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Article

Research on the mechanism of the effect of music rhythm synchronization training on biomechanics gait optimization and rehabilitation outcome

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Abstract: The integration of movements or activities that match the beat of music is known as music rhythm synchronization (MRS). Excessive musical tempo can enhance motor abilities and general movement efficiency and it requires synchronizing physical activities like walking or exercising. Enhancing the speed of movement that leads to quick walking, longer step length symmetric, and functional walking ability. The training with MRS mechanism, this research aims to analyze the movement in biomechanics, optimization, and the findings of rehabilitation impacts. This research utilizes 75 participants with Parkinson's illness and they are divided into two categories group A with training in MRS mechanism and received traditional mechanism training in group B. This research explores the training in MRS mechanism-affected biomechanics movements are performed by utilizing the pre-post method by providing more evaluations. The three-week supervised rehabilitation program presenting the MRS has been followed by the two-week follow-up stage as a part of the intervention. There are two significant deviation estimations in the patterns of normal gait like the gait variable score (GVS) and gait profile score (GPS). The regression analysis, Analysis of Variance (ANOVA), regression analysis, and paired sample t-test, which are the data assessment techniques are evaluated by utilizing the SPSS statistical software for the performance. The conclusion demonstrates the MRS mechanism training significantly improved gait biomechanics. The GPS score shows the enhanced overall quality of gait and it decreased significantly. These findings illustrate the potential of the MRS mechanism training mechanism in improving gait biomechanics and producing excellent rehabilitation outcomes.

Keywords: music rhythm synchronization (MRS); biomechanics; rehabilitation outcome; parkinson's disease; statistical analysis

1. Introduction

One of the most crucial abilities for achieving everyday tasks, basic requirements, and forming social bonds is the ability to walk. Being able to walk is a dynamic outcome of the thin neuromata and interacting systems [1]. The temporal and periodic variations of the tensing and relaxing processes that result in movement, specifically, the explanation of the movement's dynamic quality as the rhythm of movement [2]. Human body movements are intricate processes produced by the neurological system and movement asserts that it is motivated by a set of regulations [3]. In this structure, the movement's rhythm is significant on its own. The primary component that permits the motions to rhythm is the ability to flow and occur in a particular order [4]. The beat is a crucial component in establishing the flow of movement, putting movement into practice, growing it, and turning it into a delightful one. A non-progressive condition affecting the baby's or foetus's brain, cerebral palsy (CP) limits activities and impairs mobility development permanently as well as alignment [5]. It is established that motor impairments in cerebral areas are numerous causes of palsy, including spasticity, dystonia, muscle spasm, abnormalities of the bones, issues with coordination, weakness of muscles, and an inability to control movement selectively [6]. When neuromata impairments arise in CP patients, they lead to restrictions on movement-related activities, including posture and strolling. Consequently, there is a secondary gait abnormality [7]. In patients with cerebral palsy (CP), damage to the cerebral cortex disrupts the regular progression of the motor control system. It results in symptoms like imbalance, muscular atrophy, and aberrant gait. Deterioration in balance and motor control are two of the most prevalent conclusions from studies [8]. Specifically, there might be modifications that impair their capacity to walk, and patients might abruptly transition to a distinct kind of walking [9]. Consequently, gait analysis evaluation aids in the diagnosis of gait abnormalities as well as support for treatment planning. Currently, two and three-dimensional motor analysis systems are used in clinical gait analysis [10]. In essence, it shows the patient's limitations concerning walking abilities by gathering and examining quantitative data on the patient's gait characteristics. The walking cycle the name for the wandering stage of walking is gait. It becomes more intricate with each new CP gait type. Being unique to every person, much like our fingerprints. There are numerous reasons why walking components are different [11]. Nonetheless, there are still essential components that can be computed and assessed by physicians, podiatrists, or scientists. The things that take place during the walking period are the space between one foot's contact with the ground and the same foot's second contact with the ground level. Clinical gait analysis offers comprehensive details on the four primary data types that are instantaneously recorded spatiotemporal, electromyography, kinetics, and kinematics. Uniform digital video is typically used to record healthcare videos, cameras, and the optoelectronic system in sync [12]. Human movement synchronization with a rhythmic external stimulation is known as sensorimotor synchronization (SMS). Clinical assessment and rehabilitation have been done using SMS. Metronomes, music, and interpersonal interactions are all suitable for cadential stimuli. These are components of the SMS architecture. When deliberate synchronization requirements are met, people are expressly directed to align with a specific stimulus. In contrast, unintentional situations are those in which a person and rhythmic stimuli synchronize on their own [13].

1.1. Objective of the study

To evaluate how the mechanism of MRS training affects Parkinson's disease patients' gait biomechanics, gait optimization, and rehabilitation results. 75 participants were divided into two groups for the study, such that group B received normal training, and group A received MRS instruction. To evaluate how MRS mechanism training affected changes in gait biomechanics, a pre-post design with follow-up examinations was used. To ascertain the mechanism efficacy of MRS training in enhancing gait quality and overall rehabilitation outcomes for Parkinson's patients, a thorough data-gathering process was undertaken, encompassing gait metrics and rehabilitation outcomes.

1.2. Key contribution

1) The research gathered 75 participants with Parkinson's illness and the gathered participants were divided into two categories group A and group B.
2) The pre and post-test assessment with the factor analysis utilizing gait variable score (GVS) and gait profile score (GPS) to analyze the movement and gait disorder.
3) Statistical analysis was performed to evaluate the efficiency of both categories with significant outcomes.
4) The performance implemented on the SPSS statistical software and the findings show that group A provides more significance in terms of paired t-test, and descriptive analysis. ANOVA and regression analysis.

2. Related works

To develop more information on the impacts of the musical signals on the neurological system and phenomena of musical embodiment, how people coordinate their movements related to the musical sensations. Samadi et al. [14] investigated the impacts of musical sensations on walking and the application of musical treatment in brain and Parkinson's illness patient's rehabilitation of motor skills. It examined dementia and other neuro-degenerative or neuro-traumatic disorders. They formed a bridge between musical theory and cognitive science, promoting interdisciplinary cooperation where one discipline learns from the other.

Gouda and Andrysek [15] investigated the real-time detection of gait symmetry using rhythmic auditory stimulation (RAS). Three RAS-based methods for biofeedback were contrasted, including both constantly changing target levels for open-loop and closed-loop RAS. Finding out if these systems could cause Temporal Gait Asymmetry (TGA) was the goal of the investigation. Comparing the three techniques to the baseline, temporal symmetry significantly improved. The closed-loop technique produced the biggest changes at every goal level. Speed and cadence did not change throughout RAS-based biofeedback gait training, suggesting that the system remained stable. Interestingly, participants were able to reach their symmetry target more effectively when the metronome was set to a target that was farther away than the intended goal. The results have significance for creating customized RAS gait training regimens. Kantan et al. [16] employed a user- centered design methodology and three feedback algorithms. Musical, abstract, and wading noises were developed by filtering gyroscopic data from four inexpensive mobile motion units using kinematic data from fifteen hemiparetic patients. In an interactive focus group, five physical therapies evaluated the algorithms. Because of the ambiguous information and poor sound quality, they suggested discarding the abstract and musical algorithms. Following their feedback-based modifications to the wading algorithm, they tested the viability of the idea using 9 hemiparetic patients and seven physical therapists in a conventional over-ground training session. Most patients found out about the comments. They anticipate that the results could add to the current investigation into the use of auditory input derived from inertial sensors to enhance motor skill development in neurological rehabilitation. Michnik et al. [17] examined the impact of different forms of metro-rhythmic stimulations as they were applied to the variation in gait frequency within a population lacking disorders impairing movement. Gait tests were performed on twenty-two adults, split into two equal groups. First group members received sounds but were not prompted to do anything; second group members were informed ahead of time to walk to the rhythm of music stimulation. On a Zebris functional dynamic modeling system (FDM-S) treadmill, locomotor function testing was conducted. The investigation included variations in gait frequency during the walk-in response to different kinds of auditory stimuli, from rhythmic stimulus to rhythmic stimulation at a rate that corresponds with gait frequency, the desired speed, and rhythmic stimulation. Li et al. [18] identified one of the main problems with Parkinson's disease patients was freezing of gait, which greatly increased the risk of falls, a reduction in one's ability to live independently, and a lower quality of life itself. To those suffering from Parkinson's disease, managing freezing of gait (FOG) has shown to be challenging and sometimes unsuccessful with a range of interventions, including medications and surgical treatments. They indicated that the combination of listening to music and engaging in physical exercise, known as music-based movement therapy (MMT), could yield encouraging outcomes. There was evidence that MMT improved general physiological activity, emotional health, and motor function. Pilot research findings have been positive in that MMT could successfully lower FOG symptoms and enhance PD patients' quality of life. About overcoming the drawbacks of conventional treatments, the creative method offered new hope for enhancing the standard of living and daily activities of individuals suffering from Parkinson's disease. Shay [19] provided much research regarding the way loud music affects people's vitality as they walk, run, and engage in other exercise and sporting activities. The findings of the previous research, which included a variety of physical activities and experimental settings, were conflicting. It used a single-case experimental approach to investigate the impacts of sound intensity on walking vigor for auditory stimuli such as music and metronome. During the experiment stepping at a constant pace of 116 beats per minute walking in unison along a 2-mile circle track through forests. Kogutek et al. [20] focused on the outcomes of asynchrony measurements made during Parkinson's disease patients' Improvised Active Music Therapy (IAMT) sessions. Three right-handed PD people were included in the investigation, and their asynchrony was evaluated while they performed a continuous piece of improvisational music implementing simplified electronic drumming equipment using a single-subject multiple baseline approach across subjects. The composition psychoanalyst showed total positive mean synchronization ratings both within and through conditions, whereas all participants had total negative mean synchronization. Scores for the left and right feet varied more between subjects and within scenarios than the upper extremities did for all subjects. Kania et al. [21] examined the subjects' physiological responses to metro rhythmic stimuli of synchronous and pseudo synchronous stimulation, as well as any synchronization errors; synchronization has a beat that's externally controlled, but which was created or controlled by pressing. The study included 19 participants without motor disorder diagnosis. The Neuro-Optimized Rehabilitation and Assessment system for Orthopedic Needs (NORAXON) system was used to record the electromyography signal and reaction time throughout two tests. Additionally, the empath ice enhanced monitoring for physiological and affective tracking in interactive care and assessment, enhancing 4 vital signs (E4) was used to measure physiological signals like blood volume pulse, and electrodermal activity. Duppen et al. [22] have used motor learning mechanisms that tend to be more overtly weighted than implicitly weighted occur in gait training that uses rhythmic auditory stimuli. Making the switch to gait training that makes use of more implicit systems could be beneficial for some populations. For instance, utilizing a subtle beat cue to induce error-based recalibration during rhythmic auditory cueing may help young adults who were blind but unaffected by it to integrate implicit motor learning processes. It was measured while walking on a treadmill and on different terrains by analyzing the degree to which isochronous rhythmic and gradually shifting metronome frequencies were retained, both explicitly and indirectly. Hoque et al. [23] classified the response to asymmetric rhythmic signals into several levels of adaptation. Force and motion capture data were gathered. Fit people using a split-belt treadmill and interventions using rhythmic cueing. Separated into two unique systems of adaptation sensorimotor and educational modification in line with the interventions and combining such discoveries with the trade-off mechanisms inside kinetic, spatiotemporal, and gait characteristics.

3. Methodology

Using SPSS 26 for statistical analysis, the study assesses the effect of MRS on biomechanics and gait. Data were collected from 75 Parkinson's disease patients, divided into two groups: group B received normal training, and group A received MRS training mechanism. ANOVA investigated disparities between groups, descriptive analysis assessed gait characteristics, paired samples t-tests were used to compare pre-and post-training modification sand regression analysis was used to gain insight into the relationship between training and better gait. **Figure 1** depicts the study design.

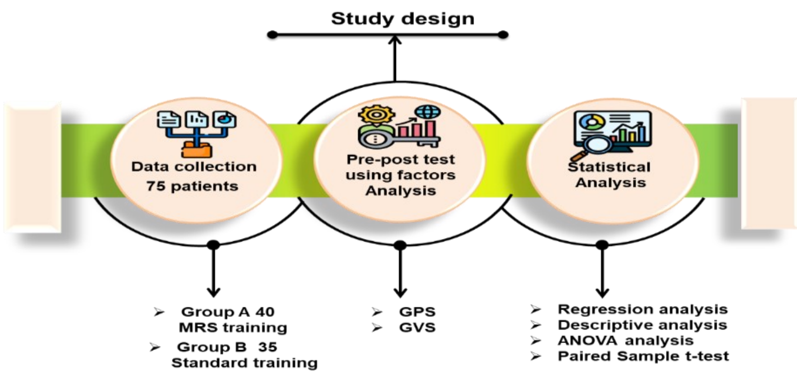

Figure 1. Study design.

3.1. Music rhythm synchronization (MRS) mechanism

The process of integrating movements of the body with musical rhythms is known as MRS. This technique involves skilled bodily actions, with mobile, nudging, or exercise, to agree with a musical arrangement's beat or beats. It is frequently applied in therapeutic contexts to assist people in developing their stability, bringing together, and motor skills. Persons can expand their timing and movement efficiency by timing their movements to music. MRS is used in rehabilitation to increase gait designs, lengthen steps, and quicken walking. It is especially used for people with movement abnormalities, such as Parkinson's disease, as it enhances the constancy and regularity of their pace. Studies have designated that this type of implementation can result in notable increases in total mobility. It can also serve as an inspiring and entertaining way to spend time exercising. Movement and music together have positive effects on the body and mind.

3.2. Biomechanics gait

The term biomechanics gait defines the method icalsearch of the principles essential to walking and other human movement patterns. It looks into the interaction of tendons, ligaments, muscles, and bones to create motion. Experts in biomechanics gait analysis can quantify joint angles, muscle activation, and force distribution, as well as assessand measure efficiency and spot nonstandard patterns. Because it aids in the detection of gait problems, this study is particularly helpful for people who have been battered or suffer from diseases such as Parkinson's disease, CP, or arthritis. The results are frequently realistic to maximize mobility, enhance walking gait and balance, and lower the chance of falling. When creating individualized rehabilitation plans, planning operations, or creating orthotic designs, biomechanics gait is essential. It significantly improves athletic performance by perfecting walking or executing methods. Biomechanics gait analysis uses cutting-edge technologies such as force plates and motion capture to deliver comprehensive insights for enhancing physical health and movement.

3.3. Data collection

75 Parkinson's patients were involved in the data collection and were divided into two groups. Group A received MRS training and group B received standard training. Following the experiment, there was a 3-week MRS intervention and a 2-month follow-up treatment session. Pre and post-tests were used to evaluate if the gait biomechanics changed. Measurements were made of important markers such as step length, gait speed, and symmetry.

Group A had 40 participants in total, representing a range of ages and an equal number of men and women. The lengths of the diseases ranged from brief to considerable. Body mass indices covered underweight to overweight categories, and physical activity levels varied from sedentary to extremely active. An extensive analysis of MRS training's effects on biomechanics and gait was made possible by this diverse demographic profile. Since each demographic element offered information about possible variations in training results, the study's conclusions applied to a variety of population groups. Furthermore, the study considered other characteristics, the majority of patients had no co-morbid conditions, while some had one or more. The type of treatment varied, with most participants receiving medication only, while others engaged in physical therapy or a combination of treatments. This diverse demographic profile allowed for a comprehensive analysis of the effects of MRS training mechanism on gait biomechanics, enabling the findings to apply to a wide range of patient populations. **Table 1** shows the demographic dataset for group A. **Figure 2** shows the MRS training patients.

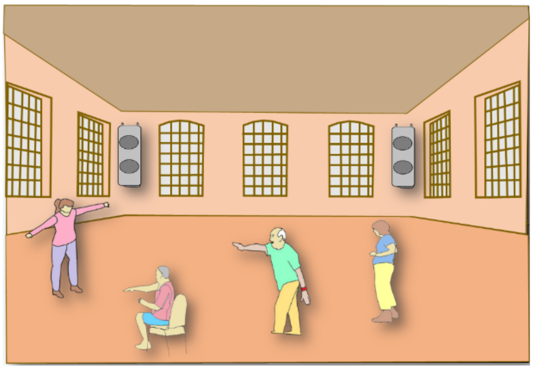

Figure 2. MRS-based training.

Table 1. Demographic dataset for group A.

Category		**Frequencies (*N* = 40)**
Gender	Male Female	20 20
Age	40–50 50–60	15 25
Mean Duration of Disease	1–3 3–5	20 20
Physical Activity Level	Sedentary, Moderately Highly	15 15 10
Duration of Treatment	1–2 years 2–4 years Above 4 years	15 15 10
Co-morbid Conditions	None One Two or more	10 15 15
Type of Treatment	Medication Only Physical Therapy Combination Therapy	25 10 5
Body Mass Index (BMI)	Underweight, Normal Weight, Overweight,	20 10 10

Group B consisted of 35 participants with a balanced gender distribution, including 15 males and 20 females, reflecting a diverse demographic. The age range varied significantly, with participants predominantly between 40–60 years old. The duration of their illnesses ranged from 1 to over 5 years, indicating varying levels of disease progression. Body Mass Index (BMI) classifications included underweight, normal weight, and overweight, showcasing the participants' varied health statuses. Additionally, physical activity levels were recorded, with participants categorized as sedentary, moderately active, or highly active. This broad range of characteristics facilitated a thorough examination of the effects of conventional training on gait biomechanics. By capturing this diversity, the study aimed to enhance the generalizability of its findings, ensuring the results could be applied across different populations and improving the overall relevance of the research. **Table 2** displays the demographic characteristics of Group B and **Figure 3** represents the traditional training mechanism.

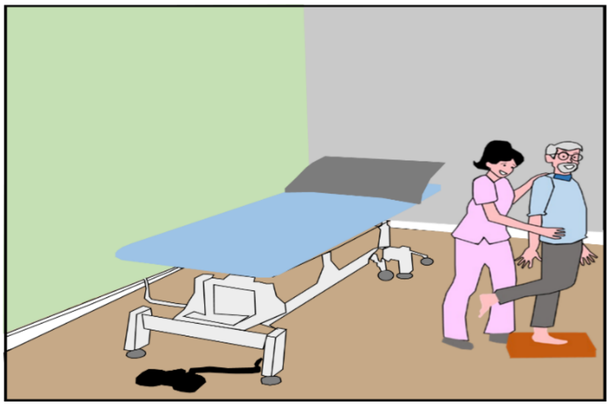

Figure 3. Traditional-based training.

Table 2. Demographic dataset for group B.

Category		**Frequencies (*N* = 35)**
Gender	Male Female	15 20
Age	40–50 50–60	10 25
Mean Duration of Disease	1–3 3–5	13 22
Duration of Treatment	1–2 years 2–4 years Above 4 years	12 15 8
Type of Treatment	Medication Only Physical Therapy Combination Therapy	20 10 5
Physical Activity Level	Sedentary, Moderately Highly	15 10 10
Co-morbid conditions	None One Two or more	10 15 10
BMI	Underweight, Normal weight, Overweight,	15 10 10

3.4. Analysis of variables

To evaluate movement and gait disorders, the gait variable score (GVS) measures walking–related parameters such as step length, ankle dorsiflexion, and gait speed. The gait profile scores (GPS), which focus on hip and knee flexion extension, pelvic tilt, and rotation, is a tool used to quantify deviations from normal gaits. In clinical contexts, both measures are used to assess patients' gait who have movement problems. The resources aid in creating customized rehabilitation programs.

3.4.1. Gait variable score (GVS)

GVS refers to a composite metric that is used to evaluate and quantify different facets of an individual gait, or way of walking. It is frequencies used to assess general mobility and aberrant gaits in clinical settings and research. This score is frequently generated using a variety of gait-related factors to offer a thorough evaluation of a person's walking habits.

Gait Speed

An individual's gait speed is the rate at which they cover a particular distance over level surfaces. This can serve as an important indicator of the general health and capacity for function. Genetics, disease, trauma, or issues in both legs and legs can lead to abnormal gaits. Abnormal movements such as waddling, crossing one's legs, or shuffling one's feet are possible among them.

Step Length

The distance that separates the front of your foot's point touch with the ground from your back foot's point of contact when walking is called your step length. Walking normally causes similar step lengths on the left and right. A person's height, leg length, level of fitness, and unique biomechanics can have an impact on the length of the steps.

Ankle Dorsiflexion

The technical phrase for the movement is ankle dorsiflexion, which brings your toes closer to the knee. Pushing the toes down and away from the knee is known as ankle flexion, which is the switch). The tightness in the lower limb posterior chains muscle is one of the primary symptoms of inadequate dorsiflexion. Limitations in ankle flexibility, frequently arising from previous ankle trauma, represent a different contributing factor. Anterior weak muscles that tire quickly are the other possibility.

Knee Valgus-Varus

The legs are bent outside once at a varus knee. These patients will walk with their knees bent slightly. Whereas valgus knees cause the legs to bend outward as the knees point inside. Patient knee abnormalities occur in a pair of groups such as genu varum, or bowlegs, and genu valgum, or knock-knees. A patient is considered to have bow legs as they are standing and have the feet together with the knees not touching.

Foot progression angle

An essential part of a clinician's evaluation is determining the foot progression angle during walking. The angle formed by the foot's long axis from the heel to the second metatarsal and the gait progression line is known as the foot-plant angle. When the foot plant angle is negative in-toeing is indicated, and when it is positive that indicates out-toeing.

3.4.2. Gait profile score (GPS)

The total divergence of kinematic gait data from normative data is summarized by the GPS, a single index measure. Through the deconstruction of the GPS, major component kinematic gait variables can be obtained as GVS, which are displayed as a movement assessment pattern.

1) Pelvic tilt angle

The angle resulting from the line of the center on the bifemoral head to the mid-way of the sacrum endplate and a vertical line is known as the pelvic tilt angle. Sitting on a table and dangling your legs over the edge is an easy measurement for pelvic tilt. Move one leg in the direction of the chest, then the other. Your resting leg's back can lift the table if the pelvis is not in the proper position.

2) Pelvic Obliquity Angle

The angle formed by the pelvic coronal standard axis and a horizontal reference axis is known as pelvic obliquity (PO). It evaluates the degree of pelvic asymmetry, a sign of postural abnormalities or scoliosis among other problems. Previous assessment of the angle aids in the identification and treatment of disorders influencing pelvic alignment and walking.

3) Pelvic Rotation Angle

The pelvic rotation angle quantifies the degree of rotation of the pelvis relative to the horizontal plane while walking or engaging in activity. It shows the degree of pelvic twisting, which might have an impact on posture and gait. Anomalous pelvic rotation has been linked to musculoskeletal problems and impairments of gait.

4) Hip Flexion/Extension

Reducing the angle between the thigh and the abdomen by moving the thigh towards the torso is known as hip flexion. The opposite movement, known as hip extension, increases this angle by pulling the thigh away from the body.

5) Knee Flexion-Extension

Knee flexion-extension is the action of the knee joint where the approach among the lower leg and thigh is increased during extension and decreased during flexion. These are essential motions for running, walking, and other everyday tasks.

3.5. Data assessment

The method of systematically employing logical and/or statistical techniques to define, represent, summarize, analyze, and assess data is known as data analysis. The data analysis employs various analysis techniques including ANOVA, regression analysis, paired sample t-test, and descriptive analysis for the evaluation of performance on the effect of music rhythm synchronization training. The experiment was implemented by utilizing the SPSS software.

Descriptive analysis: This is the process of extracting patterns and correlations from both historical and present information. It can be referred to as the most basic type of data analysis because it focuses just on describing relationships and patterns without applying them deeper. Measures of frequency, which indicate the number of times an event occurs, Assessments of central tendency, and Measures of distribution or variation are the main categories of descriptive statistical methods.

Paired samples t-test: A statistical method that examines the means of each variable for a single group is called a paired samples t-test or a dependent samples t-test. It is employed to determine that the two variables' mean difference is zero. When there are paired measurements, such as before and after measurements, measurements from two perspectives of an issue, and measurements under various circumstances, the paired samples t-test is beneficial.

Analysis of Variance (ANOVA): The ANOVA test compares the findings of three or more independent samples or groups to find variances within the research outcomes. One independent variable is used in a one-way ANOVA and two independent variables are used in a two-way ANOVA. A statistically significant mean difference is found in at least one pair when this test provides a significant *P* value. To identify the most significant match, it makes utilization of several comparisons.

Regression analysis: Regression analysis is a statistical approach used to assess the correlations between several independent variables and the dependent variable. It can be used to assess the degree of relatedness between variables and simulate possible relationships between them. When determining the gathered data occurred randomly, the regression model's *p*-value quantifies the strength of the support against the null assumption. An association between the variable and the response that is relevant is indicated by a low *p*-value (< 0.05), which indicates that the value of the coefficient is significant.

4. Performance analysis

ANOVA, regression analysis, paired t-tests, and descriptive statistics are used to examine the data, and the results show that group A and group B differ in all GPS and GVS variables. There were notable variations in the gait characteristics, with group A values. These results highlight that better step length, symmetry, and total gait efficiency can be achieved in the MRS-trained group when compared to standard training, highlighting the efficacy of MRS training in improving gait biomechanics.

4.1. Descriptive analysis

Descriptive data for the GPS and GVS variables are displayed in **Tables 3** and **4**. For every variable, group A and group B means and standard deviations are comparable, according to both tables. The GPS and GVS measures based on the *p*-values don't appear to differ significantly between the groups. It implies that both inside and between the groups, there is little variety.

Table 3. Descriptive analysis result for GPS.

Variables	Group (A) mean	Group (B) mean	Group (A) SD	Group (B) SD	*p*-value
1	16.8	15.6	4.2	4.4	0.001
2	6.5	5.9	2.0	2.2	0.001
3	7.5	5.0	1.6	1.8	0.001
4	8.0	6.6	3.0	3.4	0.001
5	13.2	12.8	3.7	4.0	0.001

Table 4. Descriptive analysis result for GVS.

Variables	Group (A) mean	Group (B) mean	Group (A) SD	Group (B) SD	*p*-value
A	10.2	10.6	3.0	3.2	0.005
B	60.0	63.5	8.3	8.7	0.005
C	1.3	2.1	0.3	0.2	0.005
D	1.2	2.0	0.8	1.0	0.005
E	6.8	8.2	2.1	2.0	0.005

4.2. Paired samples t-test

The outcomes of paired t-tests for the GPS and GVS variables are shown in **Tables 5** and **6**, separately. For all GPS variables, group A consistently exhibits higher mean values than Group B, with significant mean differences and *t*-values. Strong statistical significance is indicated by the *p*-values, which clearly show differences between the groups. Group A has higher mean values for all GPS variables than group B. The significant differences between the groups in both GPS and GVS measurements are further supported by the *p*-values.

Table 5. paired t-test result for GPS.

Variables	Group (A) mean	Group (B) mean	*t*-value	Mean difference	*p*-value
1	30.5	25.3	3.45	5.2	0.002
2	15.8	12.4	4.12	3.4	0.001
3	8.7	7.0	2.89	1.7	0.001
4	10.5	9.1	3.22	1.4	0.003
5	40.2	35.6	3.95	4.6	0.001

Table 6. paired t-test result for GVS.

Variables	Group (A) mean	Group (B) mean	*t*-value	Mean difference	*p*-value
1	16.4	18.2	3.67	2.2	0.004
2	55.5	68.3	2.76	4.2	0.003
3	1.45	2.30	4.08	0.15	0.002
4	5.5	6.0	3.50	1.5	0.003
5	4.8	6.5	3.22	1.3	0.005

4.3. ANOVA

GPS and GVS factors’ ANOVA results are shown in **Tables 7** and **8**, correspondingly. With *f* and *p*-values showing statistical significance, group A exhibits significantly higher means than group B for every GPS variable. Comparably, group A mean values are higher across the board for all GVS variables, along with significant *f* and *p*-values. These findings show that the two groups’ GPS and GVS measures differed significantly.

Table 7. ANOVA result for GPS.

Variables	Group (A) mean	Group (B) mean	*p*-value	*f*-value
1	30.5	25.3	0.001	5.12
2	15.8	12.4	0.001	6.78
3	8.7	7.0	0.001	4.33
4	10.5	9.1	0.001	5.21
5	40.2	35.6	0.001	7.42

Table 8. ANOVA result for GVS.

Variables	Group (A) mean	Group (B) mean	*p*-value	*f*-value
1	16.4	18.2	0.001	4.89
2	49.5	68.3	0.001	6.14
3	1.45	3.30	0.001	8.23
4	2.5	4.0	0.001	5.37
5	7.8	8.5	0.001	4.75

4.4. Regression analysis

The findings of the regression analysis for the GPS and GVS variables are shown in **Tables 5** and **6**, respectively. Group A consistently outperforms Group B in all GPS measures, which also displays significant regression coefficients and *p*-values. Group A also had higher mean values for all GPS variables, with similarly significant regression coefficients and *p*-values, The GPS and GVS metrics show significant variations between the two groups, as demonstrated by these results. The following **Tables 9** and **10** show the outcome of regression analysis for GPS and GVS.

Table 9. Regression analysis results for GPS.

Variables	Group (A) mean	Group (B) mean	Regression Coefficient (β)	Standard Error	*t*-value	*p*-value
1	30.5	25.3	0.45	0.12	3.75	0.002
2	15.8	12.4	0.32	0.10	3.20	0.005
3	8.7	7.0	0.27	0.08	3.38	0.002
4	10.5	9.1	0.38	0.11	3.45	0.005
5	40.2	35.6	0.50	0.13	3.85	0.001

Table 10. Regression analysis results for GVS.

Variables	Group (A) mean	Group (B) mean	Regression Coefficient (β)	Standard Error	*t*-value	*p*-value
1	14.4	18.2	0.29	0.09	3.22	0.005
2	72.5	88.3	0.36	0.11	3.27	0.005
3	1.45	3.30	0.55	0.14	3.93	0.005
4	5.5	6.0	0.42	0.12	3.50	0.005
5	4.8	6.5	0.33	0.10	3.30	0.005

4.5. Discussion

Study underscores the significant effectiveness of the intervention applied to group A, as evidenced by the higher performance in gait biomechanics compared to group B. Descriptive statistics reveal that while both groups exhibit similar means and standard deviations in gait variables, group A's elevated gait profile score (GPS) and lower gait variable score (GVS) illustrate a distinct advantage. This aligns with previous research suggesting that specific interventions tailored to enhance motor skills can lead to substantial improvements in movement patterns. The strong statistical significance highlighted by ANOVA and paired t-tests reinforces the notion that the differences observed are not merely due to chance but reflect a true enhancement in gait functionality. Furthermore, the regression analysis, which yielded significant constants and p-values, indicates that the interventions used in group A foster a more active and efficient gait pattern, likely through mechanisms such as improved proprioception and neuromuscular coordination. These findings emphasize the necessity for continued exploration of targeted gait training methodologies, as they present promising avenues for enhancing rehabilitation strategies and optimizing functional mobility in populations with gait impairments.

5. Conclusion

The study demonstrates that MRS training offers significant advantages over conventional rehabilitation in improving gait biomechanics for patients with Parkinson's disease. Data gathered from 75 Parkinson's disease patients divided into two groups showed that group A MRS training significantly outperformed group B conventional training in key gait metrics such as step length, gait speed, and overall gait symmetry. Comprehensive statistical analysis using SPSS 26 and statistical techniques, including descriptive statistics, regression analysis, paired samples t-tests, and ANOVA, revealed significant differences between the groups, with group A consistently displaying higher mean values for gait measures. The results from the paired t-tests ($p < 0.005$), ANOVA ($p < 0.001$), and regression analysis ($p < 0.005$) consistently indicate that group A, which received the MRS training mechanism, significantly outperformed group B across all evaluated gait metrics. These findings underscore the mechanism of MRS training mechanism in enhancing gait biomechanics and highlight its potential as a superior alternative to conventional rehabilitation methods for Parkinson's patients.

Future scope and limitations: The following studies should concentrate on the long-term effects of psychological resource administration training, a variety of patient demographics, and the most effective combination of therapies. Investigating the underlying reasons and utilizing state-of-the-art technologies could improve the results. The study's problems, which include a small number of subjects, a short study time, a constrained setting, and no control of external variables, may affect how broadly and irresponsibly the conclusions may be drawn. Increasing sample sizes, extending follow-up periods, and utilizing a range of assessment methods could help overcome those limitations.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

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