

Effects of Virtual Yoga on Functional Balance and Limits of Stability in Adults with Diabetic Peripheral Neuropathy: A Randomised Controlled Trial

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ABSTRACT

Introduction: Diabetic Peripheral Neuropathy (DPN) is a prevalent consequence of Type 2 Diabetes Mellitus (T2DM) that severely impacts balance, postural control, and functional mobility. Virtual yoga has been proposed as a potential rehabilitation approach that anybody can use, although there is not much information addressing how it affects measurable outcomes related to balance in patients with DPN.

Aim: To determine the effects of an eight-week virtual yoga program on functional balance and Limits Of Stability (LOS) in middle-aged persons with DPN.

Materials and Methods: A single-blinded randomised controlled study was conducted among 50 adults aged 40-59 years with DPN. Participants were randomised into the virtual yoga group (n=25) or conventional physiotherapy group (n=25). Both groups received supervised interventions for eight weeks, three times per week. Outcome measurements comprising Single Leg Stand Test (SLST), Four Square Step Test (FSST) and

LOS parameters included Reaction Time (RT) and Directional Control (DCL). Baseline and post-intervention assessments were conducted. For intragroup comparisons, either the Paired T-Test (PTT) or the Wilcoxon Signed Rank Test (WSRT) was employed and for intergroup comparisons either the Independent samples t-test (ITT) or the Mann-Whitney U Test (MWUT) was utilised, depending on the distribution of the outcome variable.

Results: Significant intragroup improvements were observed after intervention in both groups ($p < 0.05$). However, the virtual yoga group revealed significant improvement in SLST, FSST, LOS RT, and DCL in most directions ($p < 0.05$) with moderate-to-large effect sizes compared with the conventional physiotherapy group.

Conclusion: An eight-week virtual yoga program significantly improved functional balance and LOS in middle-aged persons with DPN. Virtual yoga may be a useful supplemental home-based rehabilitation technique to improve balance and stability in this group.

Keywords: Complementary therapies, Postural control, Telerehabilitation, Yoga

INTRODUCTION

The T2DM is one of the most common chronic metabolic diseases globally, and remains a significant public health issue due to its growing prevalence and consequences. Recent global estimates indicate a dramatic increase in the burden of diabetes and its accompanying disabilities in the future decades, underscoring the need for effective interventions that target both metabolic control and the functional impairments related to the condition [1,2]. One of the most prevalent and severe microvascular complication of Diabetes Mellitus (DM), DPN affects sensory and motor nerve function and is strongly associated with poor physical function and quality of life among the chronic complications of DM. DPN is a gradual nerve injury due to persistent hyperglycaemia, oxidative stress, metabolic dysfunction and microvascular anomalies [3-6]. These pathogenic changes involve peripheral sensory receptors and motor pathways resulting in decreased proprioception, poor vibration perception, delayed neuromuscular responses, and decreased lower extremity muscle function. As a result, people with DPN often have problems with their balance [7,8].

Functional balance exams offer clinically useful information about an individual's capacity to maintain stability during static and dynamic exercises [7-9]. The SLST is a common test for the evaluation of postural stability and proprioceptive control in eyes-open and eyes-closed situations, and the FSST is used to examine multidirectional stepping ability, dynamic balance and movement coordination [7,8]. These measurements are particularly relevant in subjects with DPN as they are representative of the capacity to conduct tasks demanding

quick changes in the body position and an adequate control of the centre of mass. Besides functional balance measures, computerised posturographic assessment enables an objective assessment of dynamic postural control. The LOS examination measures an individual's capacity to deliberately move their centre of gravity towards fixed objects while maintaining balance. Parameters such as RT and DCL provides insight into movement initiation, weight-shifting efficiency, sensorimotor processing and movement precision [7].

Recent comprehensive reviews and experimental studies have shown that structured exercise therapies can enhance postural stability, functional mobility, and overall physical performance in persons with DPN [10-12]. Yoga is gaining momentum as a possible supplemental intervention because it integrates physical postures, controlled breathing and mindfulness practices in one therapeutic context. Kanjirathingal JP et al., found significant improvement in standing balance following a yogasana intervention in people with DPN, while Willis Boslego LA et al., reported improvement in balance confidence and occupational performance after yoga-based training [7,8]. Also, systematic reviews of the evidence indicate positive benefits of yoga on physical fitness, flexibility, and functional performance in persons with T2DM [12]. Additionally, other studies have shown the beneficial effects of yoga on glycaemic management, oxidative stress and diabetes-related problems, which may indirectly lead to improvements in physical function and balancing performance [13-16].

Virtual yoga could be a potentially accessible and scalable rehabilitation technique that allows participants to participate

from their homes, thereby mitigating constraints related to travel, accessibility, and availability of supervised services. Previous research on online yoga programs has demonstrated great satisfaction and acceptability confirming the practicality of virtual delivery modalities [17,18]. Moreover, the majority of past studies exploring yoga for DPN have focused on traditional face-to-face therapies, pilot studies, or generic health-related outcomes. Evidence of the efficacy of virtual yoga on functional balance and computerised assessments of LOS in middle-aged persons with DPN is limited. Thus, the purpose of the current randomised controlled experiment was to examine the effects of eight weeks of virtual yoga on functional balance and LOS in middle-aged persons with DPN. The current manuscript is a part of a larger study which aims to assess nerve conduction parameters, quality of life along with LOS and balance in adults with T2DM. However, only LOS and balance measures are discussed in this current manuscript.

MATERIALS AND METHODS

A single blinded randomised controlled trial was performed between December 2024 till February 2026, in a tertiary Healthcare Institute's Physiotherapy department, to determine the effect of eight weeks of virtual yoga intervention on functional balance and LOS in middle-aged adults with DPN. The study was approved by the KJSMC Institutional Ethics Committee, ref. no. April-2024/4, dated 18.04.24, registered with CTRI/2024/10/075731 and written informed consent was obtained from all the participants prior to participation. Participants were recruited using convenience sampling from diabetes clinics and community settings.

Inclusion criteria: People aged 40-59 years with a diagnosis of T2DM and DPN were screened for eligibility. Presence of DPN was confirmed using the Michigan Neuropathy Screening Instrument (MNSI), where patients scoring greater than two points on a 10-point scale on the clinical portion of the MNSI are considered neuropathic [19]. People who volunteered, and were able to understand and follow instructions were enrolled.

Exclusion criteria: The people who had severe visual impairment affecting balance, vestibular disorders, recent lower limb surgery or fracture, unstable cardiovascular conditions, neurological disorders other than DPN, musculoskeletal conditions limiting participation in exercise, or participation in any form of structured exercises or yoga during the preceding six months were excluded from the study.

Sample size estimation: Sample size calculation was done based on the data of balance outcome reported by Kanjirathingal JP et al., in subjects with DPN [7]. The sample size was calculated based on the reported mean difference of SLST, standard deviation, 95% confidence level and 80% statistical power, and adjusted for anticipated attrition. A total sample of 50 participants (25 per group) was deemed sufficient for the study.

Eligible participants were randomly assigned to either the virtual yoga group or the conventional physiotherapy group by a computer-generated random number sequence and concealed envelope method. The outcome assessor was blinded to group allocation.

Study Procedure

Virtual Yoga Group (Group A): Participants in the virtual yoga group were delivered a supervised virtual yoga program, by a trained therapist for eight weeks, three sessions per week. An online platform was used to hold sessions which included:

- Meditation/mind conditioning (5 min)
- Yogasanas emphasising flexibility, postural control, and balance were given (35 min)

The session started with sukshma vyayam for entire body, later following asanas were performed.

Standing: Tadasana I and II, Vrikshasana, Utkatasana and Trikonasana

Sitting: Parvatasana I and II, Yogic Mudra and Balasana

Lying: Viparita Karani, Supta Matsyendrasana and Bhujangasana

Each yogasana was repeated for three times and maintained for five seconds each.

- Pranayama practices: Anulom vilom and Bhramari, five repetitions each (10 min)

Each session lasted around 50 minutes. Participants were requested and encouraged to attend all scheduled sessions and to participate regularly during the intervention period.

Conventional Physiotherapy Group (Group B): Participants allocated to the conventional physiotherapy group received conventional physiotherapy exercises for mobility and balance and walking-based activity for eight weeks of similar duration and frequency. The program was composed of flexibility exercises, strengthening exercises, balance-related activities, and walking exercises as routinely prescribed for people with DPN.

- Mobility exercises included the following:

Supine: Bridging and segmental rotation (5 reps each); heel slides (10 reps each).

Sitting: Neck, shoulder, and back mobility exercises, toe curls (5 reps each).

Standing: Hip and knee mobility exercises (10 reps each).

- Balance exercises included the following:

Bilateral heel and toe raises (10 reps each).

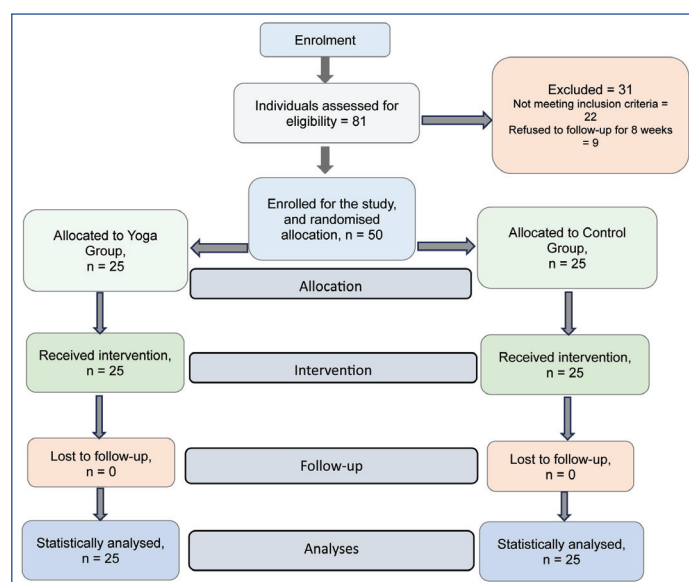
Standing, eyes closed, feet close (10 sec hold x 3 reps each).

One leg standing (with/without support, 10 sec hold x 3).

- Walking program (brisk walking for 20 min at comfortable speed)

The frequency and duration of training were matched to the intervention group (50 min)

Outcome measures: Assessments were conducted at baseline and post the eight-week intervention. The outcome assessor was blinded for the group allocation of the participants. The CONSORT flowchart for the enrollment of participants and analysis has been described in [Table/Fig-1].



[Table/Fig-1]: Flow chart for enrollment of participants.

Functional Balance

Single Leg Stand Test (SLST) [20]: SLST time was measured in eyes open and eyes closed conditions. The participants were asked to balance on one leg as long as they could and the time (in seconds) was recorded. Three trials were given and the best score was recorded.

Four Square Step Test (FSST) [21]: Dynamic balance and multidirectional stepping ability were assessed using the FSST.

The time taken to complete the stepping sequence was recorded as seconds. Three trials were given and the best score was recorded.

Limits of Stability (LOS) [22]: The Balance Master system was used to assess the LOS. The following parameters were studied:

1. Reaction time (RT);
2. Directional Control (DCL).

The RT was used to measure the speed of initiation of movement towards a target and DCL was used to measure the accuracy of movement towards the intended target.

All the above tests were conducted using the individual baseline scores and post interventions changes were noted.

STATISTICAL ANALYSIS

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 24 software. The normal distribution of the data was assessed using the Shapiro-Wilk test [23]. Descriptive statistics were used for all variables. Baseline and after eight week intervention assessments were conducted. For intragroup comparisons, either the PTT or the WSRT was employed and for intergroup comparisons either the ITT or the MWUT was utilised, depending on the distribution of the outcome variable [24]. The $p < 0.05$ was considered statistically significant. Effect sizes were calculated using Cohen's d if parametric test used or r -value if non parametric test used [25].

RESULTS

No significant between-group differences in baseline demographic and clinical characteristics, including age ($p = 0.954$), height ($p = 0.342$), weight ($p = 0.424$), MNSI-PQ score ($p = 0.929$), and MNSI-TS score ($p = 0.567$) was observed. Similarly, sex distribution did not differ significantly between the groups ($p = 0.777$), indicating comparable baseline characteristics [Table/Fig-2a,b].

Variables	Group	Mean $\pm$ SD	Median (IQR)	Shapiro Wilk Test p-value	Distribution	Test	p-value
Age (years)	Group A	51.28 $\pm$ 5.42	52.00 (47.00, 56.00)	0.167	Normal	MWUT, Z=-0.058	0.954
	Group B	51.28 $\pm$ 5.32	52.00 (46.50, 55.50)	<0.001	Non-normal		
Height (cm)	Group A	163.36 $\pm$ 7.99	162.80(156.80,170.85)	0.04	Non-normal	MWUT, Z=-0.951	0.342
	Group B	161.52 $\pm$ 8.26	158.90(154.30,169.35)	0.018	Non-normal		
Weight (kg)	Group A	65.74 $\pm$ 10.95	64.90 (55.10, 74.95)	0.328	Normal	ITT, t=0.806, df=48	0.424
	Group B	63.25 $\pm$ 10.88	63.05 (53.25, 70.75)	0.279	Normal		
MNSI PQ Score	Group A	8.56 $\pm$ 1.87	8.00 (7.00, 10.00)	0.008	Non-normal	MWUT, Z=-0.090	0.929
	Group B	8.36 $\pm$ 1.60	8.00 (7.00, 10.00)	0.023	Non-normal		
MNSI TS Score	Group A	5.40 $\pm$ 1.78	5.00 (4.00, 7.00)	0.006	Non-normal	MWUT, Z=-0.572	0.567
	Group B	5.08 $\pm$ 1.58	4.00 (4.00, 6.50)	0.001	Non-normal		

[Table/Fig-2a]: Descriptive analyses of basic characteristics of participants.

MNSI: Michigan neuropathy screening instrument; PQ: Patient questionnaire; TS: Test score; IQR: Inter quartile range; PTT: Paired t-test; WSRT: Wilcoxon signed-rank test; ITT: Independent samples t-test; MWUT: Mann-Whitney U test; SD: Standard deviation

Sex	Group A n (%)	Group B n (%)	Total
Female	13 (52.0%)	14 (56.0%)	27 (54.0%)
Male	12 (48.0%)	11 (44.0%)	23 (46.0%)
Total	25 (100.0%)	25 (100.0%)	50 (100.0%)

[Table/Fig-2b]: Descriptive analysis of sex of the participants.

Chi-square Test; $\chi^2 = 0.081$, $df = 1$, $p = 0.777$, $n =$ number of participants

Significant improvements were seen in SLST in Group A and Group B post-interventions ($p < 0.001$) as seen in [Table/Fig-3]. However, Group A improved significantly more than Group B ($p = 0.005$ to < 0.001), with effect sizes ranging from moderate to large.

Significant improvements were seen in FSST in Group A and Group B post interventions ($p < 0.001$) as demonstrated in [Table/Fig-4].

However, Group A improved significantly more than Group B, along with large effect size.

Significant improvements were seen in LOS-RT in Group A and Group B post interventions ($p < 0.001$). However, Group A improved significantly than Group B, along with large effect size for front and right direction [Table/Fig-5].

[Table/Fig-6] demonstrates significant improvements in LOS-DCL in both Group A and Group B after the intervention ($p < 0.001$). Between-group analysis showed significantly greater improvement in Group A compared with Group B in the front, right and left directions ($p < 0.001$), with large effect sizes in all three directions. No significant between-group difference was observed in the back direction ($p = 0.095$), with a small effect size.

DISCUSSION

The present randomised controlled trial investigated the effects of an eight-week virtual yoga intervention on functional balance and LOS in middle-aged individuals with DPN. Results demonstrated significant improvements in functional balance and dynamic postural control following virtual yoga with bigger benefits than traditional treatment. Performance on the single-leg stance, FSST, response speed, and DCL indicated improved postural stability and sensorimotor function. These findings are consistent with the expanding body of literature demonstrating potential benefit of exercise-based therapies on balance function in individuals with DPN, and extend prior observations to establish the efficacy of a remotely delivered yoga program [7,8,10].

Functional balance was significantly improved following the intervention as demonstrated by a superior performance on the SLST and FSST. Postural stability impairments in DPN are mainly due to diminished plantar sensitivity, poor proprioception, delayed motor responses and decreased neuromuscular coordination, which result in worse postural stability during static and dynamic tasks [3-6]. The greater improvements in the virtual yoga group may

be explained by the balance specific demands of yoga postures that commonly require controlled weight shifting, single leg stance, trunk stabilisation and coordinated movement transitions. These results are consistent with earlier research showing favourable effects of yoga practice in standing balance, dynamic stability and functional mobility in individuals with DPN [7,8,26,27]. Kanjirathingal JP et al., exhibited considerable improvement in standing balance following yogasana intervention but Shaik AR, found better improvement in dynamic balance after yoga training than Tai Chi exercises [7,26].

Therapeutic yoga has also shown improvements in postural control, mobility, and gait performance in various populations. The present investigation showed a significant improvement in the RT within the stability testing limits. RT is the time taken by a person to start movement in response to a stimulus and is an important component

Balance Test	Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	Mean change (Mean±SD)	Intragroup comparison			Intergroup comparison		
					test	p-value	Effect size	test	p-value	Effect size
EO - Right	A	5.27±1.10	6.79±1.18	1.52±0.74	PTT, t=-10.328, df=24	<0.001	d=2.066	MWUT=166.5, Z=-2.833	0.005	r=0.40 (moderate)
	B	5.18±1.10	6.17±1.42	1.00±0.53	PTT, t=-9.362, df=24	<0.001	d=1.872			
EO - Left	A	5.42±1.28	6.81±1.16	1.39±0.66	PTT, t=-10.593, df=24	<0.001	d=2.119	ITT, t=3.260, df=48	0.002	d=0.92 (large)
	B	5.73±1.39	6.63±1.45	0.90±0.38	PTT, t=-11.905, df=24	<0.001	d=2.381			
EC - Right	A	2.64±0.86	3.71±0.83	1.07±0.43	PTT, t=-12.564, df=24	<0.001	d=2.513	MWUT=176.5, Z=-2.643	0.008	r=0.37 (moderate)
	B	2.26±0.98	3.19±1.08	0.92±0.21	WSRT, Z=-4.375	<0.001	r=0.874			
EC - Left	A	2.64±0.88	3.93±0.89	1.29±0.29	PTT, t=-22.194, df=24	<0.001	d=4.439	MWUT=74.5, Z=-4.620	<0.001	r=0.65 (large)
	B	2.12±0.89	3.04±0.86	0.92±0.26	WSRT, Z=-4.374	<0.001	r=0.874			

[Table/Fig-3]: Shows the intergroup and intragroup analyses of Single Leg Stand Test (SLST).

EO: Eyes open; EC: Eyes closed; PTT: Paired t-test; WSRT: Wilcoxon signed-rank test; ITT: Independent samples t-test; MWUT: Mann-Whitney U test; SD: Standard deviation; d, Cohen's d; r, effect size correlation coefficient; df: degrees of freedom

Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	Mean change (post-pre) (Mean±SD)	Intragroup comparison			Intergroup comparison		
				test	p-value	Effect size	test	p-value	Effect size
Group A	8.01±0.85	5.86±0.81	-2.15±0.33	WSRT, Z=-4.374	<0.001	r= 0.87	MWUT, Z = -5.968	<0.001	r=0.84 (large)
Group B	7.53±0.71	6.61±0.72	-0.92±0.26	PTT, t = 17.606, df = 24	<0.001	d= 3.52			

[Table/Fig-4]: Inter group and Intra group analyses of Four Square Step Test (FSST).

PTT: Paired t-test; WSRT: Wilcoxon signed-rank test; MWUT: Mann-Whitney U test; SD: Standard deviation; d, Cohen's d; r, effect size correlation coefficient; df: degrees of freedom

Limits of Stability (LOS) Reaction Time (RT)	Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	Mean change (post-pre) (Mean±SD)	Intragroup comparison			Intergroup comparison		
					test	p-value	Effect size	test	p-value	Effect size
Front	A	1.99±0.85	0.72±0.36	-1.27±0.71	WSRT, Z=-4.372	<0.001	r=0.87	MWUT, Z=-3.920	<0.001	r=0.55 (mod-large)
	B	2.05±0.76	1.49±0.52	-0.57±0.42	PTT, t=6.670, df=24	<0.001	d=1.33			
Back	A	2.74±1.18	1.92±1.16	-0.83±0.79	WSRT, Z=-4.373	<0.001	r=0.87	MWUT, Z=-2.921	0.003	r=0.41 (small-mod)
	B	2.42±0.90	1.98±0.86	-0.43±0.58	PTT, t=3.770, df=24	0.001	d=0.75			
Right	A	2.85±1.21	1.38±0.61	-1.47±0.65	PTT, t=11.336, df=24	<0.001	d=2.26	MWUT, Z=-4.327	<0.001	r=0.61 (large)
	B	2.41±0.92	1.73±0.68	-0.68±0.40	PTT, t=8.529, df=24	0.001	d=1.70			
Left	A	2.21±0.57	1.10±0.43	-1.11±0.47	WSRT, Z=-4.372	<0.001	r=0.87	MWUT, Z=-2.290	0.022	r=0.32 (small)
	B	2.25±0.52	1.43±0.55	-0.82±0.45	WSRT, Z=-4.346	0.001	r=0.86			

[Table/Fig-5]: Intergroup and Intragroup analyses of Limits of Stability (LOS) - Reaction Time (RT) (ms) in front, back, right and left directions.

RT: Reaction time; PTT: Paired t-test; WSRT: Wilcoxon signed-rank test; ITT: Independent samples t-test; MWUT: Mann-Whitney U test; SD: Standard deviation; d, Cohen's d; r, effect size correlation coefficient; df: degrees of freedom

LOS Directional control (DCL)	Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	Mean change (post-pre) (Mean±SD)	Intragroup comparison			Intergroup comparison		
					test	p-value	Effect size	test	p-value	Effect size
Front	A	66.52±12.79	77.00±12.80	10.48±6.30	PTT, t=-8.319, df=24	<0.001	d=1.66	ITT, t=3.826, df=48	<0.001	d=1.08 (large)
	B	66.76±9.88	71.80±10.72	5.04±3.31	PTT, t=-7.613, df=24	<0.001	d=1.52			
Back	A	42.72±7.82	46.92±8.58	4.20±3.71	PTT, t=-5.663, df=24	<0.001	d=1.13	MWUT, Z=-1.670	0.095	r=0.24 (small)
	B	44.04±8.15	47.28±8.48	3.24±3.96	PTT, t=-4.090, df=24	0.001	d=0.81			

Right	A	68.96±7.31	81.40±10.66	12.44±6.80	PTT, t=-9.154, df=24	<0.001	d=1.83	MWUT, Z=-4.541	<0.001	r=0.64 (large)
	B	68.84±6.94	73.32±7.23	4.48±3.86	PTT, t=-5.798, df=24	0.001	d=1.16			
Left	A	63.68±7.97	77.00±10.36	13.32±5.48	PTT, t=-12.164, df=24	<0.001	d=2.43	MWUT, Z=-4.084	<0.001	r=0.58 (mod-large)
	B	63.68±7.98	70.28±8.32	6.60±4.35	PTT, t=-7.587, df=24	0.001	d=1.51			

[Table/Fig-6]: Intergroup and intragroup analyses of Limits of Stability (LOS) - Directional Control (DCL) (%) in front, back, right and left directions.

DCL: Directional control; PTT: Paired t-test; WSRT: Wilcoxon signed-rank test; ITT: Independent samples t-test; MWUT: Mann-Whitney U test; SD: Standard deviation; d, Cohen's d; r, effect size correlation coefficient; df: degrees of freedom

of dynamic postural control. In DPN, peripheral sensory deficits slow the processing of somatosensory input necessary for adequate postural corrections, leading to recurrent delayed RTs [3-6]. The reduction in RT following virtual yoga may be related to improved sensory integration and increased efficiency of postural response mechanisms. Yoga practice requires constant control of the body position, the start of the coordinated movements and controlled postural shifts that may accelerate neuromuscular reactions. Previous findings have also shown increases in neuromuscular abilities, peripheral nerve function, and physical performance in patients with DPN after participation in structured training regimens [27-29]. However, after the intervention, DCL also increased, indicating an improvement in the precision of voluntary centre-of-gravity displacement. DCL means the ability to move efficiently in the direction of a target and minimise wasted corrective sway. Altered proprioceptive input and postural control impairments in DPN patients results in lower movement accuracy and inadequate weight shifting capabilities [3-5]. The better direction control in this study suggests that virtual yoga can improve the coordination of sensory-motor processes that are important in maintaining dynamic equilibrium. These findings are consistent with previous studies showing improved balance function and postural control after exercise-based therapies in individuals with DPN [9,10].

The positive effects of virtual yoga on balance performance can be explained by numerous causes. Yoga consists of static and dynamic postures which challenge the postural control system by frequent weight transfers, changes in the base of support and continuous balance-oriented postures. Such activities can improve proprioceptive sensitivity, activation of muscles of the lower extremity and neuromuscular coordination. Moreover, yoga has been associated with improved physical fitness, flexibility, and functional performance in patients with T2DM [12]. Previous study has also suggested that yoga may reduce oxidative stress and increase physiological function that may contribute to improved neuromuscular efficiency as well as postural control [13-16,27]. These physiological changes may combined explain the observed improvement in functional balance and stability limits seen in the current study.

Another aspect of the study is the virtual delivery of the intervention. The increasing use of telerehabilitation has highlighted the need for accessible home-based exercise regimens which may be provided in non-clinical settings. Previous studies by Brinsley J et al., and Portz JD et al., have shown high levels of practicability and acceptability of online yoga training [17,18]. Recent findings from virtual yoga implementation studies add further evidence for the efficacy of structured yoga therapies delivered via distant platforms with participant involvement and adherence [30]. Positive results have also been documented with yoga based multimodal lifestyle treatments in T2DM, which suggests to integrate yoga based interventions in chronic disease management programs [31]. The present results show the potential for virtual yoga as an available rehabilitation treatment to persons with DPN, with evidence that great improvements in balance and postural control can be obtained through a supervised virtual format.

The findings of this study suggest that virtual yoga may be a useful adjunct to routine rehabilitation to enhance functional balance

and dynamic postural control in middle-aged adults with DPN. Improvements in SLST, FSST and LOS metrics indicates that virtual yoga can be effectively given in a home-based context to target balance deficits due to diabetic neuropathy. With the increasing focus on lifestyle-based interventions and community-based management of non-communicable diseases, virtual yoga may present an accessible rehabilitation option that can complement existing physiotherapy services and support functional independence in individuals with DPN.

Limitation(s)

There are some limitations in the present study. The first limitation relates to the study being performed on middle-aged adults with DPN which limits the generalisability of the results to other age groups and people with different severities of neuropathy. Second, the duration of the intervention was only eight weeks and long-term durability of the gains in balance and postural control could not be ascertained. Third, the study lacked follow-up assessments to determine the extent to which treatment gains were maintained after the intervention ended. Finally, this study only investigated the objective measurements of functional balance and LOS.

Future studies can be done which can be larger, multicentric, for longer duration of intervention and follow-up to know whether balance improvements following virtual yoga are sustainable. Further research may also investigate different severity levels of DPN and include other outcomes such as gait variables, physical activity, falls, adherence and psychosocial measures, in an effort to determine the broader clinical effectiveness and long-term feasibility of virtual yoga.

CONCLUSION(S)

An eight-week virtual yoga program enhanced functional balance and LOS in middle-aged persons with DPN. The virtual yoga group showed enhanced single limb stand performance, reduced FSST completion time, significant improvements in LOS-RT in all directions, improved DCL during postural tasks in front, right and left directions, compared with the control group. Thus, virtual yoga demonstrated better improvements compared to conventional physiotherapy in many of the balance outcome measures, justifying its usage under supervision as an easy home-based rehabilitation option in individuals with DPN.

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