Efectividad del entrenamiento de la marcha mejorado por estimulación auditiva rítmica y ejercicios de Frenkel para mejorar la movilidad entre la población geriátrica

Effectiveness of rhythmic auditory stimulation enhanced gait training and Frenkel exercises in improving mobility among geriatric population

Basvendran S[1], Saravan Kumar J[2], Priyadharshini K[3]

[1] Undergraduate. Department of Physiotherapy. Saveetha Institute of Medical and Technical Science. Chennai. Tamilnadu (India)
[2] Assistant Professor. Department of Physiotherapy. Saveetha Institute of Medical and Technical Science. Chennai. Tamilnadu (India)
[3] PG Scholar. Department of Physiotherapy. Saveetha Institute of Medical and Technical Science. Chennai. Tamilnadu (India)

ABSTRACT

Age-related changes in mobility demand interventions.One of the difficult faced by older patients are decreased walking speed and increased risk of falling. Rhythmic auditory stimulation and enhanced gait training may be a successful intervention technique, on the other hand Frenkel exercise shows improvement in dynamic balance. In order to determine the best between these two the study protocol has been designed.

Aim: To find any significant differences between the effect of rhythmic auditory stimulation, enhanced gait training and Frenkel exercises in improving mobility among the geriatric population.

Method: A total of 40 participants were selected using convinent sampling method based on inclusion and exclusion criteria, then the subjects were divided into two groups. In Group A (n=20) patients received RAS enhanced gait training. In Group B (n=20) patients received Frenkel exercise , one session per day, six days per week, for a duration of 25 mins of 4 week.

Result: The paired and unpaired t-test were used to statistically analyze. According to the post-test mean value of the 10 m walk test and time up and go test yielded a p-value of less than 0.05. This demonstrates that RAS have a significant impact on mobility for geriatic population.

Conclusion: From the data analysis obtained in the study, it concluded that rhythmic auditory stimulation group have better improvement than the Frenkel exercise group.

Keywords: Walking, exercise, gait, aging.

RESUMEN

Una de las dificultades que enfrentan los pacientes mayores es la disminución de la velocidad al caminar y el mayor riesgo de caídas. Los cambios relacionados con la edad en la movilidad exigen intervenciones. La estimulación auditiva rítmica y el entrenamiento de la marcha mejorado pueden ser una técnica de intervención exitosa; por otro lado, el ejercicio Frenkel muestra una mejora en el equilibrio dinámico. Para determinar lo mejor entre estos dos, se ha diseñado el protocolo de estudio.

Objetivo: Encontrar diferencias significativas entre el efecto de la estimulación auditiva rítmica, el entrenamiento de la marcha mejorado y los ejercicios de Frenkel para mejorar la movilidad entre la población geriátrica.

Método: Se seleccionó un total de 40 participantes utilizando un método de muestreo conveniente basado en criterios de inclusión y exclusión, luego los sujetos se dividieron en dos grupos. En el Grupo A (n =20), los pacientes recibieron entrenamiento de la marcha mejorado con estimulación auditiva rítmica. En el Grupo B (n=20), los pacientes recibieron ejercicio Frenkel, una sesión por día, seis días por semana, con una duración de 25 minutos durante 4 semanas.

Resultado: Para el análisis estadístico se utilizó la prueba t pareada y no pareada. Según el valor medio del test posterior a la prueba de marcha de 10 m y a la prueba de levantarse y caminar arrojó un valor de p inferior a 0,05. Esto demuestra que la estimulación auditiva rítmica tiene un impacto significativo en la movilidad de la población geriátrica.

Conclusión: Del análisis de los datos obtenidos en el estudio, se concluyó que el grupo de estimulación auditiva rítmica tiene una mayor mejoría que el grupo de ejercicio Frenkel.

Palabras clave: Caminar, ejercicio, marcha, envejecimiento.

INTRODUCTION

Walking is a foundation for optimal mobility and independence while aging, a natural phenomena impact gait . The aging process needs to be examined as a unique physiological bodily mechanism with a specific evolutionary purpose. Ageing is characterized by a decrease in the body's capacity for adaptation, which is brought on by a symptomatic deterioration in organ, system, and cell capabilities.[1]

Walking is an ordinary part of everyday life where it involves the cardio-respiratory system, musculoskeletal components, and all levels of the neurological system. The prevalence of balance and gait abnormalities are noticeable, rising with age, from around 10% in those between 60 and 69 years old to over 60% in people over 80 years old. Furthermore, the most frequent cause of serious injuries among the elderly may be preceded by issues with balance and gait. Walking speed at which they walk has a strong correlation with life expectancy. Significantly, sluggish gait in older adults without dementia is associated with a risk of dementia develop later in life than subjective cognitive impairment.[2]

Correspondencia: sbasvendran2002@gmail.com
Cómo citar este artículo: Basvendran S, Saravan-Kumar J, Priyadharshini K.
Effectiveness of rhythmic auditory stimulation enhanced gait training and Frenkel exercises in improving mobility among geriatric population. Galicia Clin 2025; 86-4: 7-11.
Recibido: 14/04/2024 ; Aceptado: 24/04/2025 // https://doi.org/10.22546/86/4/1298

According to research, the older people who are at high risk of falling, move more slowly (to avoid risk of fall).[3]

There are several ways to increase gait speed, including practicing on a treadmill, using a robot to aid with walking, and applying rhythmic auditory stimulation (RAS). It is difficult to implement, due to the high expense of the necessary tools and labor as well as the challenges associated with moving the equipment.[4]

The objective of locomotor training is to force the use of unmasked routes by powerful sensory cues from many sources. It is a functional activity, and early attention should be placed on tasks linked to walking.[5]

Individuals who undergone treadmill training after a stroke, with or without body weight support, have a higher chance of improving their ability to walk on their own. However, those who do not receive treadmill training may experience decrease in walking speed and capacity.[6,7]

For chronic stroke patients, treadmill walking may be a helpful strategy to enhance their walking capacity and speed. It has been linked to increase in power, decrease in energy use, as well as improvement in the quality and pace of walking.[8]

Rhythmic auditory stimulation (RAS) is a technique of practicing gait while playing the sound of metronome or other songs at general intervals, which enhances stride length and gait speed.[9]

There seems to be a carryover effect while walking with RAS, which supports the idea that increase mobility and lower the risk of falls.[10]

Several physical therapy intervention techniques have been developed to enhance parkinsonian repetitive movements as a result of the condition's reliance on outside stimuli to produce repetitive, rhythmic movements. Effective example include metronome therapy, rhythmic auditory stimulation (RAS), and physical rehabilitation programs (PRPs) that involve a range of motor exercises carried out in combination with rhythmic sound in various cadences.[11,12]

Frenkel's exercises included turning, sitting, and standing up using ordinary objects such as beds, chairs, and lines drawn on the floor, as well as acquiring walking skills using one's upper extremities.[13]

Frenkel's exercise depends on the principles of focus, accuracy, and repetition of motions. The term "rhythmic-auditory stimulation" (RAS) refers to the therapeutic use of pulsed rhythmic or musical stimulation to enhance gait or movement characteristics associated to gait. Balance is adversely impacted by the loss of gray matter in the brain regions that control motor processes, the basal and thalamic nuclei. Similar findings were reached when analyzing the parietal lobe's gray matter volume, which showed that decreasing this amount affects balance.

Frenkel's exercise is a training program made up of a group of precisely designed exercises which helps to force the patient to use the residual muscular sense that has effort to stop further deterioration of the sense or even to produce an improvement. Frenkel's workout regimen, which is mainly utilized for movement correction and coordination, is now widely employed by therapists.[14,15]

In comparison to younger adults, elderly people exhibit much lower foot position awareness, which is probably caused by a decline in plantar mechanoreceptive sensitivity. Shoes contribute to this reduction by reducing tactile feedback, which reduces awareness of foot position. The mechanoreceptive sensation in the toes and heels also decreases with age. In addition to inclining with age, vestibular function also starts to decrease significantly hence balance was affected.[16]

MATERIALS AND METHODS

A comparative study was done with the subjects meeting the inclusion criteria and pre-evaluation of mobility of the group. RAS enhanced gait training group and frenkel exercise group was recruited from physiotherapy op at primary hospital Chennai Tamil nadu. This study was approved by institutional scientific review board (ISRB 01/005/2023/ISRB/SR/SCPT). Trough convinent sampling technique, 40 individuals were selected for study. 40 subjects diagnosed with age-related gait impairement were screened for inclusion and exclusion criteria. This study involved both men and women aged above 60 years and who have ability to walk at least 10m with the confirmation of aging gait impairment. This study excludes the subject with persons with visual impairment that interferes with daily living, history of chronic illness. All participant were asked to sign their consent form. Before providing their consent form every participants were briefed experimental methodology and techniques. The subjects are split up into two groups, A and B. Each group has twenty participants, and after being informed about the intervention and the study, their informed agreement was obtained.

In addition to the timed up and go test and the 10-meter walk test, demographic data were collected. The patients in Group A (n=20) received the rhythmic auditory stimulation enhanced gait training method. Group B (n=20) received the Frenkel exercise treatment once a day, six days a week, for four weeks, for a total of 25 minutes. The collected data and outcome will be analyzed and evaluated. A statistical comparison and evaluation are made between the test pre and after values. The Frenkel exercises, Rythmic auditory stimulation enhanced gait training exercise were given to the respective groups. They are documented by using the outcome tools such as time up and go test and ten meter walk test to assess the mobility.

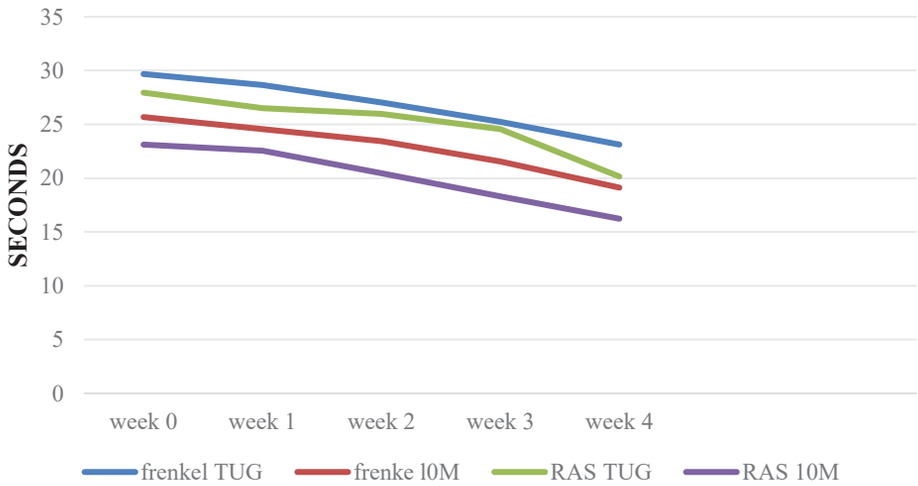
10-meter walk test

The 10-meter walk test is a clinical assessment used to assesses an individual's mobility and gait speed by measuring time it takes to cover the distance of ten meters. It is widely utilized in healthcare to asses mobility, gait speed, and overall physical performance. Every participant was told to walk for 10 meters at a comfortable, regular pace. The middle 6 m was timed, the 2m front for acceleration and back 2 m were excluded. The leading foot's toes crossed the 2- and 8-meter marks. Using these measurements, the speed was computed by dividing the walking distance in seconds (the middle 6 m) by the walking duration .

Timed up and go test

Timed up and go test is widely used to assess mobility and balance. Patients can wear their usual shoes and, if needed, a walking aid. At first, the patient is seated. The patient gets up, moves three meters, turns around, and returns to the chair to sit down. Time stops when the patient is seated.

Image 1. Pre to post Frenkel group and RAS (10m walk test, time up and go test)



Note: RAS = rhythmic auditory stimulation; TUG = timed up and go test; 10M = 10M walk test.

The Frenkel exercises comprise

- hip flexion, extension, abduction, and adduction (10 rep, 2 set)
- knee flexion and extension (10 set, 2 rep)
- bring the heel to the patella, midpoint of the tibia, and the opposing leg's ankle joint (10 rep, 3 set)
- standing up with both feet fully on the floor (10 rep, 2 set)
- walking heel to toe (10 rep, 2 set)
- walking forward (2 mins, 3 times)
- walking sideways and back to the starting position (1 min, 3 times)
- walking backwards (1 min, 3 times)
- walking and turning around 90 to 180 degrees (1 min, 3 times)
- walking in a zigzag pattern (1 min, 3 mins)

Rythmic auditory stimulation

Rhythmic auditory stimulation should be carried on a smooth, plain, flat walking path free from sound or musical influences. The patient is asked to walk and the time taken before receiving rhthymic auditory stimulation was noted. The pace at which the RAS is administered will vary from person to another and be 110 percent more than the person before walking rate. With a metronome, beats where used to provide the RAS while performing enhanced gait training lower the risk of falling, the therapist is always close by. Rest periods are timed and lengthened at the therapist's discreation

Materials required: meter tape, stopwatch, chair, neckband, mobile.

RESULT

The gathered information was analyzed and examined For each parameter, the mean and SD were utilized. The statistically significant differences between pre-test and post-test measures were examined using the Paired t-test. The difference between the post-test values was determined using unpaired t-test (Image 1).

When compared to the pre-assesment and the post-assessment shows that there is a significant increase in mobility (walking speed) using 10 m walk test and time up and go test scales. The statistical mean value for 10 m Group A pre-intervention was 23.12± and standard deviation was 4.85, post-intervention value was 16.23±3.28. Hence the post-intervention mean value shows more significant value than the pre-intervention. The statistical mean value for 10 m of group B pre-intervention was 25.68± and standard deviation was 4.12, and post-intervention value was 19.12±3.49. Hence the post-intervention mean value shows more significant value than the pre-intervention (Table 1).

The statistical mean value for time up and go of Group A pre-intervention was 27.95± and standard deviation was 4.97±, post-intervention value was 20.15± and 3.94±. Hence the post-intervention mean value shows more significant value than the pre-intervention. The statistical mean value for time up and go test of Group B pre-intervention was 29.68± and standard deviation was 4.97±, post-intervention value was 23.12± and 4.73±. Hence the post-intervention mean value shows more significant value than the pre-intervention (Table 2).

The paired t-test and unpaired t-test was used to statistically analyze the values. A statistically significant difference was found between Group A (RAS) and Group B (Frenkel exercise) as well as within the group,according to the statistical analysis performed on the quantitative data. In Group A the post mean and sd value of 10 m and time up and go test is 16.23±3.28 and 20.15± 3.94, whereas in Group B it is 19.12 ±3.49 and 23.12±4.73 (Table 3).

This demonstrates that the rhythmic auditory stimulation enhanced gait training group final results show a significant improvement in mobility.

DISCUSSION

The goal of the study is to determine if rhythmic auditory stimulation enhanced gait training and Frenkel exercises are useful for treating geriatric population with gait impairement especially gait speed.

This research extends the application of RAS to the geriatric context, aiming to contribute insights into its potential advantages for mobil-

Table 1. Pre and post-test values for RAS group A and Frenkel exercise (10 m walk test)

GROUP		MEAN ± SD	T-TEST	P-VALUE
RAS	PRE-TEST	23.12 ±4.85	5.2627	<0.0001
	POST-TEST	16.23± 3.28		
Frenkel	PRE-TEST	25.68±4.12	5.4333	<0.0001
	POST-TEST	19.12± 3.49		

Table 2. Comparison pre-test and post-test value of RAS group and Frenkel group (time up and go test)

GROUP		MEAN ± SD	T-TEST	P-VALUE
RAS	PRE-TEST	27.95±4.97	5.500	<0.0001
	POST-TEST	20.15± 3.94		
Frenkel	PRE-TEST	29.68±4.97	4.2759	<0.0001
	POST-TEST	23.12± 4.73		

Table 3. Comparison post-test value of Frenkel group and RAS (10m walk test, time up and go test)

POST TEST		MEAN ± SD	T-TEST		P-VALUE
10m walk test	RAS	16.23±3.28	5.2627	2.6985	0.0103
	Frenkel	19.12±3.49	5.4333		
Time up and go test	RAS	20.15±3.94	5.500	2.1576	0.0373
	Frenkel	23.12±4.73	4.2759		

ity improvement in the elderly. The involvement of either rhythmic stimuli or Frenkel training is considered in our study and findings on RAS also aligns with MH Thaut *et al*. (1997), where comparison to gait training without rhythmic facilitation, gait training with rhythmic facilitation shows greatly increased stride length and gait velocity. In comparison to the control group, rhythmic facilitation also resulted in a discernible improvement in stride symmetry.[17]

This study, the utilization of rhythmic auditory stimulation (RAS) for gait training enhancement in the geriatric population is being investigated so the effectiveness of RAS in improving mobility is being explored, while Soo Ji Kim *et al*. (2011) highlighted the benefits of RAS for addressing motor coordination challenges in individuals with cerebral palsy (CP), the causation of RAS is attributed to repetitive rhythmic sound patterns that increase the excitability of spinal motor neurons via the reticulospinal pathway, enabling the entrainment of axial and proximal movement in response to a specific motor command.[18]

Conklyn D *et al*. (2010): The frequency of the rhythmic auditory signal in the aforementioned investigations was chosen based on the subjects' desired gait cadence. Nonetheless, it seemed that a noteworthy rise in the rhythmic auditory cue frequency cadence in this investigation was 10% greater than the individuals' favored tempo. The study's findings corroborated those showing that MS patients' stride length, cadence, and gait speed significantly improved.[19]

As per a study by Roerdink *et al*. (2009) in stroke rehabilitation, auditory stimulation is used to increase the reticulospinal pathway's ability to excitably sense spinal motor neurons, hence lowering the time it takes for a tissue to respond to a nerve signal. When sensory stimulation is applied rhythmically, in sync with the motor response, and in harmony with walking performance, it can be a useful tool for improving functional movement.[20]

The 10-Meter Walk Test (10MWT) is widely used to assess gait speed, a key indicator of functional mobility and rehabilitation outcomes. However, there are inconsistencies in the literature regarding whether the entire 10 meters or only the middle 6 meters should be timed. This discrepancy is due to variations in protocol design, study objectives, and historical methodologies.

The most widely accepted approach, supported by Fritz & Lusardi (2009) and Bohannon (1997), recommends timing only the middle 6 meters, excluding the first 2 meters for acceleration and the last 2 meters for deceleration. This ensures that gait speed is measured at a steady-state pace, reducing variability introduced by changes in walking momentum. Studies have demonstrated that using the 6-meter timing approach provides higher test-retest reliability and better clinical applicability in stroke rehabilitation, Parkinson's disease, and older adult populations. Given these considerations, the 6-meter timing method remains the preferred protocol for assessing functional gait speed while whole 10 meter timing method best in endurance.[21,22]

CONCLUSION

Rhythmic auditory stimulation and Frenkel exercise are the better interventions to treat and improve the gait and mobility in the geriatric

population. From the data analysis and results obtained in the study, it concluded that rhythmic auditory stimulation group have better improvement than the Frenkel exercise group.

CONFLICT OF INTEREST
The authors have no conflict of interest.

FUNDING
Self-financed. Not funded by any agency of country or outside the country.

ETHICAL ASPECTS
All participants submitted a consent form to be included in this study.

ACKNOWLEDGEMENT
It is a pleasure to acknowledge the department and I owe to many people who had an influence on me and helped me develop my foundation in this study work. My special thanks to all the participants who had participated in this study, without them this project would not have been successful.

REFERENCES

1. Yoshimoto H, Sato S, Masuda T, Kanno T, Shundo M, Hyakumachi T, et al. Spinopelvic alignment in patients with osteoarthrosis of the hip: A radiographic comparison to patients with low back pain. Spine. 2005;30(14):1650-7.
2. Pirker W, Katzenschlager R. Gait disorders in adults and the elderly: A clinical guide. Wien Klin Wochenschr. 2017;129(3):81-95.
3. Weiss A, Brozgol M, Dorfman M, Herman T, Shema S, Giladi N, et al. Does the evaluation of gait quality during daily life provide insight into fall risk? A novel approach using 3-day accelerometer recordings. Neurorehabil Neural Repair. 2013;27(8):742-52.
4. Thaut MH, Leins AK, Rice RR, Argstatter H, Kenyon GP, McIntosh GC, et al. Rhythmic auditory stimulation improves gait more than NDT/Bobath training in near-ambulatory patients early poststroke: A single-blind, randomized trial. Neurorehabil Neural Repair. 2007;21(5):455-9.
5. Richards CL, Malouin F, Wood-Dauphinee S, Williams JI, Bouchard JP, Brunet D. Task-specific physical therapy for optimization of gait recovery in acute stroke patients. Arch Phys Med Rehabil. 1993;74(6):612-20.
6. Mehrholz J, Thomas S, Elsner B. Treadmill training and body weight support for walking after stroke. Cochrane Database Syst Rev. 2017;8:CD002840.
7. Sullivan KJ, Knowlton BJ, Dobkin BH. Step training with body weight support: Effect of treadmill speed and practice paradigms on poststroke locomotor recovery. Arch Phys Med Rehabil. 2002;83(5):683-91.
8. Ada L, Dean CM, Hall JM, Bampton J, Crompton S. A treadmill and overground walking program improves walking in persons residing in the community after stroke: A placebo-controlled, randomized trial. Arch Phys Med Rehabil. 2003;84(10):1486-91.
9. Thaut MH, Rice RR, Braun Janzen T, Hurt-Thaut CP, McIntosh GC. Rhythmic auditory stimulation for reduction of falls in Parkinson's disease: A randomized controlled study. Clin Rehabil. 2019;33(1):34-43.
10. Hausdorff JM, Lowenthal J, Herman T, Gruendlinger L, Peretz C, Giladi N. Rhythmic auditory stimulation modulates gait variability in Parkinson's disease. Eur J Neurosci. 2007;26(8):2369-75.
11. del Olmo MF, Arias P, Furio MC, Pozo MA, Cudeiro J. Evaluation of the effect of training using auditory stimulation on rhythmic movement in Parkinsonian patients—a combined motor and [18F]-FDG PET study. Parkinsonism Relat Disord. 2006;12(3):155-64.
12. Singla D, Veqar Z. Methods of postural assessment used for sports persons. J Clin Diagn Res. 2014;8(4):LE01.
13. Winser SJ, Pang M, Tsang WW, Whitney SL. Tai chi for dynamic balance training among individuals with cerebellar ataxia: An assessor-blinded randomized-controlled trial. J Integr Complement Med. 2022;28(2):146-57.
14. Isa L, Abubakar A, Rufa'i A, Mukadas A. Blood pressure and heart rate adjustment following acute Frenkel's ambulatory exercise in chronic hemiparetic stroke survivors: A comparative study. Afr Health Sci. 2014;14(4):906-12.
15. Mańko G, Pieniążek M, Tim S, Jekiełek M. The effect of Frankel's stabilization exercises and stabilometric platform on balance in elderly patients: A randomized clinical trial. Medicina (Kaunas). 2019;55(9):583.
16. Osoba MY, Rao AK, Agrawal SK, Lalwani AK. Balance and gait in the elderly: A contemporary review. Laryngoscope Investig Otolaryngol. 2019;4(1):143-53.
17. Thaut MH, McIntosh GC, Rice RR. Rhythmic facilitation of gait training in hemiparetic stroke rehabilitation. J Neurol Sci. 1997;151(2):207-12.
18. Kim SJ, Kwak EE, Park ES, Lee DS, Kim KJ, Song JE, et al. Changes in gait patterns with rhythmic auditory stimulation in adults with cerebral palsy. NeuroRehabilitation. 2011;29(3):233-41.
19. Conklyn D, Stough D, Novak E, Paczak S, Chemali K, Bethoux F. A home-based walking program using rhythmic auditory stimulation improves gait performance in patients with multiple sclerosis: A pilot study. Neurorehabil Neural Repair. 2010;24(9):835-42.
20. Thaut MH, Kenyon GP, Schauer ML, McIntosh GC. The connection between rhythmicity and brain function. IEEE Eng Med Biol Mag. 1999;18(2):101-8.
21. Fritz S, Lusardi M. White paper: "Walking speed: the sixth vital sign." J Geriatr Phys Ther. 2009;32(2):2-5.
22. Bohannon RW. Comfortable and maximum walking speed of adults aged 20-79 years: Reference values and determinants. Age Ageing. 1997;26(1):15-9.