially those of the younger generation.

KEYWORDS: Kazimiera Milanowska, medical rehabilitation, physiotherapy, history of rehabilitation

Acta Balneol. 2026;68(1):65-69. doi: 10.36740/ABAL202601111

IN MEMORIAM

PProfessor Kazimiera Milanowska was born on 28 February 1926 in Korzec in the historic region of Volhynia (formerly a part of Poland, now part of Ukraine). She was the eldest child of Jan Adamski, who came from Żelazkowo near Gniezno, Poland, and Salomea née Karolewska from Gniezno. At the time of her birth, her father, a senior sergeant in the Border Protection Corps (Polish: Korpus Ochrony Pogranicza), was serving in Korzec near Hoszcza. Thus, she graduated from primary school in Hoszcza in 1938, and only then did the family move to Czortków near Zaleszczyki (Tarnopolskie Voivodeship). However, already in 1940 she escaped to Hoszcza with her mother and sisters (her father had been sent from the front to a prisoner-of-war camp). She was then displaced to Gniezno. In August 1940, the Germans displaced the family to Kownacica near Dęblin, located near Sobolew in Garwolin County, where the future Professor continued her education. In 1942, she passed her gymnasium exam in Warsaw, for which she had prepared on her own, and in 1944 she passed her maturity exam (Polish secondary school final examinations) at a clandestine school organised by teachers of the E. Plater Secondary School. She also completed a three-month course in medical rescue and a two-month course in nursing. In July 1944, she enrolled at the Faculty of Medicine of the Western University in Warsaw, but just before the outbreak of the Warsaw Uprising she managed to leave the capital and return to Sobolewo.

In April 1945, she began her studies at the Faculty of Medicine at the University of Poznań, from which she graduated in 1950. Initially, she wanted to specialise in paediatric surgery, but already during her studies (from 1946) she became a junior assistant under Prof. Eugeniusz Piasecki (1872–1947) at the Physical Education Department of the Faculty of Medicine at the University of Poznań. Her task was to maintain a library and collect bibliographies on medical gymnastics and massage. As a student interested in school medicine and medical gymnastics and working at the Physical Education Department, she took the opportunity to learn about the methods of physical rehabilitation and in the following years she developed a broader interest in this new field of medicine.

In 1949, she took up a job (still without a diploma) at the Therapeutic Rehabilitation Ward of the Orthopaedic Department of the University of Poznań, which had been opened a year earlier by Professor Wiktor Dega (1896–1995). She worked at the Clinic until 1961, becoming one of the Professor's closest collaborators. At that time, she also worked at the Academy of Physical Education in Poznań, which allowed her to gain experience in both rehabilitation and teaching.

In 1950, she defended her doctoral thesis entitled "Principles of walking training in musculoskeletal disorders", written under the supervision of Prof. W. Dega. In 1953, together with Associate Professor Janina Sikorska-Tomaszewska (1911–1998), she was appointed by the Minister

of Health as one of the first persons in Poland to receive the title of a specialist in medical rehabilitation. In 1966, on the basis of an assessment of her scientific achievements and her thesis entitled "Functional value of paretic muscles after poliomyelitis (strength 2, 3, and 4 according to the Lovett scale) in automatic movements and during work", she was awarded the degree of doctor habilitatus of medical sciences. She became an associate professor in 1984 and was awarded the title of full professor in 1991.

During her professional career, she made a major contribution to the training of professionals working in the field of rehabilitation. In 1951, during the threat of poliomyelitis in Poland, she first completed a three-month course in therapy using the Kenny method in Krč near Prague*, and then, during the polio epidemic in the country (the first signs of the disease were diagnosed in September 1951 in Silesia), she participated in the training of medical staff, including in the field of rehabilitation. At that time, working as the head of the Medical Care Unit for Poliomyelitis at the Central Voivodship Maternity and Child Health Clinic in Poznań, she trained doctors and nurses and helped establish infectious disease wards and rehabilitation sanatoria.

She also began to study thoroughly the issues and problems connected with rehabilitation, which over the years became the purpose of her life. From 1951 to 1960, she was mainly concerned with improving and developing methods of muscle re-education and therapeutic rehabilitation in cases of peripheral neuron damage. Since 1955 she conducted lectures and practical classes in therapeutic gymnastics. In 1958, her and Prof. W. Dega's efforts resulted in the establishment of first- and second-level specialisations in medical rehabilitation.

Also in cooperation with Prof. W. Dega, in 1960 she co-organised the first Department of Rehabilitation Medicine in Poland and Europe, which was located in Poznań. Based on an agreement between the WHO and the Polish Government, an academic rehabilitation centre with 180 beds, facilities, and diagnostic and rehabilitation departments was built for this Department. It served as a curricular and exemplary teaching, research, and training facility in the field of rehabilitation. As a result, in the following years Dr. K. Milanowska became a co-author of rehabilitation curricula at the Academy of Medicine and the Academy of Physical Education, as well as curricula for technical schools of physiotherapy (1960), occupational therapy (1962), postgraduate education in medical rehabilitation (1970), and physical rehabilitation (1984). Her total scientific output includes more than 220 original and co-authored scientific papers, including 38 textbooks, for instance the first textbook on kinesitherapy, occupational therapy and medical rehabilitation**.

Professor K. Milanowska held managerial positions for many years. In 1952–1967 she headed the Voivodeship Rehabilitation Clinic in Poznań; in 1970–1983 she headed the Department of Physical Rehabilitation of the Academy of Physical Education in Poznań; and in 1978–1996 she headed the First Rehabilitation Clinic of the Academy of Medicine in Poznań. In 1960–1974 she served as a voivodship consultant in rehabilitation for the Katowice Voivodship, and in 1987–2002 she served as the national consultant in medical rehabilitation.

She was also very involved in organisational and social activities. In 1953 she started cooperation with the National Rehabilitation Specialist Supervision and in 1956 began work at the Polish Academy of Sciences, serving as secretary of the problem-focused team named Research on Physiological and Social Basis of Rehabilitation. From 1965 to 1988 she served as secretary of the Committee on Rehabilitation and Experimental Therapy, and from 1988 to 2003 as chairwoman of the Committee on Rehabilitation and Social Adaptation at the 6th Division of the Polish Academy of Sciences. From 1977 she advised the WHO on rehabilitation issues. She conducted a study on the Evaluation of rehabilitation services according to the needs of the population, and from 1978 she served as an interim advisor on rehabilitation. She supervised the construction and organisation of the Therapeutic and Occupational Rehabilitation Centre in Repty Śląskie.

In 1960 she became a co-founder and a member of the Executive Board of the Polish Society for Combating Disability. From 1966 she was a member of the Board of

* The method was created by Elizabeth Kenny (1880-1952) – a nurse practising from the 1930s, first in Australia and then in the United States. The method included, for instance, blanketing – wrapping the patient in a hot blanket (50-60 degrees Celsius) to reduce pain, trigger hyperaemia of contracted muscles, and to facilitate exercise, followed by the use of positioning relieving tension in affected muscles, physical modalities, and passive exercises focusing on facilitating proprioceptive sensation etc. The method developed by Kenny for the rehabilitation of polio patients is considered a significant contribution to the development of physiotherapy.

** The most important works include: K. Milanowska, Wartość czynnościowa mięśni niedowładnych po poliomyelitis (o sile 2, 3, 4, wg skali Lovetta) w ruchach automatycznych i podczas pracy [Functional value of paresis muscles after poliomyelitis (strength 2, 3, and 4 according to the Lowett scale) in automatic movements and during work], Wyd. AM in Poznaniu, Poznań 1965; eadem (eds.), Terapia zajęciowa [Occupatinal therapy], PZWL, Warszawa 1965; eadem, Hydroterapia i balneoterapia [Aquatherapy and balneotherapy], [in:] W. Dega, (eds.), Ortopedia i rehabilitacja, II edition, PZWL, Warszawa 1968, pp. 165-170; eadem, Gimnastyka w wadach postawy i skoliozach [Gymnastics in faulty posture and scoliosis], pp. 384-400; eadem, Lecznicze usprawnianie w chorobach układu nerwowego [Therapeutic rehabilitation in nervous system diseases], [in:] Ibidem, pp. 748-781; eadem, Kinezyterapia [Kinesitherapy], PZWL, Warszawa 1970; eadem, Drogi rozwoju rehabilitacji chorych z dysfunkcją narządu ruchu i ze schorzeniami układu nerwowego [Ways to improve rehabilitation for patients with motor dysfunction and nervous system disorders], [in:] A. Hulek (eds.), Rehabilitacja inwalidów w PRL, PZWL, Warszawa 1973, pp. 142-145; eadem (red.), Techniki pracy w terapii zajęciowej [Techniques of work in occupational therapy], PZWL, Warszawa 1982; eadem, Podstawy leczenia usprawniającego – Kinezyterapia [Basics of rehabilitation treatment – Kinesitherapy], [in:] W. Dega, K. Milanowska (red.), Rehabilitacja medyczna, PZWL, Warszawa 1983, pp. 28-48; eadem, Wady postawy [Postural defects], [in:] Ibidem part II, pp. 271-286; eadem, Rehabilitacja osób po urazach [Rehabilitation of patients after injuries], [in:] Ibidem, pp. 321-358.

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the International Society for Rehabilitation Medicine, a member of the Medical Commission of that society, an honorary member of the Polish Rehabilitation Society, and a member of the Board of the European Federation for Scientific Research in Rehabilitation.

Making use of her previously established contacts and even friendships with members of the Lions International movement from Sweden, including Lennart Sandberg, who came to the Institute of Orthopaedics and Rehabilitation in Poznań with charitable help, on 9 March 1991 she founded the Lions Club Poznań Patria – the first female Lions Club in Poland and in Central and Eastern Europe. Professor Kazimiera Milanowska made her first contacts with Swedish Lions already in the 1980s, but as a woman she could not found a club, as it was a men's organisation at that time. Therefore, in 1988 her husband Dr Zbigniew Milanowski contacted his colleague Dr Franciszek Wilamowski, who was working in Sweden at the time, and persuaded him to cooperate and establish contacts with Swedish clubs. These talks led to the registration of the first Polish club, LC Poznań Poland, on 6 April 1989, i.e. before the system transformation of 1989 in Poland. The members of this club are obliged to act according to the values represented in the acronym LIONS, i.e. Liberty, Intelligence, Our Nation's Safety, which literally means that freedom of action should wisely strive to make our society safe. It seems that this formulation fully reflects the content of Professor Kazimiera Milanowska's life and many years of professional work.

In 1996, Madam Professor retired, but her organisational and scientific work continued. Between 1998 and 2004, she was affiliated with the Medical School of Greater Poland (a post-secondary school) in Poznań, where, among other things, she developed curricula for occupational therapy and undergraduate (BSc) studies in physiotherapy. In the following years she also made a major contribution to the

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establishment and development of the College of Education and Therapy in Poznań, of which she was rector from 2005 to 2015 – the College has been named after her since 2015. During her 10 years as rector, she contributed to raising the didactic level by selecting qualified staff and equipping learning facilities. Thanks to this, the College was granted permission to launch graduate (MSc) studies in physiotherapy.

She received numerous awards and distinctions for her professional, scientific and social work: among others the Knight's Cross of the Order of Polonia Restituta, five individual awards from the Ministry of Health and Social Welfare, two individual awards from the Chairman of the Main Committee of Physical Culture and Sports, the special medal of the Creator of Polish Rehabilitation, the 2000 New Millennium Medal of Honour for contribution to the humanity of the world awarded by the American Biographical Institute, the Jędrzej Śniadecki Medal awarded by the Polish Academy of Sciences for outstanding scientific, didactic and organisational achievements in the field of rehabilitation and for the popularisation of the achievements of the Polish school of rehabilitation in Poland and around the world, the award for Exemplary Work in the Health Service, and the International Woman of the Year 2000/2001 award granted by the Cambridge International Biographical Centre for merit in the field of medicine.

Professor Kazimiera Milanowska passed away on 24 January 2018. The funeral ceremony took place on 31 January 2018 at the Nowina 1 cemetery in Poznań.

According to her patients, she highly valued contact with ill people and the opportunity to help those in need and suffering, and thanks to many years of high-level teaching of young people she passionately combined these two aspects of her professional activity.

For many of us, brought up on her textbooks and scientific output, Madame Professor will be remembered as a charismatic and demanding educator, a distinguished figure in the pantheon of the founders of Polish rehabilitation and physiotherapy, a scientist and an authority in these fields. We should therefore always remember her significant contribution and achievements.

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CONFLICT OF INTEREST

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RECEIVED: 30.10.2025
ACCEPTED: 28.01.2026