Journal of Fundamentals of Mental Health

Mashhad University of Medical Sciences

Psychiatry and Behavioral Sciences Research Center

Original Article **Open Access**

Evaluating the comparison of 10-week dual task exercise and Yoga practice on dynamic balance and gait speed under dual-task conditions among bipolar patients

Sahand Ebrahimi[1]; *Razieh Khanmohammadi[2]

[1]*Department of Motor Behavior and Sport Events Management, Faculty of Sports Sciences, Urmia University, Urmia, Iran.*
[2]*Assistant professor, Department of Motor Behavior and Sport Events Management, Faculty of Sports Sciences, Urmia University, Urmia, Iran.*

Abstract

Introduction: This study was to compare the effects of Yoga and dual-task exercise on bipolar patients' gait and dynamic balance under single- and dual-task conditions.

Materials and Methods: Sixty male bipolar patients living in Urmia Psychiatric Center, Iran, in 2023-2024 were assigned to four groups: control (n= 15), dual-task training (n= 15), Yoga (n= 15), or dual-task + Yoga (n= 15). All intervention protocols included 20 group sessions, twice a week. Gait was measured using a 10-meter gait speed test under normal (GS), dual-task cognitive gait (GS_{cog}), and dual-task motor gait (GS_{man}) conditions. Dynamic balance was measured using the Timed Up and Test (TUG), the TUG with a cognitive dual task (TUG_{cog}), and the TUG with a manual dual task (TUG_{man}). We analyzed the data using Shapiro-Wilk test, Levene's F test, ANCOVA test, paired t-test, covariance test and SPSS version 26.

Results: The GS_{cog} and the TUG_{man} were significantly ($P< 0.05$) different from pre- to post-test in dual-task, Yoga, dual-task + Yoga groups. The TUG_{cog} was significantly ($P< 0.05$) different from the pre- to post-test in the dual–task Yoga group. The GS_{cog} in the Yoga practice group was better than the Yoga + dual task group.

Conclusion: Given the observed enhancements in gait speed and dynamic balance under dual-task conditions through dual-task practice and Yoga, we recommended that psychiatric care centers incorporate these interventions into the rehabilitation programs.

Keywords: Balance, Bipolar, Dual task, Gait speed, Yoga

Please cite this paper as:
Ebrahimi S, Khanmohammadi R. Evaluating the comparison of 10-week dual task exercise and Yoga practice on dynamic balance and gait speed under dual-task conditions among bipolar patients. Journal of Fundamentals of Mental Health 2024 Nov-Dec; 26(6): 373-380. DOI: 10.22038/jfmh.2024.82235.3161

Introduction

Bipolar disorder is a major cause of disability among young adults, marked by cognitive impairment and frequent use of healthcare services (1). Emerging research links mood disorders, including bipolar disorder, with

***Corresponding Author:**
Department of Motor Behavior and Sport Events Management, Faculty of Sports Sciences, Urmia University, Urmia, Iran.
r.khanmohamadi@urmia.ac.ir
Received: Aug. 12, 2024
Accepted: Oct. 01, 2024

motor behavior abnormalities, such as impaired gait and balance control. For example, individuals with bipolar disorder often exhibit an unsteady gait (2) and recent findings suggest that balance disturbances are particularly pronounced during depressive episodes, even in younger patients (3). Motor symptoms such as diminished gait velocity and shortened step length correlate with heightened falls and hospital admissions chances. (4). In addition to motor impairments, executive dysfunction and difficulties with divided attention are prevalent in bipolar disorder (5). Research indicates that concurrent cognitive processes while walking influence gait characteristics. The performance cost of walking during the dual task is more evident in the elderly and people with neurological diseases (6). Dual-task training, which combines cognitive and motor exercises, has shown promise in improving gait and balance in various populations (7-9). However, its effects on individuals with bipolar disorder remain underexplored (10). Yoga has been proposed as another potential intervention for improving dynamic balance and gait speed (11,12). Previous investigations suggest that Yoga may enhance Brain-Derived Neurotrophic Factor (BDNF) levels, which are linked to improved cognition and motor learning (13,14). Nonetheless, there is scant evidence comparing the effects of dual-task training versus Yoga in this population.

Given the challenges of postural instability, walking difficulties, and executive dysfunction in bipolar disorder, non-pharmacological treatments such as dual-task training and Yoga may offer valuable therapeutic benefits. This study aims to evaluate the efficacy of these two interventions on gait speed and dynamic balance in individuals with bipolar disorder.

Materials and Methods

This study was conducted from September 2023 to February 2024. The statistical population included all patients with bipolar disorder at Urmia Psychiatric Center. The patients were 120 in a period of 2 months. The minimum sample size by using G*power software version 3.1.9.2 was obtained 60 patients. The inclusion criteria included having a net diagnosis of bipolar disorder by a psychiatrist, having DSM-5 diagnostic criteria for major depression, taking at least one antipsychotic medication along with a daily benzodiazepine dose for a minimum of three consecutive months, having a minimum level of reading and writing, not being hospitalized in the last 2 months due to intolerance of psychological treatment in the acute phase of the disease for at least two months since the last period of relapse. Patients were excluded if they met any of the following criteria: Occurrence of aggressive behaviors, mental retardation, developmental disorders, dementia, physical diseases including liver failure, having epilepsy or other neurological and mental diseases, consumption of opioids and other drugs, having cardiovascular diseases, or musculoskeletal system diseases. The participants took part in a briefing session to get acquainted with the type and purpose of the research, how to cooperate, and how to use the research tools. After obtaining consent, demographic characteristics, gait speed, and dynamic balance were measured. The samples were randomly placed in four groups: dual-task training (n= 15), Yoga (n= 15) and, combined (n= 15), control (n= 15). The intervention groups engaged in assigned programs for 10 weeks, attending two 75-minute sessions per week, while the control group maintained their usual routines without any intervention. Antipsychotic medications were kept consistent before and throughout the study period. All participants were instructed to avoid sports activities during the study. After the 10-week period, all measurements were repeated.

Yoga practice

The patients performed Yoga sessions under the experienced Yoga instructor. The postures included in the program were tree pose, triangle pose, bound angle pose, cat-cow pose, dog looks down pose, cobra pose, camel pose, plow pose, fish pose, Janu pose, half-bridge pose, shoulder-stand pose, candle pose, bow pose, child pose, and lotus pose. Yoga session started with a 10-minute warm-up and finished with 20 minutes of mental exercises focusing on attention and relaxation exercises (10).

Dual-task exercise program

This program outlined by Jardim et al. (15) consisted of 20 sessions to enhance physical and cognitive functions. Each session (75 minutes) included a warm-up: 10 minutes, aerobic exercise: 30 minutes, alternating between walking and functional circuit training (like agility drills and balance exercises), resistance training: 30 minutes, featuring multi-joint exercises targeting major muscle groups (e.g., squats, bench press) with progressive overload every two weeks, stretching: 5 minutes. The program incorporated cognitive tasks alongside physical exercises, which included activities focused on speech and memory: tasks like reciting sequences and forming sentences with specific words, motor learning and choreography: learning and repeating dance moves, reasoning, and problem-solving: engaging in math problems and storytelling, attention, and inhibition: performing tasks in response to auditory stimuli and completing the Stroop test (16).

Dual-task exercise + Yoga

Those participants underwent individual combined dual-task exercises and Yoga (75 minutes), resulting in 30 minutes of dual-task exercise and 30 minutes of Yoga per session. The intervention program was implemented for 10 weeks, 2 times a week, and a total of 20 sessions. Dual-task exercise started with a 10-minute warm-up and a 30-minute aerobic exercise using the equipment. Then, Yoga is followed by asana (physical postures) and a 5-minute cool-down.

Table 1. Dual task intervention protocol

Session	Stimulus	Cognitive tasks simultaneous to exercise	Exercise
1	Speech	Reciting days, months, alphabet	Functional circuit + walking
	Long-term memory	Reproducing words	Resistance training
2-3	Motor learning	New choreography	Dance
	Semantic and phonological fluency	Encouraging the group to memorize words from a particular category or phoneme and say them out loud	Resistance training
	Mathematical thinking	Asking participants to solve addition, subtraction, multiplication, and division problems	Resistance training
4-5	Mathematical thinking	Guessing words	Circuit + walking
	Reasoning	Guessing words	Resistance training
6-7	Long-term memory and motor learning	Story telling	Dance
	Speech	Story telling	Resistance training
8-9	Attention, decision-making	Motor tasks on cues	Functional circuit + walking
	Short-term memory and attention	Motor tasks on cues	Resistance training
10-11	Motor learning	Learning a new choreography	Dance
	Reasoning	Providing clues for participants to guess a hidden word on the board	Resistance training
12-13	Attention, decision-making, and inhibition	Stroop Test	Functional circuit + walking
	Inhibition and processing speed	Stroop Test	Resistance training
14-15	Long-term memory and motor learning	Autobiographical	Dance
	Long-term memory and autobiographical	Autobiographical	
16-17	Motor learning	Learning a new choreography.	Dance
	Mathematical reasoning	Simple mathematical problems.	Resistance training
18-19	Short-term memory	Story telling	Functional circuit + walking
20	Emotional prosody	Identifying emotions on displayed images	Resistance training
	Speech	Story telling	Functional circuit + walking

Research instruments

A) Timed up and Go test (TUG): This test measures dynamic balance ability. Patients were asked to perform the TUG in different ways, such as holding a cup of water (TUG_{man}) or counting down by threes from a number randomly between 70 and 99 (TUG_{cog}) (17,18).

B) The 10-meter Walk Test: This test measures gait speed in meters per second. The test was conducted under three conditions: simple, cognitive dual task (GS_{cog}), and motor dual task (GS_{man}). Patients were asked to compare a projected image with a preceding one, carry a cup with their dominant hand, and complete the test (19). The participants completed both tests twice, and the mean of the two trials was analyzed. We used Shapiro-Wilk test, Levene's F test, and ANCOVA test to check data distribution normality, variance homogeneity, and regression slope. The paired t-test and covariance were used to analyze the data. We applied SPSS version 26.

Results

Demographic variables are seen in Table 2.

The variances and regression slope homogeneity assumption were checked using Levene's F test and ANCOVA test. Therefore, we used the paired t-test ANCOVA test to analyze the data. In Table 3, the results of the paired t-test to investigate the intragroup effects are presented.

Table 2. The demographic characteristics of the groups

Variable	Dual task (Mean ± SD)	Yoga (Mean ± SD)	Yoga +Dual task (Mean ± SD)	Control (Mean ± SD)
Age (Year)	43.40 ± 8.09	45.07 ± 7.12	43.06 ± 6.58	43.27± 8.92
Weight (Kilogram)	70.60 ± 3.06	71.00 ± 4.10	71.20 ± 2.73	70.87 ± 5.11
Height (Centimeter)	172.40 ± 5.23	171.60 ± 3.33	170.93 ± 2.86	169.20 ± 2.81

Table 3. Paired t-test results

Group	Variable	Mean Difference (Pre-test – Post-test)	Pre-test Mean ± SD	Post-test Mean ± SD	T	df	P
Dual task	GS (Second)	-0.76	11.09 ± 1.22	10.33 ± 0.96	-2.36	14	0.033*
	GS_{man} (Second)	-1.50	13.57 ± 1.96	12.07 ± 1.95	-2.62	14	0.020*
	GS_{Cog} (Second)	-8.51	23.10 ± 5.55	14.59 ± 2.16	-6.56	14	0.001*
	TUG (Second)	-0.49	16.31 ± 2.25	15.81 ± 2.34	-1.91	14	0.076
	TUG_{man} (Second)	-2.24	17.69 ± 2.17	15.45 ± 1.97	-5.503	14	0.001*
	TUG_{Cog} (Second)	-1.15	17.72 ± 2.62	16.58 ± 2.83	-1.67	14	0.11
Yoga	GS (Second)	-0.45	10.64 ± 1.44	10.19 ± 1.23	-1.32	14	0.208
	GS_{man} (Second)	-0.19	13.08 ± 2.11	12.89 ± 2.34	-0.796	14	0.439
	GS_{Cog} (Second)	-9.46	22.53 ± 5.01	13.07 ± 1.79	-7.322	14	0.001*
	TUG (Second)	-0.38	16.35 ± 2.27	15.97 ± 2.34	-0.66	14	0.520
	TUG_{man} (Second)	-2.76	17.79 ± 2.30	15.03 ± 1.96	-8.16	14	0.001*
	TUG_{Cog} (Second)	-1.09	17.78 ± 2.70	16.69 ± 2.49	-1.51	14	0.15
Yoga + Dual task	GS (Second)	0.08	10.12 ± 1.84	10.21 ± 1.28	0.267	14	0.793
	GS_{man} (Second)	-0.13	12.65 ± 2.11	12.52 ± 1.95	-0.266	14	0.794
	GS_{Cog} (Second)	-7.25	23.64 ± 6.03	16.40 ± 2.91	-6.75	14	0.001*
	TUG (Second)	-0.56	16.49 ± 2.36	15.93 ± 2.50	-0.952	14	0.357
	TUG_{man} (Second)	-3.14	18.10 ± 2.16	14.96 ± 1.27	-6.525	14	0.001*
	TUG_{Cog} (Second)	-2.30	18.68 ± 2.52	16.39 ± 2.36	2.86	14	0.013*
Control	GS (Second)	0.16	10.40 ± 1.12	10.56 ± 1.09	1.054	14	0.310
	GS_{man} (Second)	-0.14	12.45 ± 1.94	12.31 ± 1.90	-1.032	14	0.319
	GS_{Cog} (Second)	0.29	23.78 ± 5.84	23.49 ± 5.70	-2.058	14	0.059
	TUG (Second)	0.03	16.75 ± 2.31	16.78 ± 2.33	0.702	14	0.494
	TUG_{man} (Second)	-0.28	17.95 ± 2.37	17.67 ± 2.33	-1.086	14	0.296
	TUG_{Cog} (Second)	-1.39	18.55 ± 2.41	17.16 ± 5.27	-1.191	14	0.253

GS= GS single, GS_{man}= GS manual, GS_{Cog}= GS cognitive, TUG= TUG single, TUG_{man} = TUG manual, TUG_{Cog}= TUG cognitive. *P<0.05

The results of the paired t-test showed that TUG_{man} and GS_{Cog} improved significantly in all experimental groups from pre-test to post-test stages (P< 0.05). Also, the GS (T(14)= -2.36, P= 0.033) and GS_{man} (T(14)= -2.62, P= 0.020) improved significantly from pre-test to post-test in the dual task group. Also, the TUG_{Cog} (T(14)= 2.86, P= 0.013) improved significantly in Yoga+ dual task from the pre-test to the post-test stages. The results of the covariance analysis showed that after removing the pre-test effect, there was no significant difference between the post-test scores of GS, GS_{man}, TUG, and TUG_{Cog} in the groups (P> 0.05). The ANCOVA test results showed that after removing the pre-test effect, there was a significant difference between the post-test scores of GS_{Cog} and TUG_{man} in the research groups (P< 0.05) (Table 4). Therefore, Bonferroni's post hoc test was used to compare pairs of groups (Table 5).

Table 4. ANCOVA test results

Variable	Source	Sum of squares	df	Mean square	F	P	Partial Eta
GS (Second)	Pre-test	30.24	1	30.24	38.13	0.001 *	0.41
	Group	3.077	3	1.026	1.29	0.28	
	Error	43.62	55	0.793			
GS_{man} (Second)	Pre-test	119.914	1	119.914	57.64	0.001 *	0.51
	Group	13.65	3	4.55	2.18	0.100	
	Error	114.42	55	2.08			
GS_{Cog} (Second)	Pre-test	319.36	1	319.36	48.23	0.001 *	0.47
	Group	872.002	3	290.667	43.900	0.001 *	0.70
	Error	364.16	55	6.62			
TUG (Second)	Pre-test	175.87	1	175.87	68.78	0.001*	0.56
	Group	4.161	3	1.387	0.54	0.65	
	Error	140.618	55	2.55			
TUG_{Cog} (Second)	Pre-test	112.219	1	112.219	11.140	0.002 *	0.17
	Group	7.06	3	2.35	0.23	0.87	
	Error	554.04	55	10.074			
TUG_{man} (Second)	Pre-test	120.34	1	120.34	76.26	0.001 *	0.58
	Group	72.86	3	24.28	15.39	0.001 *	0.46
	Error	86.78	55	1.57			

GS= GS single, GS_{man}= GS manual, GS_{Cog}= GS cognitive, TUG= TUG single, TUG_{man}= TUG manual, TUG_{Cog}= TUG cognitive. *P<0.05

Table 5. Bonferroni post hoc test results

Variable	Group I	Group J	Mean Difference (I-J)	P
GS_{Cog} (Second)	Control	Dual task	-8.608	0.001 *
		Yoga	-9.89	0.001 *
		Yoga + Dual task	-7.036	0.001 *
	Dual task	Yoga	1.57	0.99
		Yoga + Dual task	-0.75	0.601
	Yoga	Yoga +Dual task	2.85	0.022 *
TUG_{man} (Second)	Control	Dual task	-2.055	0.001 *
		Yoga	-2.53	0.001 *
		Yoga + Dual task	-2.81	0.001 *
	Dual task	Yoga	-.48	0.99
		Yoga + Dual task	-.75	0.63
	Yoga	Yoga + Dual task	-.27	0.99

*P< 0.05

The results of Bonferroni's post hoc test revealed a significant difference (P< 0.05) in the TUG_{man} and GS_{Cog} between the groups of dual task (P= 0.001) (P= 0.001), Yoga (P = 0.001) (P= 0.001) and Yoga + Dual task (P= 0.001) (P= 0.001) with the control group. The TUG_{man} and GS_{Cog} in all the intervention groups were better than the control group. Also, there was a significant difference in the GS_{Cog} between the Yoga and Yoga + Dual task group (P= 0.009). Also, the GS_{Cog} in the Yoga group was lower than in the Yoga + Dual task group. We did not see any significant difference between other pairs of groups.

Discussion

This study compared the effect of various interventions (dual-task multimodal physical exercise training, moderate intensity, and Yoga) on the gait and dynamic balance under single and dual-task conditions in bipolar patients. The results showed that the GS was improved in the dual-task group. However, no significant difference was observed between the groups. Our results align with those of Plummer et al. (20), Kim et al. (21), and An et al. (22), who also demonstrated improvements in gait speed following dual-task training. These studies share similar methodologies in employing dual-task paradigms, where participants perform cognitive tasks while walking, highlighting the shared neural pathways between gait and cognition. Dual-task exercises enhance motor and cognitive functions, corroborating the neuroplasticity theories associated with the shared demands on attention and motor control pathways (23).

However, unlike previous studies that reported significant differences between groups (24,25), our study did not find such differences. This discrepancy could be attributed to variations in study design and population characteristics. For example, Tasvuran Horata et al. (25) focused on older healthy adults. At the same time, our study included bipolar patients whose motor and cognitive impairments may be influenced by mood fluctuations and medication effects, as highlighted by Zarate et al. (26). The findings demonstrated a significant improvement in GS_{man} in the dual-task group, consistent with results from Liu and Wang (27). Dual-task paradigms are widely employed to explore how cognitive resources are distributed between two tasks. This approach is based on three key assumptions: (1) attention capacity is limited, (2) performing any task consumes a portion of this capacity, and (3) when two tasks demand more attention than available, performance in one or both tasks will decrease (28). In dual-task training, the simultaneous cognitive load may interfere with task execution, leading participants to recruit additional muscles to compensate for this interference. As a result, their muscle strength and neuromuscular fitness improved, contributing to the observed enhancement in gait speed. Additionally, participating in dual-task training likely reduced the attention required for motor tasks, allowing participants to allocate their cognitive resources more effectively, further improving gait speed.

Additionally, the improvements in GS_{Cog} across all intervention groups indicate that both dual-task training and Yoga enhanced cognitive-motor integration. The superiority of Yoga in GS_{Cog} over the Yoga + dual-task group may suggest that the simultaneous cognitive load imposed by dual-task training reduced the potential for motor improvement, as proposed by the valence sharing theory (23). This controlled movement in Yoga may foster better motor control than the divided attention required in dual-task settings.

Contrary to our expectations, no improvement in TUG performance was observed in any group except for TUG_{Cog} in the dual-task + Yoga group. The timed up test assesses functional mobility by measuring balance, lower limb strength, and gait. While Konak et al. reported significant improvements in TUG following dual-task balance exercises in older adults with osteoporosis (29), our study did not replicate these findings. One reason for this inconsistency may lie in the interventions. In Konak's study, participants engaged in balance-specific exercises, whereas our interventions included resistance and aerobic training, which may not target the neuromuscular control required for the TUG. Moreover, the frequency of intervention in Konak's study (three sessions per week) was higher than in our study (two sessions per week), which may have contributed to the different outcomes. Increasing the intervention frequency could improve TUG performance in future studies.

The improvement in TUG Cog within the dual-task + Yoga group supports the idea that combined cognitive and motor training enhances attention allocation during dual-task scenarios. This finding is consistent with Chen and Tang, who reported that improvements in attention-related tasks translate to better performance under cognitive load conditions. Yoga's role in promoting focus and awareness during movement execution may also have contributed to these improvements, as patients need to maintain attention during yoga postures, thus enhancing cognitive engagement and focus (18). TUG_{man} improved in all intervention groups, with the Yoga, dual-task + Yoga, and dual-task groups performing better than the control group. Given that TUG_{man} emphasizes motor load more than cognitive load (23), this improvement may be attributed to the motor-focused nature of these interventions (10) and Kelley et al. also found that Yoga enhances balance under dual-task conditions, which is consistent with our findings (30). Participants' strength and balance influence the TUG_{man} test, as it requires maintaining dynamic stability during tasks like transferring, turning, and walking without spilling water. Yoga contributed to physical improvements through stretching, strengthening, and balancing exercises. As a complementary therapy, Yoga fosters the integration of mind and body, enhancing muscle strength, endurance, flexibility, range of motion, and proprioception-all of which contribute to better balance.

Conclusion

This study evaluated the effects of dual-task, moderate-intensity, and Yoga on gait and dynamic balance in bipolar patients under single- and dual-task conditions. The results showed that Gait Speed (GS) improved in the dual-task group, with GS_{man} improving in the dual-task group and GS_{Cog} improving across all intervention groups. The Yoga group performed better GS_{Cog} than the combined Yoga + Dual-task group. The Timed Up and Go (TUG) test showed no improvement in any group, but TUG_{Cog} improved in the dual-task + Yoga group, and TUG_{man} improved in all intervention groups, outperforming the control group. Considering the improvement of gait speed and balance through cognitive dual-task practice and Yoga practice, it is suggested that these interventions be included in the rehabilitation program of psychiatric care centers.

Acknowledgments

We thank the patients and their families for participating in this study and appreciate the full cooperation of the university officials.

Conflict of Interest

The authors declare no conflict of interest.

Funding

The authors declare no funding.

Ethical Considerations

Participants reviewed and signed an informed consent form. They were assured they could withdraw from the research at any stage if they did not wish to continue cooperating. All interventions were provided free of charge. The Ethical Committee of Biomedical Research at the Institute of Physical Education and Sports Sciences approved the study.

Code of Ethics

ID IR.SSRC.REC.1402.127

Authors' Contributions

S.E: Methodology/study design, data curation, resources, and R.K.: Methodology/study design, investigation, writing original draft, and editing.

References

1. Mayor S. Bipolar disorder: most patients receive suboptimal treatment, finds Scottish study. BMJ 2019; 364: I957.
2. Adolph D, Tschacher W, Niemeyer H, Michalak J. Gait patterns and mood in everyday life: A comparison between depressed patients and non-depressed controls. Cognit Ther Res 2021; 45: 1128-40.
3. Kang GE, Mickey BJ, Krembs BS, McInnis MG, Gross MM. The effect of mood phases on balance control in bipolar disorder. J Biomech 2019; 82: 266-70.
4. Hoogendijk EO, Rijnhart JJ, Skoog J, Robitaille A, Van Den Hout A, Ferrucci L, et al. Gait speed as predictor of transition into cognitive impairment: Findings from three longitudinal studies on aging. Exp Gerontol 2020; 129: 110783.
5. Holtgraves T, Giordano M. Parkinson’s disease without dementia. In: Research in clinical pragmatics. USA: Ball State University; 379-407.
6. Naidu AS, Vasudev A, Burhan AM, Ionson E, Montero-Odasso M. Does dual-task gait differ in those with late-life depression versus mild cognitive impairment? Am J Geriatr Psychiatry 2019; 27(1): 62-72.
7. Abdollahi M, Kuber PM, Pierce M, Cristales K, Dombovy M, LaLonde J, et al. Motor-cognitive dual-task paradigm affects timed up & go (TUG) test outcomes in stroke survivors. Proceeding of the 11th International IEEE/EMBS Conference on Neural Engineering (NER). Baltimore, USA; 2023.
8. Ricklin S, Meyer-Heim A, van Hedel HJ. Dual-task training of children with neuromotor disorders during robot-assisted gait therapy: Prerequisites of patients and influence on leg muscle activity. J Neuroeng Rehabil 2018; 15: 1-12.
9. Mishra N. Comparison of effects of motor imagery, cognitive and motor dual task training methods on gait and balance of stroke survivors. Indian journal of occupational therapy 2015; 47(2).

10. Čekanauskaitė A, Skurvydas A, Žlibinaitė L, Mickevičienė D, Kilikevičienė S, Solianik R. A 10-week yoga practice has no effect on cognition, but improves balance and motor learning by attenuating brain-derived neurotrophic factor levels in older adults. Exp Gerontol 2020; 138: 110998.
11. Lin A-C, Lin T-T, Tan Y-K, Pan W-R, Shih C-J, Lee C-J, et al. Superior gait performance and postural stability among yoga instructors-Inertial Measurement Unit-Based Evaluation; Sensors 2022; 22(24): 9683.
12. Krejčí M, Psotta R, Hill M, Kajzar J, Jandová D, Hošek V. A short-term yoga-based intervention improves balance control, body composition, and some aspects of mental health in the elderly men. Acta gymnica 2020; 50(1): 16-27.
13. Alcantara CC, García-Salazar LF, Silva-Couto MA, Santos GL, Reisman DS, Russo TL. Post-stroke BDNF concentration changes following physical exercise: A systematic review. Front Neurol 2018; 9: 637.
14. Bisht S, Chawla B, Tolahunase M, Mishra R, Dada R. Impact of yoga based lifestyle intervention on psychological stress and quality of life in the parents of children with retinoblastoma. Ann Neurosci 2019; 26(2): 66-74.
15. Jardim NYV, Bento-Torres NVO, Costa VO, Carvalho JPR, Pontes HTS, Tomás AM, et al. Dual-task exercise to improve cognition and functional capacity of healthy older adults. Front Aging Neurosci 2021; 13: 589299.
16. De Oliveira TCG, Soares FC, De Macedo LDED, Diniz DLWP, Bento-Torres NVO, Picanço-Diniz CW. Beneficial effects of multisensory and cognitive stimulation on age-related cognitive decline in long-term-care institutions. Clin Interv Aging 2014; 9: 309-21.
17. Chan PP, Tou JIS, Mimi MT, Ng SS. Reliability and validity of the timed up and go test with a motor task in people with chronic stroke. Arch Phys Med Rehabil 2017; 98(11): 2213-20.
18. Chen H-Y, Tang P-F. Contributing factors of single-and dual-task timed up and go performance in active community-dwelling middle-aged and older adults. Phys Ther 2015; 96(3): 284-92.
19. Yoshino Y, Yoshida T, Mori T, Hirota S, Iga J, Ueno S-i. Risk of idiopathic normal pressure hydrocephalus in older inpatients with schizophrenia. Int Psychogeriatr 2016; 28(5): 863-8.
20. Plummer P, Villalobos RM, Vayda MS, Moser M, Johnson E. Feasibility of dual-task gait training for community-dwelling adults after stroke: a case series. Stroke Res Treat 2014; 2014: 538602.
21. Kim GY, Han MR, Lee HG. Effect of dual-task rehabilitative training on cognitive and motor function of stroke patients. J Phys Ther Sci 2014; 26(1): 1-6.
22. An H-J, Kim J-I, Kim Y-R, Lee K-B, Kim D-J, Yoo K-T, et al. The effect of various dual task training methods with gait on the balance and gait of patients with chronic stroke. J Phys Ther Sci 2014; 26(8): 1287-91.
23. Ruthruff E, Pashler HE, Klaassen A. Processing bottlenecks in dual-task performance: Structural limitation or strategic postponement? Psychon Bull Rev 2001; 8(1): 73-80.
24. Merchant RA, Tsoi C, Tan W, Lau W, Sandrasageran S, Arai H. Community-based peer-led intervention for healthy ageing and evaluation of the ‘HAPPY’program. J Nutr Health Aging 2021; 25: 520-7.
25. Tasvuran Horata E, Cetin SY, Erel S. Effects of individual progressive single-and dual-task training on gait and cognition among older healthy adults: A randomized-controlled comparison study. Eur Geriatr Med 2021; 12: 363-70.
26. Zarate CA, Tohen M, Land M, Cavanagh S. Functional impairment and cognition in bipolar disorder. Psychiatr Q 2000; 71: 309-29.
27. Liu Y-C, Yang Y-R, Tsai Y-A, Wang R-Y. Cognitive and motor dual task gait training improve dual task gait performance after stroke-A randomized controlled pilot trial. Sci Rep 2017; 7(1): 4070.
28. Siu K-C, Woollacott MH. Attentional demands of postural control: The ability to selectively allocate information-processing resources. Gait Posture 2007; 25(1): 121-6.
29. Konak H, Kibar S, Ergin E. The effect of single-task and dual-task balance exercise programs on balance performance in adults with osteoporosis: A randomized controlled preliminary trial. Osteoporos Int 2016; 27(11): 3271-8.
30. Kelley KK, Aaron D, Hynds K, Machado E, Wolff M. The effects of a therapeutic yoga program on postural control, mobility, and gait speed in community-dwelling older adults. J Altern Complement Med 2014; 20(12): 949-54.