International Journal of Healthcare Sciences ISSN 2348-5728 (Online)
Vol. 9, Issue 2, pp: (251-256), Month: October 2021 - March 2022, Available at: www.researchpublish.com

EFFECT OF MULTISENSORY TRAINING ON BALANCE, GAIT AND QUALITY OF LIFE IN SUBJECTS WITH DIABETIC NEUROPATHY

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Source of Data: Padmashree Physiotherapy Clinic, Padmashree Diagnostics and ESIC Model Hospital, Bangalore.

Ethical Clearance: Obtained from the Institutional Ethical Committee of Padmashree Institute of Physiotherapy.

Abstract: **Background: Diabetic Neuropathy causes superficial and deep sensitivity of the lower limbs, resulting in deficient balance and postural control. Mobility of the foot and ankle joints is often affected and altered plantar pressure is observed in these individuals.**

Objective: To determine the effect of multisensory training on balance, gait and quality of life in subjects with diabetic neuropathy.

Methodology: 30 subjects with Diabetic Neuropathy were recruited and divided into two groups. Experimental group received multisensory training and while the control group received conventional exercises for 6 weeks. Both the groups received health education on diabetes for 30 min each week during the 6 week intervention duration. Balance, gait and quality of life were assessed prior and post-intervention using Timed Up and Go test, Dynamic Gait Index and Generic Quality Of Life Measure: Health Status Questionnaire (SF36).

Results: It was observed that all the scores improved in both the groups, post-intervention (p<0.001). When the scores were compared between the groups, the TUG scores improved better in the experimental group than the control group (p<005). DGI and SF36-PF (Physical Function), SF36-RP (Physical Role Function) scores did not show any statistical difference between the groups (p>0.05).

Conclusion: Multisensory training is effective in improving balance, gait and quality of life in subjects with diabetic neuropathy and can be an integral part of rehabilitation.

Keywords: **Diabetic Neuropathy, Multisensory training, Balance, Gait, Quality of life.**

1. INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia caused by defect in insulin secretion, its action or both.[1] It is a public health concern, with great social and economic cost.[2] While Type 1 Diabetes is caused due to lack of insulin secretion, decreased sensitivity of tissues to insulin is the cause for Type 2 Diabetes.[1] One of the common complications of diabetes, Neuropathy is the progressive loss of peripheral nerve fibres.[3] An international consensus statement defined diabetic peripheral neuropathy as "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes."[2] Microvascular injuries begin early causing retinopathy, neuropathy and nephropathy while macrovascular disease can lead to cardiovascular events responsible for a majority of deaths.[4] Diabetic polyneuropathy causes a gradual and progressive loss of vibratory, thermal, tactile, and proprioceptive sensation leading to postural instability affecting balance.[5, 6] Foot and ankle joint mobility is limited, plantar pressure is altered during gait and dysfunction of intrinsic foot muscles is also noted.[7, 8] The risk of falls in older adults with diabetes is 78% compared to the 30% in healthy older adults. Compared to healthy individuals, people with diabetes may have poor standing balance in low-light conditions compared to full-light and no-light conditions.[9] Delayed reaction time keeps them from acting quickly and accurately to sudden postural changes, which could be the direct cause for increased fall risk. Diabetic complications not only lead to physical disability and include high costs, but also involve compromised health-related quality of life (HRQOL).[10, 11]

Exercise helps in reducing either the symptoms or incidence of diabetic neuropathies.[3] Somatosensory, visual and vestibular inputs are the primary sources of information which contribute to postural orientation.[12] Sensory Integration is the process of working on these distinct senses and convert them into a single perception of body-in-space.[12, 2] Variations and adaptations in movement to environmental change are made possible by the information processed from sensory inputs. Any disturbance in the tactile, proprioceptive, visual or the vestibular systems may affect an individual's ability to move and master new skills. Sensory Integration uses enhanced and controlled sensory stimulation with meaningful, self-directed movements to bring about adaptive behavior. Sensory training comprises of identification of the presented stimuli to train sensory discrimination, attention and response to the inputs provided with proper use of information that can lead to specific motor responses and improve perception.[13] Multisensory training exercises are performed on different surfaces, textures and densities to stimulate balance. Previous studies observed positive benefits with multisensory training by generating important proprioceptive inputs required for maintaining posture.[12] Since a majority of the individuals with Diabetic Neuropathy already have a compromised tactile and vibratory senses and as their balance also gets affected as the age advances, these individuals are at a high risk for falls. Hence, the present study aims to determine the effect of multisensory training on balance, gait and quality of life in subjects with Diabetic Neuropathy.

2. MATERIALS AND METHODS

Male and female subjects aged 55 to 75 years, diagnosed with Diabetic Neuropathy by a physician and having Berg Balance Score (BBS) between 21 to <50 with duration of diabetes for at least 10 years were recruited for the study. Subjects were screened for concomitant foot ulcers, musculoskeletal, neurological or surgical conditions affecting gait, any visual impairments without correction, recent complaints of dizziness or falls and those who were a part of any regular physical training during the last 3 months and were excluded from the study. Ethical clearance was obtained from the Institutional Ethical Committee and informed written consent was taken from all the participants. 30 subjects were recruited for the study and were assigned to two groups, 15 subjects in each group using convenience sampling. Baseline data such as age, gender, duration and BBS score were documented.

Experimental Group received multisensory training which consisted of walking forward, backward and sideways with eyes open and closed alternatively at varied speed and distance on floor, mattress and rubber foam for 15 minutes and exercises like single and double legged stance, tandem stance, getting up from a chair without support, tandem walking were given for 15 min with eyes open and closed on firm and soft surfaces.[2] Subjects in the control group were given conventional therapy that included active range of motion exercises for all the limbs for 15 min and walking at their comfortable pace for another 15 minutes. Rest was given as and when the subjects required preventing fatigue. Participants in both groups were treated for 30 minutes, 3 times a week for 6 weeks. Both groups also received health education on diabetes for 30 min each week, for 6 weeks. All participants were assessed for their balance, gait and quality of life using Timed Up and Go test (TUG), Dynamic Gait Index (DGI) and Generic Quality Of Life Measure: Health Status Questionnaire (SF-36) prior to- and post-intervention. The SF36-PF (Physical Function) and SF36-RP (Physical Role Function) were used in this study since diabetic neuropathy mainly affects these components.[41] The tools used in the study are well established and are reliable and valid to measure balance, gait and quality of life.[10, 14, 15, 16, 17]

3. RESULTS

Table 1: Descriptive statistics for demographic variables of subjects with Diabetic Neuropathy

Variable	Experimental Group	Control Group
Age (years)	62.87±6.06	63.53 ±6.77
Gender (M/F)	9(60%) / 6(40%)	10(67%) / 5(33%)
Duration (years)	13.73±3.90	15.33 ±6.07
BBS	30.40±2.72	30.07 ±4.15

Table 2: Range, mean and SD of TUG, DGI, SF36-PF and SF36-RP of subjects with Diabetic Neuropathy within the Experimental Group

S.No.	Outcome measures	Experimental Group				Paired t test / Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	TUG	11-16	13.20±1.57	9-13	11.00±1.25	t = 5.982	p<0.001
2	DGI	16-21	19.07±1.53	18-22	20.67±1.18	z =3.247	p<0.001
3	SF36-PF	19-26	22.00±2.17	22-28	23.87±1.80	z = 3.223	p<0.001
4	SF36-RP	13-19	16.53±1.84	15-20	17.67±1.67	z =3.914	p<0.001

Table 3: Range, mean and SD of TUG, DGI, SF36-PF and SF36-RP of subjects with Diabetic Neuropathy within the Control Group

S.No.	Outcome measures	Control Group				Paired t test / Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	TUG	10-15	13.00±1.46	9-14	12.07±1.33	t = 4.000	p<0.004
2	DGI	16-22	19.27±1.67	17-22	20.07±1.49	z = 3.464	p<0.001
3	SF36-PF	19-30	23.27±3.10	20-30	24.13±2.90	z = 3.357	p<0.001
4	SF36-RP	15-20	17.87±1.73	16-21	18.67±1.63	z = 2.972	p<0.003

Table-4: Comparison of pre and post test scores of TUG, DGI, SF36-PF and SF36-RP among subjects with Diabetic Neuropathy in between the groups

S.No.	Outcome measures	Pre test		Post test	
		Exp Group	Control Group	Exp Group	Control Group
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	TUG	13.20±1.57	13.00±1.46	11.00±0.25	12.07±1.33
2	DGI	19.07±1.53	19.27±1.67	20.67±1.18	20.07±1.49
3	SF36-PF	22.00±2.17	23.27±3.10	23.87±0.25	24.13±2.90
4	SF36-RP	16.53±1.85	17.87±1.73	17.67±1.68	18.67±1.63
Between group comparison Unpaired t test / Mann Whitney U test		TUG: t = 0.361 NS (p>0.05) DGI: z = 0.409 NS (p>0.05) SF36-PF: z = 1.049 NS (p>0.05) SF36-RP: z = 1.871 NS (p>0.05)		TUG: t = 2.449 S (p<0.05) DGI: z = 1.093 NS (p>0.05) SF36-PF: z = 0.063 NS (p>0.05) SF36-RP: z = 1.541 NS (p>0.05)	

Note: S-denotes significant (p<0.05); NS-not significant (p>0.05).

4. DISCUSSION

The primary objective of the study was to determine the effect of multisensory training on balance in subjects with diabetic neuropathy while the secondary objectives were to evaluate its effect on gait and quality of life. Prior to the study, subjects in both the groups were homogenous according to the demographic variables. Both the groups showed improvement compared to the pre-intervention values. In the experimental group, multisensory training improved balance as seen with the reduced TUG scores and the results are consistent with the study conducted by Nizar Abdul et al.[2]

Multisensory training facilitates visual, vestibular and somatosensory systems by using various surfaces, textures, tasks. The afferent neurons that carry information to the central nervous system can generate the anticipatory postural responses and volitional movements improving balance. A close interaction was seen between sensory and motor processes in postural control. Compensatory mechanisms can be improved with carefully planned sensory training with reduced proprioceptive input which can improve balance. Multisensory training also involved walking on various surfaces which could have helped in better walking and thus improved the TUG and the DGI scores. Improvement seen in the DGI score could be because of the various surfaces, textures and tasks which may have helped in stimulating the visual, vestibular and somatosensory systems improving proprioception, ankle mobility and gait speed. Martinelli et al., suggested that ankle muscle strength and joint mobility are the key factors influencing gait abnormalities in diabetic peripheral neuropathy subjects.[18] Another study concluded that specific training improved joint mobility and walking speed and gait variability in this population.[19] SF36-PF and SF36-RP scored improved with training and the results agree with Sylwia Mętel and colleagues who concluded in their study that the sensory motor exercises improved physical components of SF36, especially physical function (PF) and physical role function (RP) in older adults.[20] The reason for the observed improvement could be that the multisensory training improved proprioception, thereby improving gait speed and balance boosting the confidence to perform balance based activities and increasing activity participation that could have in turn improved Physical Function (PF) and Physical Role Function (RP) components of SF36 and quality of life. Structured physical exercises can help in regaining balance ability and confidence levels to perform activities requiring balance and improve their quality of life.

Participants in the control group also showed reduction in TUG scores and results are supported by Robitaille et al., who mentioned that physical exercise programs improve balance of older individuals in the community.[21] According to Gusi N et al., conventional exercises like walking and active exercise increases insulin sensitivity, blood supply to the skin and sensory response in the lower extremities that can improve plantar sensitivity, proprioception and balance.[22] Improvement in the DGI score could be attributed to walking. Surbala L et al., in their study mentioned that regular 12 minute walking can lead to significant improvement in a few gait parameters of the DGI score.[23] General active exercises can improve joint range of motion, muscle strength, endurance and gait speed. Another study reported that walking and ROM exercise training for 16 weeks increased both walking ability and attitude score of quality of life in elderly individuals with Type II Diabetes.[24] SF36 score is largely dependent on a person's ability to walk. It is possible that the increased walking ability of the subjects would markedly improve their quality of life.[25] Physical exercises improve functional capacity, cardiovascular fitness, improved activities of daily living leading to better quality of life. It was observed that older individuals who participated in regular physical activity of at least moderate intensity for more than one hour per week had better values in all the eight domains of HRQOL than those who were less physically active suggesting that the components of HRQOL like physical function, role limitations due to physical health, and bodily pain are positively associated with physical activity.[26]

When both the groups were compared, TUG scores showed better improvement in the experimental group than that of the control group. It could be attributed to multisensory training that challenges different systems improving balance in these subjects. However, no significant difference was observed in the SF-36 and the DGI scores in between the groups. As the control group also practiced walking as a part of conventional therapy, it could have led to improvement in gait and as walking is one of the major physical functions, the quality of life may also have been improved in the control group. The study has a few limitations like the small sample size and BMI, lower extremity muscle strength and severity of the diabetic neuropathy was not considered. Future studies can consider including the same and observe if the duration and severity of the neuropathy will have any effect on the improvement.

5. CONCLUSION

Based on the results, it was seen that balance was improved with multisensory training in subjects with diabetic neuropathy. Gait and quality of life showed similar results in both the groups. Hence, it can be concluded that Multisensory Training is more effective in the improvement of balance in subjects with diabetic neuropathy and it can be considered as an integral part of rehabilitation.

CONFLICT OF INTEREST: The authors declare that there are no conflicts of interest.

FUNDING: Self-funded.

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