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Effectiveness of Cognitive Dual Task Versus Treadmill Training on Cognition, Anxiety and Depression in Parkinson's Patients

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Abstract

Introduction / objective:

Gait abnormalities can result from motor impairments caused by Parkinson's disease (PD), including functional walking. This may lead to a decrease in gait speed and stride length and an increase in stride-to-stride variability. Early motor skill development depends heavily on the cortical parts of the brain, but dual task walking may demand attention, impairing the basal ganglia circuitry that controls the more natural walking task and increasing the risk of falls. This study aims at evaluating the effectiveness of cognitive dual task on cognition, anxiety, and depression in Parkinson's patients, to see the effectiveness of treadmill training on cognition, anxiety, and depression in Parkinson's patients and to compare the effectiveness of cognitive dual task and treadmill training on cognition, anxiety, and depression in Parkinson's patients.

Materials and methods:

Patients were assessed and those who met the screening criteria were included in the study. Written informed consent was obtained. Patients were divided into two groups, interviewed, and baseline outcomes of cognition, anxiety, and depression were obtained using the Montreal cognitive assessment and anxiety and depression scale.

A total number of 54 patients were selected for the study. The study involved screening patients using Performa and conducting a detailed physical examination. The selected patients were divided into two groups of 27 patients, each given informed consent. They were treated for three sessions per week for six weeks, with Group A focusing on cognitive dual task training and Group B on treadmill training.

Results:

The comparison between the groups using unpaired t test. All p values were less than 0.05 and was considered significant. Analysis was done using SPSS20.0 (IBM) Software.

Conclusion:

The study found that both cognitive dual task and treadmill training strategies significantly improved cognitive function and reduced anxiety and depression, with the cognitive dual task group showing the most significant improvement.

Keywords:

Parkinsonism, cognitive dual task training, treadmill training, anxiety and depression.

Introduction:

A neurological degenerative condition called Parkinson's disease (PD) causes motor deficits like functional walking. One type of functional walking that is necessary for day-to-day living is dual task walking. Walking and executing simultaneous tasks are frequently necessary in daily life. Cognitive or motor task, as holding a cup of coffee or conversing with a friend. According to reports, gait abnormalities in individuals with Parkinson's disease (PD) are most apparent when doing simultaneous tasks. These impairments include increased stride-to-stride variability and decreased gait speed and stride length[1 - 4].

The cortical areas of the brain are crucial throughout the early phases of motor skill development in movement regulation, as movements that are believed to be regulated by the basal ganglia become automatic and learned[5]. Walking is one of the learnt actions that persons with Parkinson's disease may still be produced when the performance is the focus. Dual task walking, however, may require the attention to focus on completing the secondary task, leaving the impaired basal ganglia circuitry in charge of controlling the more natural walking job[2]. As a result, when PD patients walked on two tasks as opposed to their regular walking, their gait speed dropped and their gait automaticity, as measured by their stride variabilities, rose[2]. Different dual task walking may increase the risk of falls due to secondary task interference.

Methods and material:

Study design: an experimental study.
Sample size: 54
Group A = 27 patients
Group B= 27 patients
Sampling technique: Non-Probability Sampling
Sample design: Simple random sampling with lottery method.
Duration of study: 3 days/week up to 6 weeks.

Inclusion criteria[6 - 8]:

- Diagnosis of PD according to the POSTUMA diagnostic criteria, in II-III Hoehn and Yahr, in stable drug therapy for at least 1 month
- Age: 45 to 65 years
- Gender: Male and Female
- Gait disturbance
- Ability to walk for at least 5 min without assistance.
- Willing to participate in the study and ability to understand and sign informed consent.

Exclusion criteria[6 - 8]:

- Other pathologies able to interfere with motor skills as symptomatic arthritis involving hip/knee/ankle, stroke outcomes or severe polyneuropathy.
- Cognitive impairment potentially interfering with rehabilitation procedures, estimated as a corrected score of less than 18.58 at the Montreal Cognitive Assessment (moca)
- Hallucinations and other psychiatric disorders not controlled by drug therapy, as in case of alcohol or drug abuse.

- Uncompensated visual/auditory deficit that limits the enjoyment of the cues provided by the AVR.
- Communication deficit from any because that impairs understanding of the task and the objectives of the intervention.
- Medical conditions hindering the effect of the training as severe orthostatic hypotension and severe cardiovascular diseases.

Outcome measures:

- **Montreal cognitive assessment**: Test–retest reliability data of the Arabic moca were collected approximately 35.0 ± 17.6 days apart. The mean change in Arabic moca scores from the first to second evaluation was 0.9 ± 2.5 points, and correlation between the two evaluations was high (correlation coefficient = 0.92, $P < 0.001$). The internal consistency of the Arabic moca was good, yielding a Cronbach's α on the standardized items of 0.83[9].
- **Hospital anxiety and depression Scale:** There was a good correlation between the different depression rating scales, with the magnitude of the correlations ranging from 0.39 to 0.72 (all $p < 0.01$; see Table 2), and there was a trend for an association between the Ham-D and the VAS depression ($r = -0.31$; $p < 0.05$)[10].

Method:

All the patients were assessed as per the evaluation format. Those who fulfil the screening were taken up for the study. The procedure was explained to all the patients. Written informed consent of all the players was taken. Then the subjects were divided into two groups in the initial evaluation session, patients were interviewed, and the baseline outcomes of cognition, anxiety and depression were obtained by Montreal cognitive assessment and anxiety and depression scale.

Procedure:

A total number of 54 patients were selected for the study. Each patient was screened initially by using a simple selection Performa relevant to the inclusion criteria. Those who fulfilled this symptomatic criterion underwent a detailed physical examination. Then the selected players who were willing to participate were divided into two groups of 27 patients in each group. The details and purpose of the study were explained and informed consent was obtained from each patient.

Each patient of the study was treated for 3 sessions per week for 6 weeks.

In Group A- Cognitive dual task training

In Group B- Treadmill training

Group A: Cognitive dual task training[11.]

- Walking forward – 5 minutes
- Walking in S shaped route – 5 minutes
- Walking and obstacle crossing - 5 minutes
- Tandem Walking - 5 minutes
- Backward walking - 5 minutes

➢ **Repeating Words:**

- Counting a 3-digit number
- Answering simple questions
- Reciting shopping list
- Reciting a short sentence backward
- Singing

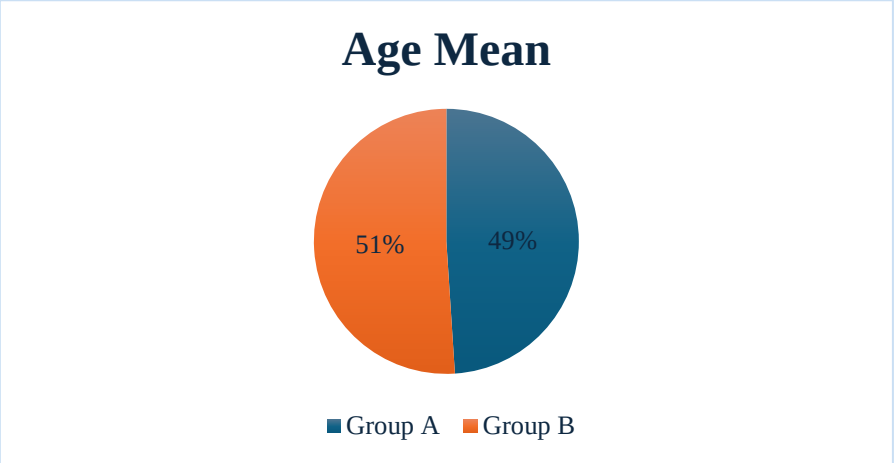
Group B: Treadmill training[12].

The training program included three 30-minute sessions per week for six weeks, for a total of eighteen sessions. Every week, the treadmill speed was modified based on a reassessment of the over ground walking speed. The use of a rigorous and gradual gait training program was a novel feature of this study. Since walking on a treadmill differs from walking on the ground, we began each patient's program by setting the treadmill speed to 80% of their comfortable walking pace on the ground. After a week, we increased this to 90% of their comfortable walking speed. All patients achieved the over ground measured comfortable walking speed (on the treadmill) by the third week of training. Starting in the third week, the treadmill speed was progressively raised to a target of 5% to 10% higher than the comfortable walking speed on the ground for that week.

Result:

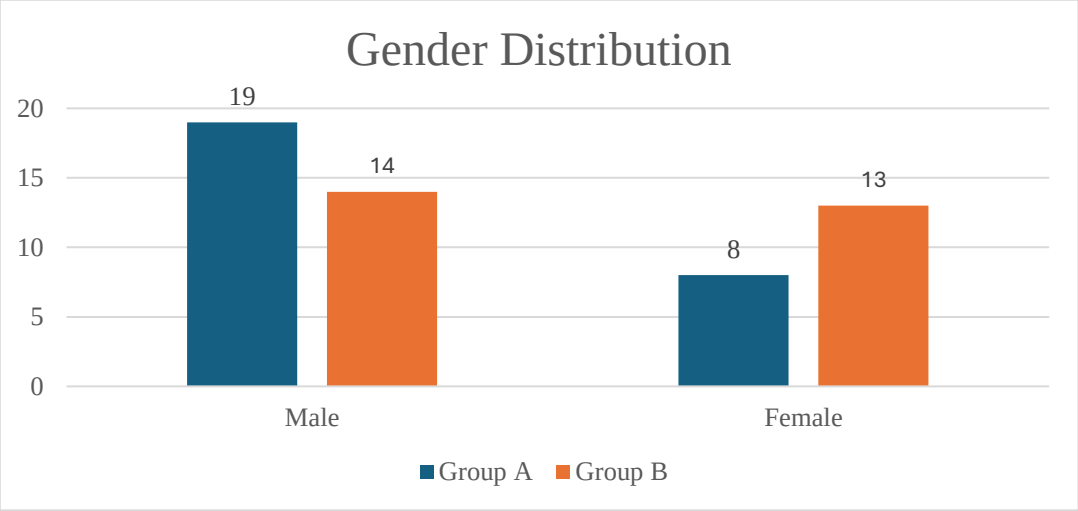
According to the study's statistical analysis, the p-value for the within-group comparison of depression, anxiety, and cognition is less than 0.001 for group A and less than 0.001 for group B, which is $p<0.05$. As a result, it matters in GROUP A & B. According to the mean theorem, group A has improved more than group B in terms of cognition, anxiety, and depression in between-group comparisons.

	Group A	Group B
Number	27	27
Mean	55.4444	57.7778
SD	6.24089	6.84702



GENDER:

	Male	Female
Group A	19	8
Group B	14	13

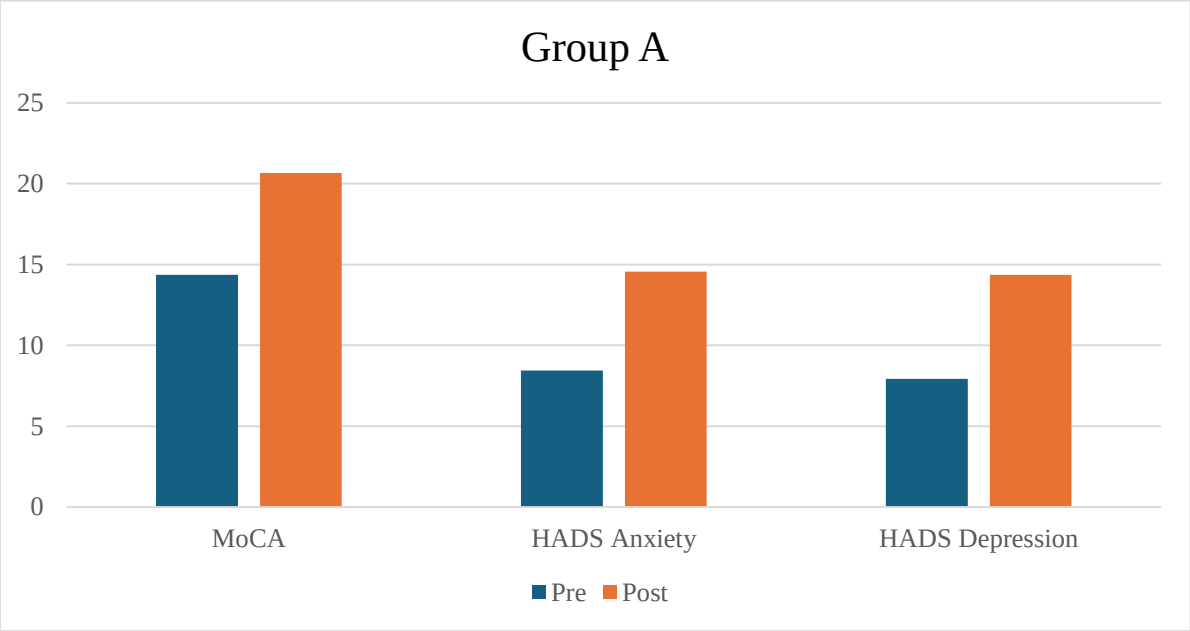


GROUP A:

MoCA	**Pre**	**Post**
Mean	14.8148	22.4444
Standard Deviation	3.76254	4.10753
p-Value	<0.001	

HADS Anxiety	**Pre**	**Post**
Mean	8.3704	14.8889
Standard Deviation	2.61869	3.58773
p-Value	<0.001	

HADS Depression	**Pre**	**Post**
Mean	8.6541	15.0452
Standard Deviation	2.5419	3.98784
p-Value	<0.001	

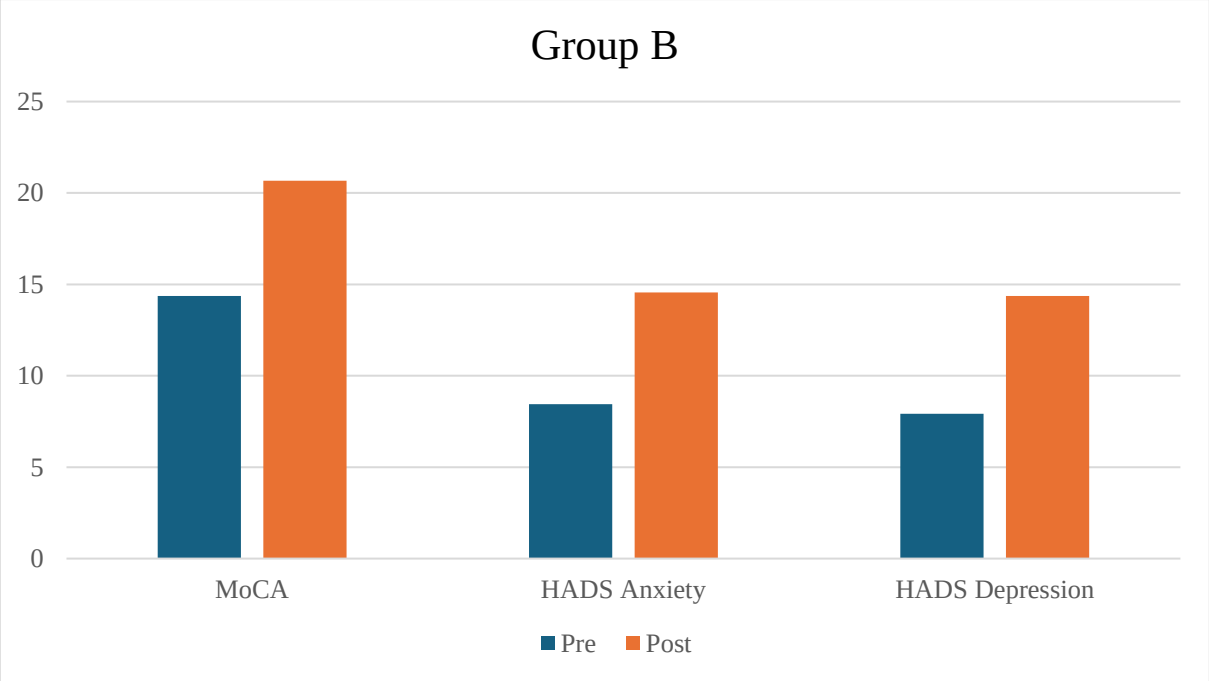


GROUP B:

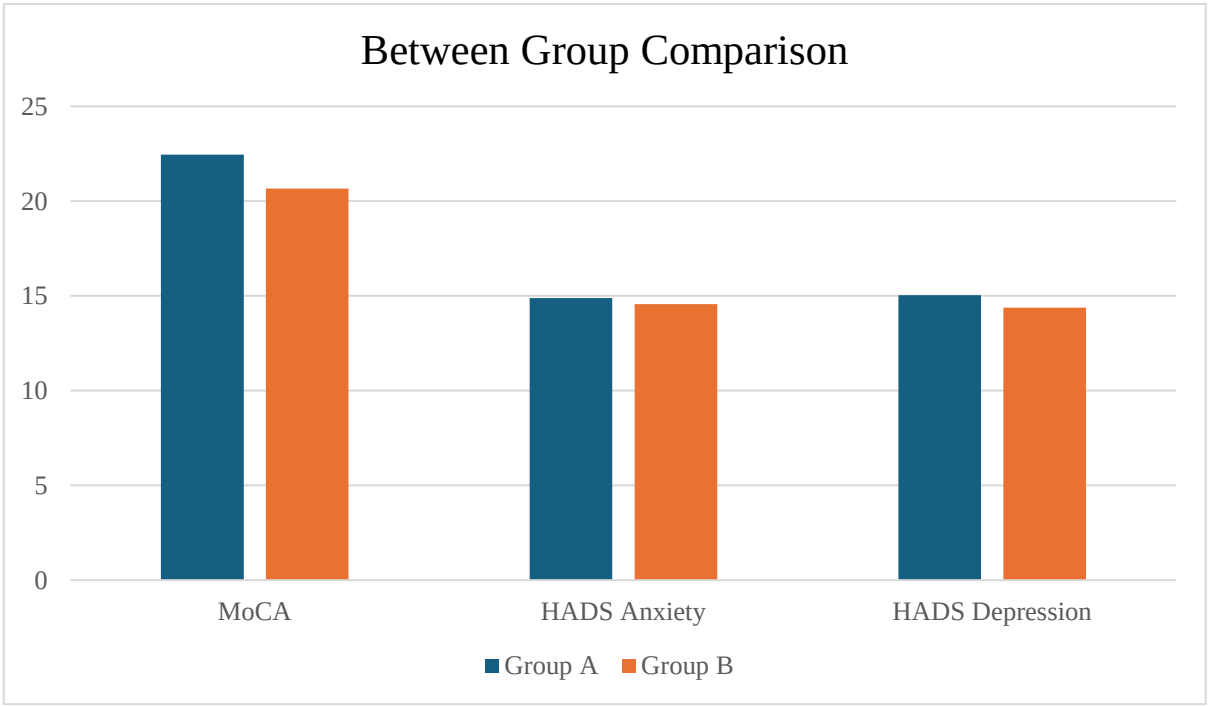
MoCA	Pre	Post
Mean	14.3704	20.6667
Standard Deviation	3.66006	4.22447
p-Value	<0.001	

HADS Anxiety	Pre	Post
Mean	8.4444	14.5556
Standard Deviation	2.75029	3.67249
p-Value	<0.001	

HADS Depression	Pre	Post
Mean	7.9259	14.3704
Standard Deviation	2.23479	3.23619
p-Value	<0.001	



OUTCOME MEASURES		MEAN	SD	t VALUE	p VALUE
MoCA	**GROUP A**	22.4444	4.10753	1.568	0.80
	GROUP B	20.6667	4.22447	1.568	
HADS Anxiety	**GROUP A**	14.8889	3.58773	0.514	0.919
	GROUP B	14.5556	3.67249	0.514	
HADS Depression	**GROUP A**	15.0452	3.98784	0.558	0.672
	GROUP B	14.3704	3.23619	0.558	



Discussion:

Mobility is influenced by cognitive function, especially executive function, and attention. For this reason, rehabilitation therapies that focus on both cognitive and motor improvement may be highly advantageous for mobility results[13 - 17]. Adding a cognitive component to physical training sessions may encourage individuals to rely more on the striatal motor pathway to perform motions rather than using compensatory cognitive methods[18, 19].

Although more study is needed to determine how dual-task training affects cognitive functioning in people with Parkinson's disease (PD), recent studies have suggested the potential advantages of integrated strategies that address both cognitive and physical components at the same time. According to a study that was randomized, those who got dual-task training significantly outperformed those in the group that did not get any intervention in terms of cognitive function during dual-task walking[20, 21].

Increased serotonin binding in limbic regions and raphe nuclei is correlated with depressive symptoms in PD patients who have not used antidepressants, potentially demonstrating reduced quantities of serotonin outside cells. It was discovered that a major factor in the pathophysiology of PD depression is aberrant serotonergic neurotransmission[22]. This may assist to clarify how moderate aerobic exercise may improve psychological well-being and improve brain health, which includes cognitive function and psychological status[22]. Exercise-induced increase of brain-derived neurotrophic factor may depend on norepinephrine activation via b-adrenergic receptors[23]. Additionally, it was proposed that exercise and physical activity improve self-image, social skills, and cognitive functioning while easing some symptoms linked to mild-to-moderate depression[24 - 26].

As was previously mentioned, using a treadmill improves motor function. It has also been shown that using a treadmill increases one's latency to fall, which improves balance[27]. These results implied that treadmill exercise may improve associated motor tasks by causing adaptive changes in the basal ganglia and motor circuitry, and that the positive effects of exercise are accompanied by distinct effects on the dopaminergic system[28].

Conclusion:

The study's statistical analysis demonstrates that Group A (cognitive dual task) and Group B (treadmill training) both used strategies that were independently beneficial in enhancing cognition and lowering anxiety and depression.

When comparing the two methods, the cognitive dual task training group showed improved cognition and decreased anxiety and depression.

References:

1. O'Shea S, Morris ME, Iansek R. Dual task interference during gait in people with Parkinson disease: effects of motor versus cognitive secondary tasks. Phys Ther. 2002; 82(9):888–97.
2. Heinzel S, Maechtel M, Hasmann SE, Hobert MA, Heger T, Berg D, et al. Motor dual-tasking deficits predict falls in Parkinson's disease: A prospective study. Parkinsonism Relat Disord. 2016; 26:73–7.
3. Rochester L, Hetherington V, Jones D, Nieuwboer A, Willems AM, Kwakkel G, et al. Attending to the task: interference effects of functional tasks on walking in Parkinson's disease and the roles of cognition, depression, fatigue, and balance. Arch Phys Med Rehabil. 2004; 85(10):1578–85.

4. Yogev G, Giladi N, Peretz C, Springer S, Simon ES, Hausdorff JM. Dual tasking, gait rhythmicity, and Parkinson's disease: which aspects of gait are attention demanding? Eur J Neurosci. 2005; 22 (5):1248–56.
5. Takakusaki K, Oohinata-Sugimoto J, Saitoh K, Habaguchi T. Role of basal ganglia-brainstem systems in the control of postural muscle tone and locomotion. Prog Brain Res. 2004; 143:231–7.
6. Hoehn MM, Yahr MD. Parkinsonism: onset, progression, and mortality.
7. Postuma RB, Berg D, Stern M, Poewe W, Olanow CW, Oertel W, et al. MDS clinical diagnostic criteria for Parkinson's disease.
8. Lombardi G, Baccini M, Gualerzi A, Pancani S, Campagnini S, Doronzio S, Longo D, Maselli A, Cherubini G, Piazzini M, Ciapetti T. Comparing the effects of augmented virtual reality treadmill training versus conventional treadmill training in patients with stage II-III Parkinson's disease: the VIRTREAD-PD randomized controlled trial protocol. Frontiers in Neurology. 2024 Jan 24; 15:1338609.
9. Rahman TT, El Gaafary MM. Montreal Cognitive Assessment Arabic version: reliability and validity prevalence of mild cognitive impairment among elderly attending geriatric clubs in Cairo. Geriatrics & gerontology international. 2009 Mar;9(1):54-61.
10. Mondolo F, Jahanshahi M, Grana A, Biasutti E, Cacciatori E, Di Benedetto P. The validity of the hospital anxiety and depression scale and the geriatric depression scale in Parkinson's disease. Behavioural neurology. 2006;17(2):109-15.
11. Yang YR, Cheng SJ, Lee YJ, Liu YC, Wang RY. Cognitive and motor dual task gait training exerted specific training effects on dual task gait performance in individuals with Parkinson's disease: A randomized controlled pilot study. Plos one. 2019 Jun 20;14(6): e0218180.
12. Herman T, Giladi N, Gruendlinger L, Hausdorff JM. Six weeks of intensive treadmill training improves gait and quality of life in patients with Parkinson's disease: a pilot study. Archives of physical medicine and rehabilitation. 2007 Sep 1;88(9):1154-8.
13. Szturm, T.; Kolesar, T.A.; Mahana, B.; Goertzen, A.L.; Hobson, D.E.; Marotta, J.J.; Strafella, A.P.; Ko, J.H. Changes in Metabolic Activity and Gait Function by Dual-Task Cognitive Game-Based Treadmill System in Parkinson's Disease: Protocol of a Randomized Controlled Trial. *Front. Aging Neurosci.* **2021**, *13*, 680270.
14. Chua, L.K.; Chung, Y.C.; Bellard, D.; Swan, L.; Gobreial, N.; Romano, A.; Glatt, R.; Bonaguidi, M.A.; Lee, D.J.; Jin, Y.; et al. Gamified Dual-Task Training for Individuals with Parkinson Disease: An Exploratory Study on Feasibility, Safety, and Efficacy. *Int. J. Environ. Res. Public Health* **2021**, *18*, 12384.
15. Caligiore, D.; Mustile, M.; Fineschi, A.; Romano, L.; Piras, F.; Assogna, F.; Pontieri, F.E.; Spalletta, G.; Baldassarre, G. Action Observation with Dual Task for Improving Cognitive Abilities in Parkinson's Disease: A Pilot Study. *Front. Syst. Neurosci.* **2019**, *13*, 7.
16. Executive Function and an Eight-Week Sensory-Motor Training Programme in Independent-Living Individuals with Parkinson's Disease.
17. Ferrazzoli, D.; Ortelli, P.; Cucca, A.; Bakdounes, L.; Canesi, M.; Volpe, D. Motor-Cognitive Approach and Aerobic Training: A Synergism for Rehabilitative Intervention in Parkinson's Disease.
18. Li, K.Z.H.; Bherer, L.; Mirelman, A.; Maidan, I.; Hausdorff, J.M. Cognitive Involvement in Balance, Gait and Dual-Tasking in Aging: A Focused Review from a Neuroscience of Aging Perspective. *Front. Neurol.* **2018**, *9*, 913.

19. Lin, Y.P.; Lin, I.I.; Chiou, W.D.; Chang, H.C.; Chen, R.S.; Lu, C.S.; Chang, Y.J. The Executive-Function-Related Cognitive–Motor Dual Task Walking Performance and Task Prioritizing Effect on People with Parkinson's Disease. *Healthcare* **2023**, *11*, 567.
20. Marusic, U.; Peskar, M.; Šömen, M.M.; Kalc, M.; Holobar, A.; Gramann, K.; Wollesen, B.; Wunderlich, A.; Michel, C.; Miladinović, A.; et al. Neuromuscular Assessment of Force Development, Postural, and Gait Performance under Cognitive-Motor Dual-Tasking in Healthy Older Adults and People with Early Parkinson's Disease: Study Protocol for a Cross-Sectional Mobile Brain/Body Imaging (mobi) Study. *Open Res. Eur.* **2023**, *3*, 58.
21. Onder, H.; Ozyurek, O. The Impact of Distinct Cognitive Dual-Tasks on Gait in Parkinson's Disease and the Associations with the Clinical Features of Parkinson's Disease. *Neurol. Sci.* **2021**, *42*, 2775–2783.
22. Politis M, Wu K, Loane C, Turkheimer FE, Molloy S, Brooks DJ, et al. Depressive symptoms in PD correlate with higher 5-HTT binding in raphe and limbic structures. Neurology 2010; 75:1920–1927.
23. Ma Q. Beneficial effects of moderate voluntary physical exercise and its biological mechanisms on brain health. Neurosci Bull 2008; 24:265–270.
24. Taylor CB, Sallis JF, Needle R. The relation of physical activity and exercise to mental health. Public Health Rep 1985; 100:195–202.
25. Mota Pereira J, Silverio J, Carvalho S, Ribeiro JC, Fonte D, Ramos J. Moderate exercise improves depression parameters in treatment-resistant patients with major depressive disorder. J Psychiatr Res, article in press.
26. Arcos Carmona IM, Castro Sa´nchez AM, Matara´n Pen˜ arrocha GA, Gutie´rrez Rubio AB, Ramos Gonza´lez E, Moreno Lorenzo C. Effects of aerobic exercise program and relaxation techniques on anxiety, quality of sleep, depression, and quality of life in patients with fibromyalgia: a randomized controlled trial. Med Clin 2011; (in press).
27. Fisher BE, Petzinger GM, Nixon K, Hogg E, Bremmer S, Meshul CK, et al. Exercise-induced behavioral recovery and neuroplasticity in the 1-methyl-4- phenyl-1,2,3,6-tetrahydropyridine-lesioned mouse basal ganglia. J Neurosci Res 2004; 77:378–390.
28. Petzinger GM, Walsh JP, Akopian G, Hogg E, Abernathy A, Arevalo P, et al. Effects of treadmill exercise on dopaminergic transmission in the 1-methyl-4- phenyl-1,2,3,6-tetrahydropyridine-lesioned mouse model of basal ganglia injury. J Neurosci 2007; 27:5291–5300.