UDC: 616.831-005.1-036.8:615.825

ENHANCING FUNCTIONAL INDEPENDENCE AND POSTURAL CONTROL AFTER ISCHEMIC STROKE: EFFECTIVENESS OF PSYCHOMOTOR THERAPY ASSESSED BY THE BARTHEL INDEX AND BERG BALANCE SCALE

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Abstract. *Stroke is a leading cause of long-term disability and frequently results in impaired motor function, balance disturbances, and reduced independence in daily activities. The aim of this study was to evaluate the effectiveness of psychomotor therapy in improving functional independence and balance in patients after ischemic stroke using the Barthel Index and the Berg Balance Scale.*

A prospective controlled clinical study included 100 patients with ischemic stroke randomly assigned to an intervention group receiving psychomotor therapy in addition to standard rehabilitation (n=50) and a control group receiving standard rehabilitation alone (n=50). Rehabilitation lasted eight weeks with four sessions per week.

After treatment, the intervention group showed greater improvements in functional independence and balance. The Barthel Index increased from 71.2 to 91.2 points compared with 71.7 to 77.5 in the control group. Berg Balance Scale scores improved from 23.88 to 43.7 in the intervention group versus 24.46 to 30.9 in the control group.

These findings indicate that psychomotor therapy significantly enhances functional independence and postural stability after ischemic stroke and may serve as an effective component of comprehensive stroke rehabilitation.

Keywords: *ischemic stroke, psychomotor therapy, stroke rehabilitation, functional independence, Barthel Index, Berg Balance Scale, balance recovery, postural control.*

Introduction. Stroke remains one of the most important global health challenges and is a leading cause of long-term disability worldwide. According to recent epidemiological studies, stroke affects millions of individuals annually and continues to impose a substantial socioeconomic burden on healthcare systems and societies. Global burden of disease analyses indicate that the absolute number of stroke survivors is steadily increasing due to population aging and improved acute stroke care, resulting in a growing demand for effective rehabilitation strategies [3, 4, 6]. Ischemic stroke accounts for approximately 70–80% of all stroke cases and frequently leads to persistent neurological deficits, including motor impairment, balance dysfunction, and reduced functional independence [7, 11, 12].

Motor deficits represent one of the most disabling consequences of ischemic stroke and affect up to 80% of stroke survivors in the acute phase. These impairments often involve muscle weakness, impaired coordination, postural instability, and limitations in activities of daily living, significantly reducing patients' quality of life and social participation [5, 11]. Balance impairment, in particular, is a major determinant of functional disability after stroke, as it increases the risk of falls and restricts independent mobility [2, 8]. Effective neurorehabilitation approaches therefore aim not only to improve motor performance but also to restore postural control and functional independence through targeted sensorimotor training [7, 1].

Stroke rehabilitation is based on the principles of neuroplasticity, which describe the ability of the central nervous system to reorganize neural pathways and restore lost functions following brain

injury. Intensive and task-oriented rehabilitation interventions can stimulate cortical reorganization and facilitate recovery of motor and functional abilities [4, 12]. Among emerging rehabilitation approaches, psychomotor therapy has gained increasing attention as a comprehensive intervention targeting the integration of motor, cognitive, and emotional processes. This therapeutic approach focuses on body awareness, proprioceptive stimulation, coordinated movements, and multisensory integration, which are essential for restoring functional motor patterns and improving postural stability after neurological injury.

The effectiveness of rehabilitation interventions is typically evaluated using validated clinical outcome measures that assess functional independence and balance performance. The Barthel Index (BI) is one of the most widely used instruments for assessing activities of daily living in stroke patients and provides a quantitative measure of functional independence ranging from total dependence to complete independence [9, 10]. The scale evaluates essential activities such as feeding, bathing, dressing, mobility, and continence, making it a reliable indicator of functional recovery after stroke [10].

In addition to functional independence, balance control represents a critical component of post-stroke recovery. The Berg Balance Scale (BBS) is widely recognized as a valid and reliable tool for assessing postural stability and fall risk in patients with neurological disorders. Numerous studies have demonstrated that BBS scores are strongly associated with mobility outcomes, functional ambulation, and discharge destination after stroke [2]. The use of both the Barthel Index and the Berg Balance Scale therefore allows a comprehensive assessment of rehabilitation outcomes by simultaneously evaluating independence in daily activities and postural control.

Despite advances in neurorehabilitation techniques, optimal rehabilitation strategies for improving balance and functional independence after ischemic stroke remain an active area of research. Psychomotor therapy, which integrates sensorimotor training with cognitive and proprioceptive stimulation, may offer a promising approach for enhancing motor recovery and postural stability. However, the clinical effectiveness of this intervention requires further investigation using validated outcome measures.

Therefore, the aim of this study was to evaluate the effectiveness of psychomotor therapy in patients with ischemic stroke by analyzing changes in functional independence and balance performance using the Barthel Index and the Berg Balance Scale.

Materials and Methods. This study was designed as a prospective controlled clinical study aimed at evaluating the effectiveness of psychomotor rehabilitation in patients after ischemic stroke. The research was conducted in cooperation with the neurology department and specialized rehabilitation centers in Tashkent, Uzbekistan.

All procedures were performed in accordance with international ethical standards for biomedical research involving human participants. Participation in the study was voluntary, and all participants provided written informed consent before inclusion.

Patients received standard neurorehabilitation therapy according to clinical practice guidelines. In addition, patients in the intervention group underwent structured psychomotor rehabilitation sessions conducted by trained rehabilitation specialists.

Participants. A total of 130 individuals were initially screened for participation in the study. Among them, 100 patients with ischemic stroke met the inclusion criteria and were included in the final statistical analysis, while 30 healthy individuals were recruited as a control group for baseline comparison.

Patients with ischemic stroke were randomly assigned into two groups using a simple randomization method (Table 1).

Table 1.

Distribution of participants across study groups

Group	Number of participants
Psychomotor therapy combined with standard	50
Standard rehabilitation	50
Healthy control	30
Total	130

Participant inclusion and exclusion were determined according to the following predefined criteria (Table 2.)

Table 2.

Inclusion and exclusion criteria for participant selection

Inclusion criteria	Exclusion criteria
confirmed diagnosis of ischemic stroke	recurrent stroke
age 30–70 years	severe somatic or psychiatric disorders
post-stroke rehabilitation stage	severe cognitive impairment
NIHSS score 5–20	epilepsy or uncontrolled cardiovascular disease
preserved cognitive ability	inability to participate regularly
stable neurological condition	absence during final evaluation
written informed consent	-

After applying these criteria, 30 patients were excluded, leaving 100 patients for final analysis.

Clinical and instrumental assessment. The diagnosis of ischemic stroke was confirmed using magnetic resonance imaging (MRI) and computed tomography (CT). MRI examinations included DWI, FLAIR, T1-weighted and T2-weighted sequences to identify ischemic lesions.

Additional diagnostic procedures included Doppler ultrasonography of the brachiocephalic arteries, electrocardiography (ECG), and echocardiography (EchoCG). These examinations were carried out to further clarify the etiology of ischemic stroke and to identify possible comorbid cardiovascular conditions that could influence the clinical course of the disease and the rehabilitation process.

Distribution of stroke localization. Stroke localization was classified according to vascular territory using MRI findings (Table 3, Figure 1).

Table 3.

Distribution of ischemic stroke localization

Localization	Psychomotor group (n=50)	Control group (n=50)
Left hemisphere (ACA + MCA)	11 (22%)	13 (26%)
Right MCA territory	17 (34%)	18 (36%)
Vertebrobasilar territory	22 (44%)	19 (38%)

No statistically significant differences between groups were observed at baseline ($p > 0.05$).

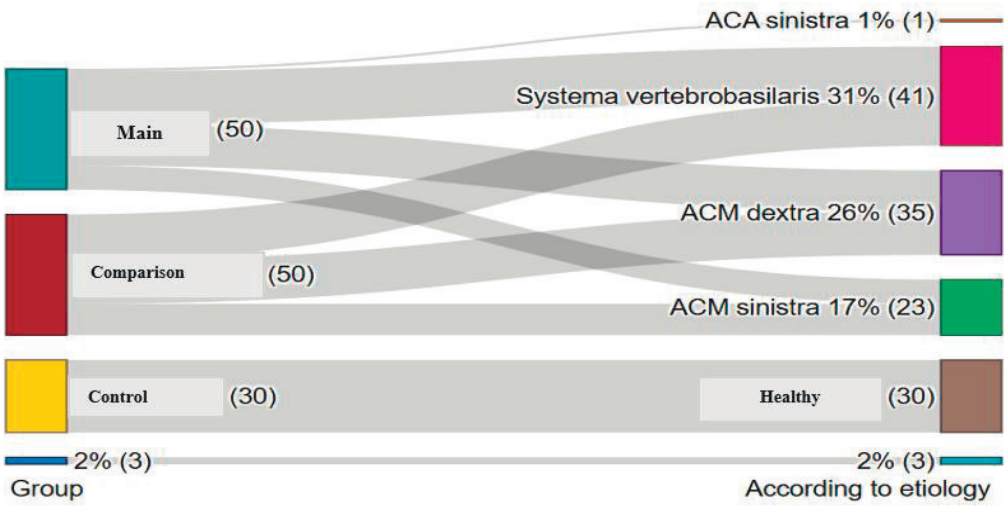


Figure 1. Distribution of stroke localization by vascular territory

Rehabilitation protocol. All participants received standard rehabilitation therapy including therapeutic exercises and functional training.

Patients in the intervention group additionally underwent psychomotor rehabilitation sessions consisting of:

- sensorimotor integration exercises
- coordination training
- rhythmic motor exercises
- task-oriented movement training
- body awareness exercises

The rehabilitation program lasted 8 weeks, with four sessions per week, each session lasting 60 minutes (Table 4).

Table 4.

Psychomotor rehabilitation protocol

Parameter	Value
Session duration	60 minutes
Sessions per week	4
Program duration	8 weeks
Total sessions	32

Recommended diagram structure:

- Warm-up (10 min)
- Sensorimotor exercises (15 min)
- Coordination and balance training (15 min)
- Task-oriented motor exercises (15 min)
- Relaxation and body awareness (5 min)
- Functional Outcome Measures

To comprehensively evaluate the effectiveness of the rehabilitation program, functional and psychoemotional outcomes were assessed using standardized and widely validated clinical scales.

These instruments were selected to capture multiple domains of recovery, including functional independence, motor performance, balance, and emotional status.

Functional independence in daily activities was assessed using the Barthel Index (BI), a widely used instrument for evaluating the level of independence in patients with neurological disorders. The scale reflects the patient's ability to perform essential activities of daily living such as feeding, bathing, dressing, toileting, transfers, mobility, and continence. The total score ranges from 0 to 100 points, where higher scores indicate greater functional independence and a lower level of disability. The Barthel Index is considered a reliable and sensitive tool for monitoring functional recovery during post-stroke rehabilitation.

Balance and postural stability were evaluated using the Berg Balance Scale (BBS), which is one of the most commonly applied clinical instruments for assessing balance performance in patients after stroke. The BBS consists of 14 functional tasks that evaluate both static and dynamic balance, including sitting, standing, transfers, reaching, turning, and single-leg stance. Each task is scored on a five-point scale (0–4), with a maximum total score of 56 points. Higher scores indicate better balance control and a lower risk of falls.

The use of both the Barthel Index and the Berg Balance Scale allows for a comprehensive evaluation of rehabilitation outcomes, as these instruments assess two key components of post-stroke recovery: functional independence in daily activities and postural stability. These measures are widely recommended in clinical and research settings for evaluating the effectiveness of rehabilitation interventions in stroke patients.

All outcome measures were administered twice: at baseline (before the start of rehabilitation) and after completion of the 8-week intervention period. This allowed for the assessment of both within-group changes and between-group differences over time.

Statistical Analysis. Statistical analysis was performed in accordance with the study design, with a significance level set at $p < 0.05$. Descriptive statistics were used to summarize baseline characteristics, with continuous variables expressed as mean ± standard deviation and 95% confidence intervals, and categorical variables as frequencies and percentages.

Due to the ordinal nature of clinical scales and potential non-normal distribution, baseline comparisons between groups were conducted using the Mann-Whitney U test. Categorical variables were analyzed using the chi-square test.

To evaluate changes over time and differences between groups, a two-way mixed-design ANOVA was applied, with time (pre- and post-intervention) as a within-subject factor and group (psychomotor therapy vs. standard rehabilitation) as a between-subject factor. The primary focus was on the interaction effect (time × group), reflecting the effectiveness of the intervention.

Effect sizes were calculated using partial eta squared (η^2p) to assess the magnitude of observed effects. All analyses were performed using standard statistical software.

Results.

Baseline comparability of the study groups. Baseline comparability between the intervention and control groups was assessed to ensure the internal validity of the study design. Since several clinical variables were not normally distributed, the non-parametric Mann–Whitney U test ($\alpha = 0.05$) was used to compare the initial values between groups.

The analysis demonstrated no statistically significant differences between the groups at baseline for any of the evaluated clinical variables, including the Barthel Index (BI), Fugl–Meyer Assessment (FMA) subdomains, Berg Balance Scale (BBS), and Hospital Anxiety and Depression Scale (HADS) subscales ($p > 0.05$). These findings indicate that the intervention and control groups were clinically and functionally comparable prior to the initiation of rehabilitation, which allows subsequent differences to be attributed to the applied rehabilitation intervention rather than pre-existing disparities.

In contrast, the healthy reference group demonstrated significantly higher functional scores and lower psychoemotional symptom levels across all scales, reflecting the expected profile of a neurologically intact population (Figure 2., Table 5).

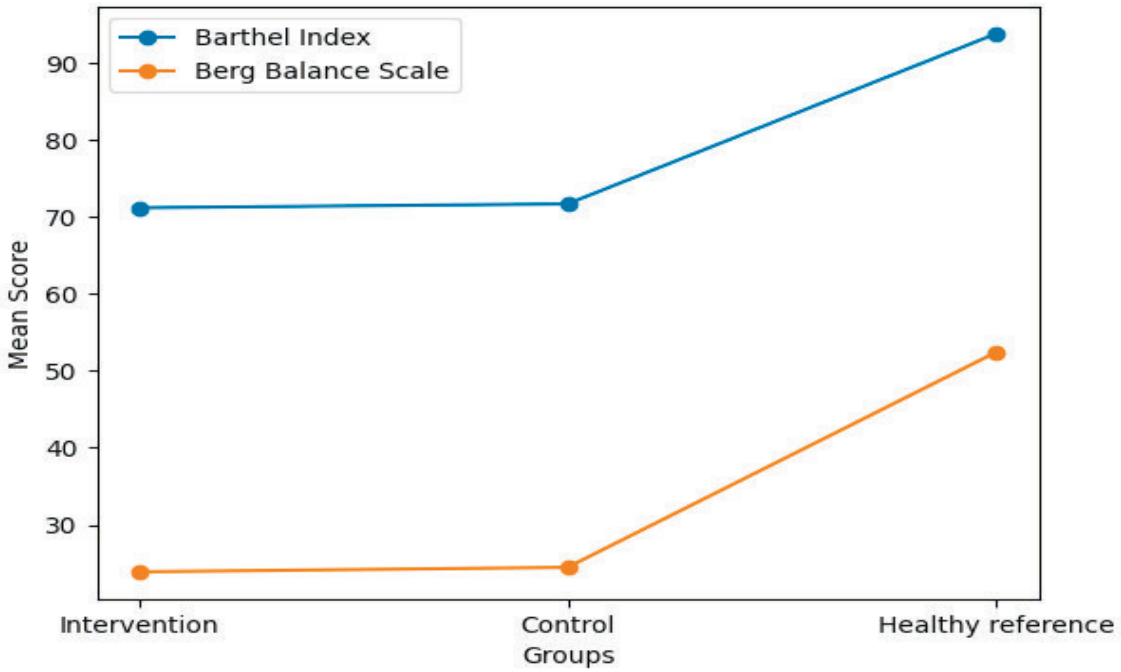


Figure 2. Baseline characteristics of the intervention and control groups according to functional and psychoemotional assessment scales

Table 5.

Baseline comparison of functional independence and balance across study groups (Barthel Index and Berg Balance Scale)

Scale	Intervention group	Control group	Healthy reference
Barthel Index	71.2	71.7	93.8
Balance Scale	23.88	24.46	52.4

Functional independence outcomes based on the Barthel Index. At the beginning of the rehabilitation program, the level of functional independence was comparable between the intervention and control groups. The mean Barthel Index score was 71.2 points in the intervention group and 71.7 points in the control group, with no statistically significant difference between groups ($p = 0.844$).

Following the 8-week rehabilitation program, improvements in functional independence were observed in both groups; however, the magnitude of improvement differed substantially. In the intervention group, the Barthel Index increased from 71.2 to 91.2 points, representing an average improvement of +20.0 points. In contrast, the control group demonstrated a more modest improvement from 71.7 to 77.5 points, corresponding to an average increase of +5.8 points (Figure 2.).

Across the entire sample, the mean Barthel Index score increased from 71.45 to 84.35 points, indicating an overall improvement in functional independence during the rehabilitation period (Table 6).

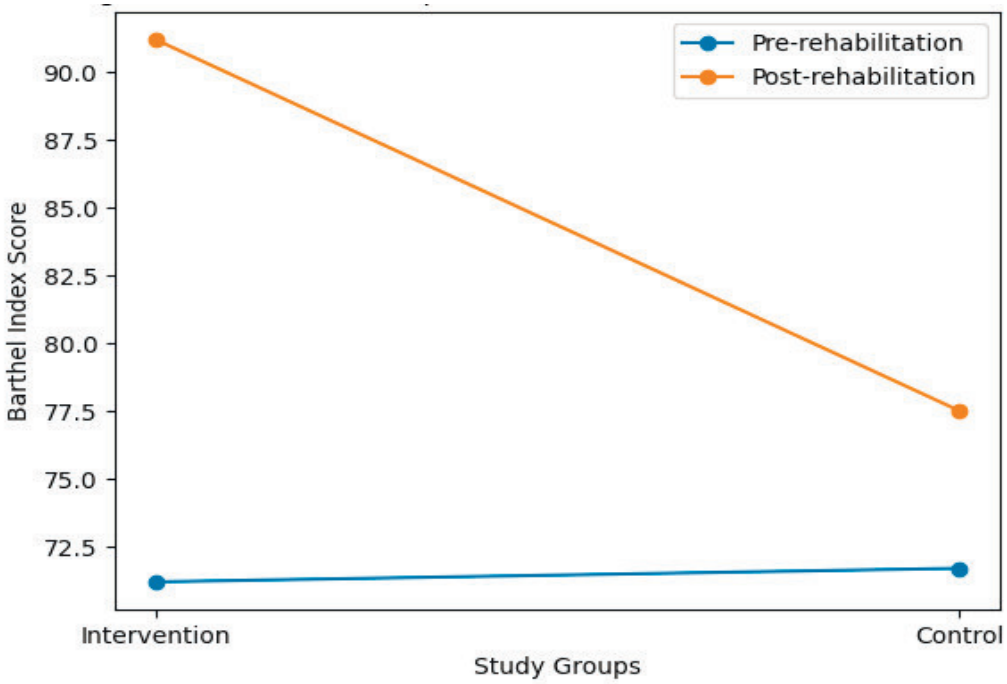


Figure 3. Changes in Barthel Index scores over time in the intervention and control groups

To further examine the effects of rehabilitation, a 2×2 mixed-design analysis of variance (ANOVA) was conducted, with time as the within-subject factor and group (intervention vs. control) as the between-subject factor.

The results demonstrated a significant main effect of time ($F(1,98) = 365$, $p < 0.001$, $\eta^2p = 0.79$), indicating a substantial overall improvement in functional independence during the rehabilitation period. The group effect was also statistically significant ($F(1,98) = 27.67$, $p < 0.001$, $\eta^2p = 0.22$), suggesting that functional outcomes differed between the intervention and control groups.

Importantly, the time × group interaction effect was highly significant ($F(1,98) = 110.57$, $p < 0.001$, $\eta^2p = 0.53$), indicating that the rate of functional recovery was significantly greater in the intervention group compared with the control group.

Table 6.

Mixed-design ANOVA results for the Barthel Index according to time and group factors

Factor	Sum of Squares	df	Mean Square	F	p	η^2	η^2p
BI (Pre vs Post)	8320.5	1	8320.5	365	<.001	0.36	0.79
Group	2178	1	2178	27.67	<.001	0.09	0.22
Time × Group	2520.5	1	2520.5	110.57	<.001	0.11	0.53
Residuals (Between)	7715	98	78.72				
Residuals (Within)	2234	98	22.8				

From a clinical perspective, the increase of the Barthel Index above 90 points in the intervention group indicates that most patients regained a high level of independence in daily activities. Although improvement was also observed in the control group, a certain degree of functional limitation remained.

Changes in balance and postural control (Berg Balance Scale). At baseline, the Berg Balance Scale (BBS) scores indicated comparable levels of balance impairment between groups. The mean

BBS score was 23.88 in the intervention group and 24.46 in the control group, suggesting moderate to severe balance impairment in both groups.

Across the entire sample, the baseline mean BBS value was 24.17, confirming substantial limitations in postural stability among the participants prior to rehabilitation.

Following the rehabilitation program, significant improvements were observed. The mean BBS score increased to 43.7 in the intervention group, while the control group reached 30.9 points. The overall post-rehabilitation mean score across the entire sample was 37.3, reflecting a general improvement in balance function.

The mean balance scores during the study period were 33.79 in the intervention group and 27.68 in the control group, indicating a greater recovery of postural stability in the intervention group (Figure 4).

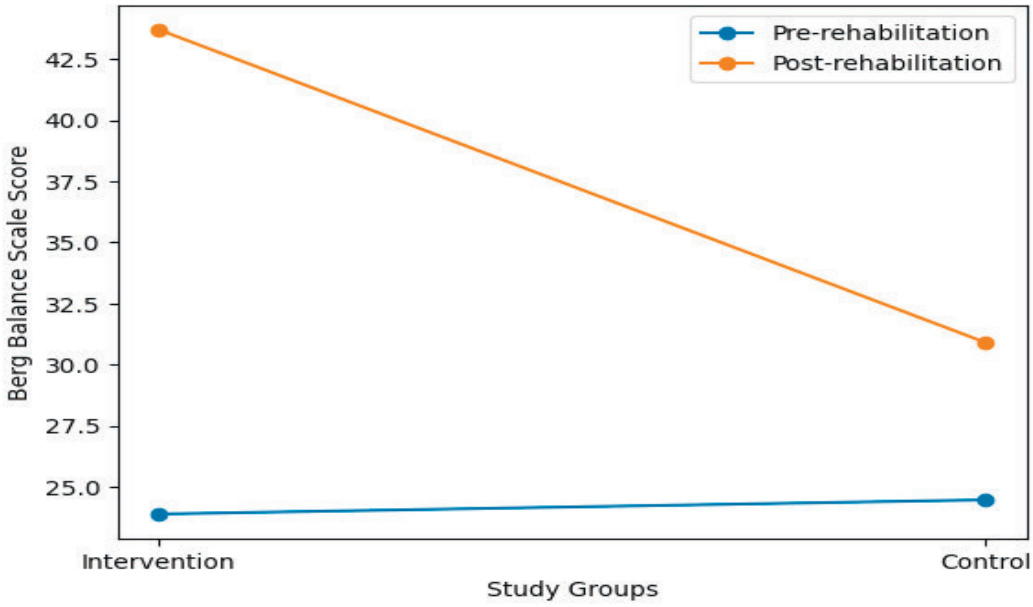


Figure 4. Dynamics of Berg Balance Scale scores in the intervention and control groups over the rehabilitation period

A 2×2 mixed-design ANOVA was performed to analyze the effects of time and group on balance performance.

The results revealed a significant main effect of time ($F(1,98) = 597.9$, $p < 0.001$, $\eta^2p = 0.86$), indicating a substantial improvement in balance function during the rehabilitation period. The group effect was also statistically significant ($F(1,98) = 157.17$, $p < 0.001$, $\eta^2p = 0.62$), suggesting differences in balance outcomes between the intervention and control groups.

Furthermore, the time × group interaction effect was highly significant ($F(1,98) = 155.22$, $p < 0.001$, $\eta^2p = 0.61$), indicating that the improvement in balance and postural control was significantly greater in the intervention group (Table 7).

Table 7.

Mixed-design ANOVA results for the Berg Balance Scale according to time and group factors

Factor	Sum of Squares	df	Mean Square	F	p	η^2	η^2p
BBS (Pre vs Post)	8619.84	1	8619.84	597.9	<.001	0.56	0.86
Group	1866.6	1	1866.6	157.17	<.001	0.12	0.62
Time × Group	2237.8	1	2237.8	155.22	<.001	0.15	0.61

Factor	Sum of Squares	df	Mean Square	F	p	η^2	$\eta^2 p$
Residuals (Between)	1163.85	98	11.88				
Residuals (Within)	1412.85	98	14.42				

These findings demonstrate that the applied rehabilitation intervention produced substantial improvements in both functional independence and balance performance, with significantly greater recovery observed in the intervention group.

Discussion. The present study evaluated the effectiveness of psychomotor therapy in improving functional independence and balance in patients undergoing rehabilitation after ischemic stroke. The results demonstrate that the integration of psychomotor therapy into a standard rehabilitation program leads to significantly greater improvements in both functional independence and postural stability compared with conventional rehabilitation alone.

At baseline, the intervention and control groups were comparable in terms of functional status and balance performance, which ensured methodological validity and allowed the observed changes to be attributed primarily to the applied rehabilitation intervention. The absence of statistically significant differences between the groups before treatment confirms that the groups were well balanced at the beginning of the study.

Following the 8-week rehabilitation program, patients who received psychomotor therapy showed a markedly greater improvement in functional independence as measured by the Barthel Index. The intervention group demonstrated an average increase of 20 points, reaching a mean score of 91.2, which indicates a high level of independence in activities of daily living. In contrast, the control group showed a more modest improvement of 5.8 points. These findings suggest that psychomotor therapy may accelerate functional recovery and facilitate a faster return to independent daily functioning.

A similar pattern was observed in balance outcomes. The Berg Balance Scale scores increased substantially in the intervention group compared with the control group, indicating a greater improvement in postural control and stability. Since impaired balance is one of the main factors contributing to falls and reduced mobility after stroke, improvements in this domain are clinically meaningful. The observed increase in balance scores in the intervention group suggests that psychomotor therapy may effectively enhance sensorimotor integration and postural control mechanisms that are essential for safe mobility.

The statistical analysis further confirmed the effectiveness of the intervention. The significant time effects observed for both the Barthel Index and the Berg Balance Scale indicate that rehabilitation overall contributed to functional recovery. However, the strong time × group interaction effects demonstrate that the magnitude of improvement was significantly greater in the psychomotor therapy group. The large effect sizes obtained in the analysis suggest that the intervention had a clinically meaningful impact on patient outcomes.

The observed improvements may be explained by the multidimensional nature of psychomotor therapy. This therapeutic approach integrates motor training with proprioceptive stimulation, body awareness exercises, and coordinated movement tasks. Such interventions may stimulate neuroplastic processes within the central nervous system and promote the reorganization of motor control networks following ischemic brain injury. Additionally, psychomotor therapy emphasizes purposeful and rhythm-based movements, which may further facilitate motor relearning and improve coordination and balance.

From a clinical perspective, the improvement of the Barthel Index above 90 points in the intervention group indicates that most patients regained a high level of independence in everyday activities. Similarly, the substantial increase in Berg Balance Scale scores suggests improved postural

control and a potentially reduced risk of falls. These outcomes highlight the potential value of incorporating psychomotor therapy into comprehensive stroke rehabilitation programs.

Overall, the findings of the present study support the growing evidence that multidimensional rehabilitation approaches targeting both motor and sensorimotor integration can enhance recovery after stroke. Psychomotor therapy may therefore represent a promising complementary intervention for improving functional independence and balance in patients recovering from ischemic stroke.

Study Limitations. Despite the promising results, several limitations of the present study should be acknowledged.

First, the study was conducted within a single clinical setting, which may limit the generalizability of the findings to other rehabilitation centers or healthcare systems. Multicenter studies involving larger and more diverse patient populations would provide stronger evidence regarding the effectiveness of psychomotor therapy.

Second, the duration of the follow-up period was limited to the rehabilitation phase. Although significant improvements were observed after eight weeks of therapy, long-term follow-up would be necessary to determine whether the observed functional gains are maintained over time.

Third, while the study included validated clinical outcome measures such as the Barthel Index and the Berg Balance Scale, additional objective assessments of motor performance and gait parameters could provide a more comprehensive evaluation of functional recovery.

Finally, although the randomized design strengthened the internal validity of the study, the open-label nature of the intervention may introduce potential performance or expectation biases. Future studies incorporating blinded outcome assessment and larger randomized controlled designs would further strengthen the evidence base.

Despite these limitations, the present study provides important insights into the potential benefits of psychomotor therapy in post-stroke rehabilitation and supports its integration into multidisciplinary rehabilitation programs aimed at improving functional independence and balance recovery.

Conclusion. The results of this study demonstrate that psychomotor therapy can significantly enhance functional independence and balance in patients undergoing rehabilitation after ischemic stroke. At baseline, the intervention and control groups were comparable in terms of functional status and balance performance, with Barthel Index scores of 71.2 and 71.7 respectively, and Berg Balance Scale scores of 23.88 and 24.46, confirming the methodological comparability of the groups prior to rehabilitation.

After the 8-week rehabilitation program, substantial improvements were observed in both outcome measures, with markedly greater changes in the psychomotor therapy group. Functional independence assessed by the Barthel Index increased by 20.0 points in the intervention group (from 71.2 to 91.2), compared with a 5.8-point improvement in the control group (from 71.7 to 77.5). Similarly, balance performance measured by the Berg Balance Scale improved from 23.88 to 43.7 in the intervention group, whereas the control group showed a more modest increase from 24.46 to 30.9.

Statistical analysis confirmed the robustness of these findings. Mixed-design ANOVA revealed a strong effect of time for both functional independence ($F(1,98)=365$, $p<0.001$, $\eta^2p=0.79$) and balance performance ($F(1,98)=597.9$, $p<0.001$, $\eta^2p=0.86$), indicating a substantial overall rehabilitation effect. Importantly, the significant time × group interaction effects for the Barthel Index ($F(1,98)=110.57$, $p<0.001$, $\eta^2p=0.53$) and Berg Balance Scale ($F(1,98)=155.22$, $p<0.001$, $\eta^2p=0.61$) demonstrate that improvements were significantly greater in patients receiving psychomotor therapy.

From a clinical perspective, the increase of the Barthel Index above 90 points in the intervention group suggests that most patients achieved a high level of independence in daily activities. Concurrently, the substantial improvement in Berg Balance Scale scores indicates enhanced postural stability and reduced risk of falls.

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