Clinical Trial/Experimental Study

Medicine

OPEN

Effects of structured exercise program on severity of dizziness, kinesiophobia, balance, fatigue, quality of sleep, activities of daily living, and quality of life in bilateral vestibular hypofunction

Sena Gizem Genç, MSc[a,b,*], Miray Budak, PhD[c,d], Mahmut Sinan Yilmaz, MD[e], Zeliha Candan Algun, PhD[f]

Abstract

Background: A minimal number of studies have documented the impact of Vestibular rehabilitation (VR) on the recovery rate of patients with bilateral vestibular hypofunction (BVH).

Objective: The purpose of this study was to investigate the effectiveness of structured VR programs on severity of dizziness, kinesiophobia, balance, fatigue, quality of sleep, activities of daily living (ADL) and quality of life (QoL) in subjects with chronic BVH.

Method: Twenty-five participants diagnosed with BVH were included in the study. A structured VR program was applied in 50-minute sessions once a week and as a home exercise program 3 times a day over 8 weeks. Participants were evaluated for severity of dizziness with the visual analog scale, for kinesiophobia with the tampa scale of kinesiophobia, for balance with the Semitandem, tandem, and standing tests, for quality of sleep with the Pittsburgh sleep quality index, for ADL with the vestibular disorders activities of daily life, for QoL with dizziness handicap inventory and for fatigue with the fatigue severity scale at the baseline (T1), at 4th week (T2), 8th week (T3), and 20th week (T4) after study started.

Results: Significant difference in terms of Tandem Test and 1 Leg Stand Test was found in favor of T3-T4 Period ($P < .05$). There were significant improvements in terms of vestibular disorders activities of daily life, tampa scale of kinesiophobia, Pittsburgh sleep quality index and dizziness handicap inventory in favor of the T3 to T4 Period ($P < .05$). Significant difference in terms of visual analog scale was found in favor of T2 Period ($P < .05$).

Conclusions: A twelve-week structured VR program may enhance severity of dizziness, kinesiophobia, balance, quality of sleep, ADL and QoL in participants with chronic BVH.

Abbreviations: ADL = activities of daily living, BVH = bilateral vestibular hypofunction, DHI = dizziness handicap inventory, PSQI = Pittsburgh sleep quality index, QoL = quality of life, TSK = Tampa scale of kinesiophobia, VADL = vestibular disorders activities of daily life, VAS = visual analog scale, VOR = vestibulo-ocular reflex, VR = vestibular rehabilitation.

Keywords: balance, bilateral vestibular hypofunction, dizziness, kinesiophobia, quality of life, quality of sleep

1. Introduction

Bilateral vestibular hypofunction (BVH) is a disease characterized by peripheral abnormalities of the bilateral labyrinths or the 8th cranial nerve (vestibulocochlear nerve), causing decrease vestibulo-ocular reflex, oscillopsia, and instability.[1] People with BVH have difficulties walking on uneven ground and in the dark, utilizing escalators, traveling in moving vehicles, and driving cars in the dark and in rain. During head movements, participants often describe an intense feeling of instability and strange but disturbing sensations in their heads, as well as a decline in their ability to see clearly.[2]

In case of bilateral decrease in peripheral vestibular function, dizziness may be seen due to movement, especially while walking.[2,3] Symptoms typically increase in the dark and on uneven ground, and some patients may also experience

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

[a] Istanbul Medipol University, Institute of Health Sciences, Doctorate Program of Physiotherapy and Rehabilitation, Istanbul, Turkey, [b] Sakarya University of Applied Sciences, School of Health Sciences, Department of Physiotherapy and Rehabilitation, Sakarya, Turkey, [c] Istanbul Medipol University, School of Health Sciences, Department of Ergotherapy, Istanbul, Turkey, [d] Rutgers University - Newark, Aging & Brain Health Alliance, Center for Molecular and Behavioral Neuroscience, Newark, NJ, [e] Sakarya University Training and Research Hospital, Department of Otorhinolaryngology, Sakarya, Turkey, [f] Istanbul Medipol University, School of Health Sciences, Department of Physiotherapy and Rehabilitation Istanbul, Turkey.

* Correspondence: Sena Gizem Genç, Istanbul Medipol University, Institute of Health Sciences, Doctorate Program of Physiotherapy and Rehabilitation, Istanbul, Turkey (e-mail: senagizemgenc@subu.edu.tr).

How to cite this article: Genç SG, Budak M, Yilmaz MS, Algun ZC. Effects of structured exercise program on severity of dizziness, kinesiophobia, balance, fatigue, quality of sleep, activities of daily living, and quality of life in bilateral vestibular hypofunction. Medicine 2023;102:30(e34435).

Received: 23 May 2023 / Received in final form: 29 June 2023 / Accepted: 30 June 2023

http://dx.doi.org/10.1097/MD.0000000000034435

oscillopsia caused by the involvement of the vestibulo-ocular reflex (VOR).[4] Kinesiophobia, which is defined as the restriction of the patient's movements and activities, can be caused by a painful experience as well as dizziness. In addition, kinesiophobia can lead to social isolation.[5] VOR ensures gaze stability during head movement by producing eye movements equal and opposite to head movement. With vestibular loss, a person cannot maintain gaze at a target during head rotation. Instead, the eyes move with the head, causing visual blurring in the patient with uncompensated vestibular loss. In the case of missing VOR, it has been seen to be associated with balance impairment as the eyes are turned away from the target.[4] Chronic postural imbalance in posture and walking is one of the primary complaints of patients diagnosed with chronic BVH. In BVH, the effects on balance and ocular-motor areas also cause an increase in the risk of falling[6,7]. According to physiological evidence, vestibular stimuli have an effect on the neurons in the pontine reticular formation that regulate transitions between stages of sleep. It has been established that the vestibular system can regulate REM sleep as a consequence. Patients with vestibular hypofunction reported to sleep for fewer hours, wake up more frequently, and have poorer quality of sleep.[8] Patients with vestibular disorders who experience dizziness and imbalance are more likely to fall, experience psychological distress, experience panic attacks, and also have cognitive impairment, especially as they become elderly. There is evidence that patients' quality of life can be considerably affected by vertigo and related vestibular disorders.[9] Activities of Daily Living (ADL) and quality of life (QoL) considerably deteriorate as functions including postural control, gaze stabilization, and balance; this may result in social isolation[10,11]

Drug therapy is widely used in vestibular diseases. It is commonly utilized to minimize or manage vestibular symptoms. The potential efficiency of treatment is still not adversely affected by the use of centrally acting drugs like antidepressants, tranquilizers, anticonvulsants, and vestibular depressants. However, it requires a significant amount of treatment time on average for people who use drugs to achieve improvements.[12] Zhao et al[13] emphasized the superiority of vestibular rehabilitation versus drug therapy in patients with BVH. Vestibular hypofunction treatment includes vestibular rehabilitation, noisy galvanic vestibular stimulation, posturography training, virtual reality and instrumental rehabilitation.[5,14] Vestibular rehabilitation therapy has been used for many years as an effective tool in the treatment of vestibular-related symptoms and has gained more popularity in recent years due to its positive effect on the rate and degree of recovery of patients.[12,14] Enhanced compensation through vestibular recovery is the target of vestibular rehabilitation, which includes exercises promoting adaptation, habituation, and substitution.[12] In patients with vestibular hypofunction, vestibular physical therapy exercises minimize vertigo, increase postural stability, which reduces the likelihood of falling, and improve visual acuity during head movements.[14] Providing supervised vestibular rehabilitation with considering the patient's preferences into consideration enables the patient to recover more quickly.[14]

The purpose of this study was to investigate the effectiveness of a structured vestibular rehabilitation program on severity of dizziness, kinesiophobia, balance, fatigue, quality of sleep, and QoL in patients with chronic BVH.

2. Material and method

2.1. Study design

This study is a single-blinded (data analyst) longitudinal trial. This trial was approved by the Non-interventional Ethics Committee at Istanbul Medipol University, Turkey (File number: E-10840098-772.02-3990/860) and was conducted in accordance with the principles of the Declaration of Helsinki. Eligible participants received written information and provided informed consent before participation.

2.2. Study population

The study was conducted with participants who were consulting in "Ear Nose and Throat Polyclinic of Sakarya Training and Research Hospital." All participants were recruited from "Ear Nose and Throat Polyclinic of Sakarya Training and Research Hospital" between September 2021 and April 2022.

The participants who were between 20 to 80 years old, diagnosed with bilateral peripheral vestibular hypofunction by videonystagmography, and had symptoms for more than 3 months from onset of illness were included into the study. The exclusion criteria was defined as having no symptoms of bilateral peripheral vestibular hypofunction, having Meniere disease, vestibular migraine and other undulating vestibular disorders, cognitive, visual, neurological or general motor impairment, and having previously received vestibular rehabilitation.

25 participants were screened, 25 participants who met the inclusion criteria were included in the study. During the study process, 5 of the participants were excluded due to not wanting to continue the study. In total, 20 participants completed the interventions and were included in the statistical analysis. The algorithm for patient allocation into the study groups was shown in Figure 1.

The sample size was determined using the "G*power sample size calculator."[15] The sample size was calculated as 19 subjects using "ANOVA: Repeated measures, within factors" design for 1 group, 4 repeated measures with a power of 0.95% ($\alpha = 0.05$, $\beta = 0.05$), $\lambda = 18.620$, F (3.54) = 2.775, and an effect size of 0.35.

2.3. Experimental design

Participants were blinded to interventions and outcome assessment. Twenty-five participants were included in the study. Participants were asked to continue their routine activities for the first 4 weeks (T1–T2 period). A structured vestibular rehabilitation program was applied to the patients with BVH for the second 4 weeks (T2–T3 period). A structured vestibular rehabilitation program was applied to the patients with BVH for the third 4 weeks and the program was continued at home via telerehabilitation for 8 weeks (T3–T4 period). The structured vestibular rehabilitation program was shown in Table 1.

2.3.1. T1 to T2 period. It was a control period. Participants were asked to continue their routine activities for 4 weeks.

2.3.2. T2 to T3 period. A structured vestibular rehabilitation program was applied in 50-minute sessions under the supervision of a physiotherapist once a week and as a home exercise program 3 days a week over 4 weeks.

2.3.3. T3 to T4 period. A structured vestibular rehabilitation program was applied in 50-minute sessions under the supervision of a physiotherapist once a week and as a home exercise program 3 days a week over 4 weeks. Afterwards, participants participated in the home program with telerehabilitation for 8 weeks.

All participants were evaluated at the beginning of the study (T1), 4 weeks later (T2), 4 weeks after structured vestibular rehabilitation (T3), and total of 12 weeks after structured vestibular rehabilitation program for 4 weeks and telerehabilitation for 8 weeks (T4).

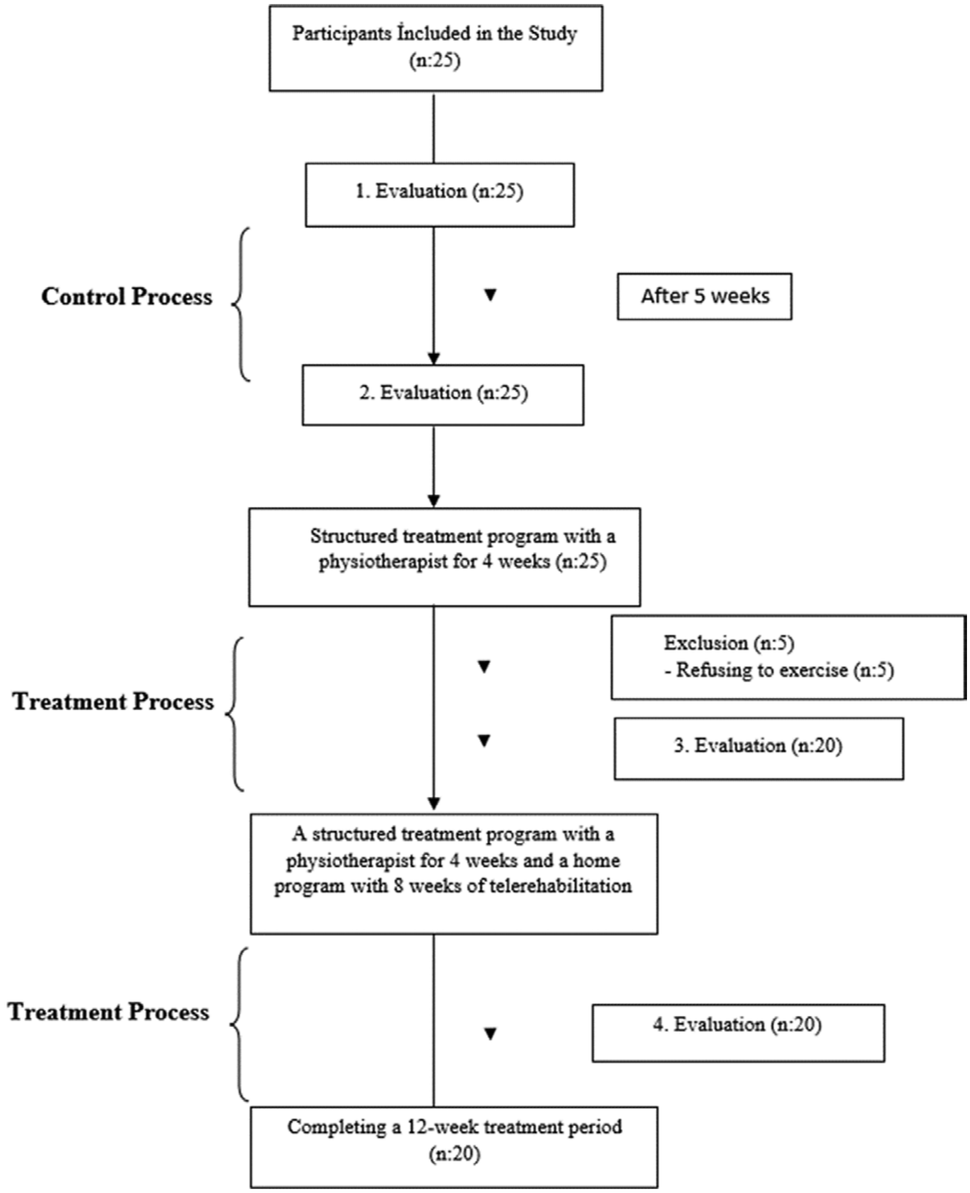

Figure 1. Flow diagram.

2.4. Structured vestibular rehabilitation protocol

The structured Vestibular rehabilitation protocol consisted of a structured vestibular rehabilitation program that included vestibular adaptation exercises, oculomotor exercises, static and dynamic balance exercises, and posture exercises. During the first 8 weeks of the 12-week structured vestibular rehabilitation program, 45 to 50 minutes sessions were applied once a week under the supervision of a physiotherapist. In addition to these sessions, the patients were given a home program for 10 repetitions, 3 times a day. In the last 4 weeks of the program, only the home program was given within the scope of telerehabilitation. The exercises in the vestibular rehabilitation program were structured specifically for the individual. Starting from simple and increasing the level of difficulty every week, possible undesirable situations such as dizziness, vomiting and falling were prevented. The structured vestibular rehabilitation program was shown in Table 1.

2.5. Outcome measurements

Demographic information was taken from participants and a Bithermal Caloric Test was received for diagnosis at the beginning of the study. Participants were evaluated for severity of dizziness with the Visual Analog Scale (VAS), for kinesiophobia with the Tampa scale of kinesiophobia (TSK), for balance with the Semitandem, Tandem, and Standing tests, for asymmetrical vestibulospinal reflex tone resulting from labyrinth dysfunction with the Unterberger test, for quality of sleep with the Pittsburgh sleep quality index (PSQI), for ADL with the vestibular disorders activities of daily life (VADL), for quality of life with dizziness handicap inventory (DHI), and for fatigue with the fatigue severity scale at the the beginning of the study (T1), 4 weeks later (T2), 4 weeks after structured vestibular rehabilitation (T3), and total of 12 weeks after structured vestibular rehabilitation program for 4 weeks and telerehabilitation for 8 weeks (T4).

2.5.1. Demographic information form. It was prepared to record the sociodemographic characteristics of participants.

2.5.2. Bithermal caloric test. Bithermal caloric test was applied while diagnosing the patients. Bithermal caloric test, Otometrics ICS Chartr 200 VNG and Air Caloric System (GN Otometrics A/S, Denmark) in supine position with 30° head flexion and 8 L/

Table 1

Structured vestibular rehabilitation program.

	Definition	Exercises
Vestibular adaptation exercises	With repeated exposure to a stimulus, stimulus desensitization is targeted. It includes pursuit and saccadic eye movements, head movements, co-ordination tasks, whole body movements and exercises for balance.	• In standing feet together/ semi tandem/ tandem position, the finger is fixed and turning the head to the right-left/ down-up while looking at the finger. • While looking at the target, turning the head to the right-left, hands to the side/ back, normal walking. • Looking around, eyes closed, hands to sides/back, normal/backward walking. • Standing feet together, turning head left and right - eyes closed.
Oculo motor exercises	Require visual fixation on a target during head movements. It includes pursuit and saccadic eye movements.	• Moving the head to the right-left/ down-up while the finger is fixed in the sitting position and looking at the finger. • Following the finger with the eye right-left/ up-down in sitting position. • Looking around, eyes closed, hands to sides/back, normal/backward walking.
Static and dynamic balance exercises	The support area includes the support floor, arm position, and eye variables.	• Hands crossed at side/back/shoulder, eyes open/closed, normal/backward gait. • Crossed eyes open/ closed normal/ back-to-back walking. • Standing on one leg with eyes open/closed on normal/soft ground.
Posture exercises	It includes the neck, shoulder and back muscles.	• Four-way head movement in sitting/standing position. • Shoulder mobilization. • Strengthening the back extensors.
Recommendations given on the first day of treatment	• You should minimize the intake of salt, tea, coffee. • You should limit the tea to 2-3 glasses a day and be careful not to drink coffee. • You should take 1 mineral water a day. • You should drink at least 1.5 liters of water daily. • You should cut down/quit smoking. • If you are deficient in B12, iron, vitamin D, you should take supplements.	

minutes air irrigator airflow at 50°C and 24°C for 60 seconds. was also carried out. There was a break of at least 5 minutes between the airflow. Horizontal eye movements were recorded with a binocular video oculography system. The maximum slow phase velocity of nystagmus was calculated after each irrigation. Jongkees formula was used to determine directional superiority and channel paresis.[16]

2.5.3. VAS. It is a validated, subjective scale used to measure the intensity or frequency of various symptoms. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed at 1 point along the length of a 10-cm line that represents a continuum between the 2 ends of the scale "no symptom" on the left end (0 cm) of the scale and the "worst symptom" on the right end of the scale (10 cm). We used this scale to measure the severity of dizziness.[12]

2.5.4. TSK. It is a 17 items self-reporting questionnaire based on evaluation of fear of movement, fear of physical activity, and fear avoidance. The total score of the scale ranges from 17 to 68, where 17 means no kinesiophobia, 68 means severe kinesiophobia, and score ± 37 indicates there is kinesiophobia.[17]

2.5.5. Balance tests. Semitandem, Tandem, and Standing tests were used to evaluate balance. Semitandem test 30, Tandem test 30, Standing tests 30 Equilibrium times (second) with eyes open-closed were recorded on hard and soft surfaces.[18]

2.5.6. PSQI. It is a self-rated questionnaire which assesses sleep quality and disturbances over a 1-month time interval. The 7 component scores consist of subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each scored 0 (no difficulty) to 3 (severe difficulty). The component scores are summed to produce a global score (range 0 to 21). Higher scores indicate worse sleep quality.[19]

2.5.7. DHI. It is used to assess the impact of dizziness on quality of life. It consists of 25 clauses which determine the aggravating factors associated with dizziness and shakiness and also the emotional and functional results of vestibular system diseases. The inventory consists of 3 subdimensions, intended to determine physical, emotional and functional effects of the vestibular system diseases.[20]

2.5.8. VADL. This scale is used to determine the degree of independence of patients with vestibular disorders, perceived inadequacies and vestibular complaints in daily activities. The scale consists of 28 items. The subscales are evaluated under 3 subheadings as Functional-F- Ambulation-A- and Instrumental-E.[21]

2.5.9. Fatigue severity scale. It was used to assess fatigue. There are 9 questions in the scale and each question consists of 7 points. An increase in the scale score indicates an increase in the level of fatigue. It detects the state of fatigue in the last month.[22]

2.6. Statistical analysis

IBM SPSS (Statistical Package for Social Science) version 25.0 was used for statistical analysis. Mean, standard deviation and percentage values were presented in the descriptive statistics of the data. The nominal data of the independent variables were evaluated with the Chi-Square Test, and the numerical data were evaluated with the 1 Sample-T Test. Regardless to the homogeneity, time dependent differences were analyzed with 2-Way Repeated Measure ANOVA and Time*Period interactions between treatments were analyzed with MANOVA. Bonferroni correction was used for post hoc tests. The significance value was accepted as $P < .05$.

3. Results

3.1. Demographic data

The average age of the participants was 53.20 ± 15.35 and the average BMI of the participants was 28.77 ± 6.37. Seventeen of the 20 participants were female. None of the participants smoked and drank alcohol. Demographic datas of the participants were shown in Table 2.

3.2. Time dependent differences within periods

Time dependent differences within periods were shown in Table 3. There were statistically significant differences in terms of balance tests (Tandem and 1 leg), VADL, TSK, PSQI, and DHI within periods ($P < .05$).

3.3. Time * period interactions

Significant differences were found in terms of Tandem Test and 1 Leg Stand Test in favor of T3 to T4 Period ($P < .05$). Significant differences in terms of VADL, TSK, PSQI and DHI were found in favor of the T3 to T4 Period ($P < .05$). There was a significant difference in terms of VAS in favor of the T2 Period ($P < .05$).

4. Discussion

In the present study, we investigated the effectiveness of a structured vestibular rehabilitation program on severity of dizziness, kinesiophobia, balance, fatigue, quality of sleep and QoL in patients with chronic BVH. We observed that a twelve-week structured vestibular rehabilitation program may enhance severity of dizziness, kinesiophobia, balance, quality of sleep, ADL and QoL in participants with chronic BVH.

Notwithstanding being among the first treatments that BVH patients consider, it has been shown that pharmacological treatment has even less impact on physical functions. Vestibular rehabilitation, which has been suggested to alleviate symptoms including dizziness and balance problems, can only be effective when individualized to each patient.[23] According to the American Physical Therapy Association's clinical practice guidelines, patients with BVH profit through vestibular rehabilitation, which has been shown to be effective in a number of studies.[23] Maslovara et al[24] reported that 20 BVH patients who had 12 weeks individualized vestibular rehabilitation programs have seen a significant improvement in functionality and self-confidence in ADL. In our study, a 12-week structured vestibular rehabilitation program was received to evaluate its effectiveness in people who had chronic BVH.

When BVH is untreated, patients have much more dizziness and other related symptoms, especially when walking in the dark or on uneven surfaces. According to Yardley L. et al[25], a 6-week vestibular rehabilitation program enhanced visual acuity and reduced dizziness in BVH patients. A structured vestibular rehabilitation program with head movements improved the vestibulo-ocular reflex and restored dynamic visual acuity in 2 adult patients with chronic BVH, according to a study investigating the effects of a 4-week head movement-based rehabilitation program on dynamic vision (VOR).[26] The structured vestibular rehabilitation program in our study included VOR exercises since VOR and dizziness are intimately connected. In our study, severity of dizziness was evaluated with DHI and it was observed that the 12-week structured vestibular rehabilitation program including the VOR provided improvement in the severity of dizziness for T3 to T4 Period. In addition, it was determined that the independence levels of the patients improved and the kinesiophobia of walking on various surfaces decreased. We assume that oculomotor and vestibular adaptation exercises, in particular, have a major impact on the substantial improvement in the

Table 2

Demographic data description.

		Participants (n = 20)
Age (mean ± SD)		53.20 ± 15.35
BMI (mean ± SD)		28.77 ± 6.37
Gender (n/ %)	Female	17/85
	Male	3/46.7
Cigarettes (n/ %)	Yes	0/0
	No	20/100
Alcohol (n/ %)	Yes	0/0
	No	20/100

* $P < .05$.
Mean = mean, SD = standard deviation.

Table 3

Time dependent differences within periods.

		Participants (n = 20)	T1 Mean ± SD	T2 Mean ± SD	T3 Mean ± SD	T4 Mean ± SD	F	Impact size (Cohen d)	P value
Balance	Semitandem Test	Eyes open	28.70 ± 3.52	33.00 ± 12.91	29.75 ± 1.11	34.25 ± 11.15	2.402	0.112	.105
		Eyes closed	26.10 ± 10.23	28.65 ± 14.93	25.75 ± 10.25	28.95 ± 14.47	0.883	0.044	.427
	Tandem	Eyes open	21.70 ± 11.11	29.25 ± 16.68	24.85 ± 9.82	33.00 ± 12.83	6.659	0.0260	.002*
		Eyes closed	9.15 ± 10.83	13.10 ± 16.52	12.15 ± 13.18	20.65 ± 15.42	6.825	0.264	.003*
	One Leg Stance- Hard Floor	Eyes open right	15.60 ± 12.14	17.80 ± 16.07	18.70 ± 12.09	24.45 ± 16.34	4.433	0.189	.013*
		Eyes open left	14.20 ± 12.76	15.90 ± 16.29	17.90 ± 11.40	23.65 ± 16.96	4.991	0.208	.009*
		Eyes closed right	2.15 ± 2.99	2.05 ± 3.84	4.90 ± 7.97	10.65 ± 14.27	7.043	0.270	.007*
		Eyes closed left	2.50 ± 3.44	2.70 ± 4.78	6.40 ± 9.74	8.50 ± 12.16	3.795	0.166	.031*
		Eyes open right	12.70 ± 13.12	11.60 ± 16.30	10.70 ± 15.37	12.90 ± 15.75	0.388	0.020	.667
		Eyes open left	12.15 ± 12.68	9.55 ± 16.12	8.30 ± 11.25	14.35 ± 12.85	1.748	0.084	.167
	One Leg Stance- Soft Floor	Eyes closed right	0.25 ± 0.78	1,75 ± 6,74	4.20 ± 9.64	9.40 ± 11.97	4.955	0.207	.009*
		Eyes closed left	0.70 ± .94	0,40 ± 1.78	2.10 ± 6.82	2.00 ± 5.11	0.791	0.040	.456
Fatique		FSS	6.68 ± 9.84	4.82 ± 1.37	4.13 ± 1.80	3.34 ± 1.92	1.500	0.073	.237
ADL		VADL	67.30 ± 25.38	69.55 ± 25.47	53.55 ± 22.38	36.00 ± 9.65	22.98	0.547	.000*
Kinesiophobia		TSK	43.00 ± 3.30	43.25 ± 3.12	37.40 ± 7.45	25.85 ± 7.22	45.079	0.703	.000*
Quality of sleep		PSQI	7.90 ± 2.80	7.50 ± 2.98	6.90 ± 2.57	6.00 ± 2.75	4.297	0.184	.023*
Dizziness on QoL		DHI	36.50 ± 16.54	35.60 ± 18.22	24.90 ± 17.51	9.40 ± 8.58	29.219	0.606	.000*
Dizziness degree		VAS	5.83 ± 2.17	5.27 ± 2.19	4.27 ± 1.74	4.50 ± 2.28	2.95	0.148	.051

ADL = activities of daily living, DHI = dizziness handicap inventory, FSS = fatigue severity scale, PSQI = Pittsburgh sleep quality index, QoL = quality of life, SD = standard deviation, TSK = Tampa scale of kinesiophobia, VADL = vestibular disorders activities of daily life, VAS = visual analog scale.
* $P < .05$.

degree of dizziness. Kinesiophobia is evaluated and treated similarly to other chronic pain conditions. An detailed evaluation of individuals with fibromyalgia and chronic fatigue syndrome revealed that education on pain neuroscience was effective in reducing patients' kinesiophobia related to pain.[27] In recent years, studies into kinesiophobia spurred on by dizziness have been undertaken. According to Sever et al[5], an 8-week structured vestibular rehabilitation program significantly reduced TSK scores in their assessment of kinesiophobia in patients with unilateral vestibular hypofunction. Throughout this study, we performed TSK to evaluate kinesiophobia and demonstrated that a structured 12-week vestibular rehabilitation program significantly reduced kinesiophobia spurred on by dizziness for T3 to T4 Period. We consider that by performing vestibular adaptation exercises in a supervised and repetitive manner, patients who are hesitant to take action due to their fear of dizziness are likely to overcome their fears.

Similar to other sensory abnormalities, the BVH balance disorder is more apparent when the eyes are closed or when walking slowly. The most crucial element of treatment is target-oriented balance training, along with active gait training and postural stability training.[28] In their study, Krebs et al[29] showed that a 12-week vestibular rehabilitation program improved postural stability and walking speed. In their study, Macias et al[30] also observed that vestibular rehabilitation improved balance and decreased the risk of falling. According to Ebrahimi et al[31], a vestibular rehabilitation program for 8 weeks that was applied to 24 hearing-impaired children with bilateral vestibular impairment increased postural stability. Similar to other studies, we found that patients with BVH could stand to gain from a 12-week structured vestibular rehabilitation program that also included postural stabilization, gait training both with open and closed eyes, and balance exercises, especially with their eyes closed, even in the T3 to T4 Period. We assume that balance exercises, particularly those included in the exercise program, are crucial to this improvement and that vestibular rehabilitation considerably improves balance in BVH patients.

Vestibular hypofunction, particularly when combined by dizziness and balance difficulties, can negatively affect an individual's QoL and level of ADL independence.[14] In their study, Wuehr et al[6] emphasized that falls in BVH patients are closely linked to impaired locomotor function, which decreases ADL participation. Maslovara et al[24] observed that an 8-week vestibular rehabilitation program administered to BVH patients dramatically improved functionality and participation in ADL while reducing the severity of the disease's symptoms. According to Susan et al, vestibular rehabilitation led to improvements in postural control, QoL, and a decrease in the anxiety and severity of dizziness.[32] According to Meli et al[33], a 6-month vestibular rehabilitation program which was then followed remotely by a 1-month supervised, 2-month home program enhanced QoL by minimizing severity of dizziness and improving performance of ADL. In our study, significant differences in terms of VADL were found in favor of the T3 to T4 Period. We suggest reducing patients' symptoms of dizziness and kinesiophobia has a big impact on enhancing ADL and QoL.

According to studies, individuals with unilateral vestibular hypofunction have bad quality of sleep as a consequence of shorter sleep duration and delayed sleep onset.[8] In their study, Sugaya et al[34] observed that 4 weeks of vestibular rehabilitation could enhance the quality of sleep. In this study, we demonstrated that a 12-week vestibular rehabilitation program significantly improved the patients BVH patients quality of sleep in favor of T3 to T4 Period. We assume that this result is also affected by the patients compliance to the recommendations. Furthermore, we consider that the patients current balance and quality of sleep improved with the relief of the complaints of dizziness and kinesiophobia.

One of the most noticeable symptoms of many neurological diseases is fatigue. Although vestibular rehabilitation has been researched in the papers for neurological diseases such Parkinson Disease, Multiple Sclerosis, and stroke, vestibular diseases have not been addressed. As far as our knowledge is concerned, this study represents the first on this topic. Tramontano et al[35] in their study, observed that fatigue decreased, balance improved, and ADL improved after 4 weeks of vestibular rehabilitation administered to 30 people who had severe Multiple Sclerosis. According to Abas et al[36], an 8-week vestibular rehabilitation program applied to Parkinson patients could enhance fatigue and ADL. As per Ghaffari et al[37], an 8-week vestibular rehabilitation program can reduce fatigue, depression, and increase independence with ADLs in stroke patients. The 12-week vestibular rehabilitation program for patients with BVH did not significantly decrease patients' levels of fatigue in our study. We assume that secondary contributors of fatigue are to contribute.

4.1. Strengths of the study

In this study, the effects of structured vestibular rehabilitation on balance, severity of dizziness and QoL, as well as on sleep quality, kinesiophobia and fatigue that were not evaluated before were investigated. In addition, it was aimed to contribute to the literature with the recommended treatment duration, treatment variety and number of patients.

4.2. Limitations of the study

One of the limitations of this study was that the physical activity levels of the subjects were not evaluated. Another limitation of the study was that although it is a scale directly related to BVH, we did not use the Visual Vertigo Analog Scale because it did not have Turkish validity and reliability.

5. Conclusion

In conclusion, a twelve-week structured vestibular rehabilitation program may enhance severity of dizziness, kinesiophobia, balance, quality of sleep, ADL and QoL in participants with chronic BVH.

Author contributions

Conceptualization: Sena Gizem Genç, Miray Budak, Mahmut Sinan Yilmaz.
Formal analysis: Miray Budak.
Funding acquisition: Sena Gizem Genç, Miray Budak.
Investigation: Sena Gizem Genç.
Methodology: Sena Gizem Genç, Miray Budak, Mahmut Sinan Yilmaz, Zeliha Candan Algun.
Resources: Sena Gizem Genç, Zeliha Candan Algun.
Supervision: Sena Gizem Genç, Zeliha Candan Algun.
Validation: Mahmut Sinan Yilmaz, Zeliha Candan Algun.
Visualization: Mahmut Sinan Yilmaz.
Writing – original draft: Sena Gizem Genç.
Writing – review & editing: Sena Gizem Genç, Miray Budak, Mahmut Sinan Yilmaz, Zeliha Candan Algun.

References

[1] Starkov D, Strupp M, Pleshkov M, et al. Diagnosing vestibular hypofunction: an update. J Neurol. 2021;268:377–85.
[2] Propper EJ, van Eijsden HMK, Schermer TR, et al. Bilateral vestibular hypofunction in a tertiary dizziness center: occurrence and etiology. J Int Adv Otol. 2022;18:327–33.
[3] Grill E, Heuberger M, Strobl R, et al. Prevalence, determinants, and consequences of vestibular hypofunction. Results from the KORA-FF4 Survey. Front Neurol. 2018;9:1076.

[4] Jahn K. The aging vestibular system: dizziness and imbalance in the elderly. Adv Otorhinolaryngol. 2019;82:143–9.
[5] Sever E, Kilic G, Algun ZC. The Effects of vestibular rehabilitation on kinesiophobia and balance with individuals who has vestibular hypofunction. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 3):4319–24.
[6] Wuehr M, Decker J, Schenkel F, et al. Impact on daily mobility and risk of falling in bilateral vestibulopathy. J Neurol. 2022;269:5746–54.
[7] Riska KM, Bellucci J, Garrison D, et al. Relationship between corrective saccades and measures of physical function in unilateral and bilateral vestibular loss. Ear Hear. 2020;41:1568–74.
[8] Micarelli A, Viziano A, Pistillo R, et al. Sleep performance and chronotype behavior in unilateral vestibular hypofunction. Laryngoscope. 2021;131:2341–7.
[9] Ogihara H, Kamo T, Tanaka R, et al. Factors affecting the outcome of vestibular rehabilitation in patients with peripheral vestibular disorders. Auris Nasus Larynx. 2022;49:950–5.
[10] Porciuncula F, Johnson CC, Glickman LB. The effect of vestibular rehabilitation on adults with bilateral vestibular hypofunction: a systematic review. J Vestib Res. 2012;22:283–98.
[11] Armağan O. İki Taraflı Vestibulopatide Vestibüler Rehabilitasyon. Türk Beyin Dam ar Hastalıkları Dergisi. 2017;23:1–9.
[12] Aksoy S. Temel Vestibüler Rehabilitasyon: Hipokrat Kitabevi; 2020.
[13] Zhao M, Han J, Li L. IGST combined with conventional drug therapy and TCM therapy for treatment of bilateral vestibular hypofunction. Evid Based Complement Alternat Med. 2022;2022:5689454.
[14] Hall CD, Herdman SJ, Whitney SL, et al. Vestibular rehabilitation for peripheral vestibular hypofunction: an evidence-based clinical practice guideline: from the american physical therapy association neurology sectioN. J Neurol Phys Ther. 2016;40:124–55.
[15] Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39:175–91.
[16] Shugyo M, Ito T, Shiozaki T, et al. Comparison of the video head impulse test results with caloric test in patients with Meniere's disease and other vestibular disorders. Acta Otolaryngol. 2020;140:728–35.
[17] Yilmaz ÖT. Tampa Kinezyofobi Ölçeği'nin Türkçe versiyonu ve test-tekrar test güvenirliği Fizyoterapi Rehabilitasyon. 2011;22:44–9.
[18] Ertunc Gulcelik G, Tarakci D, Gedik Soyuyuce O, et al. Research on the effects of a web-based system with oculomotor and optokinetic stimuli on vestibular rehabilitation. Am J Phys Med Rehabil. 2021;100:555–62.
[19] Buysse DJ, Reynolds CF, 3rd, Monk TH, et al. The pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28:193–213.
[20] Jacobson GP, Newman CW. The development of the dizziness handicap inventory. Arch Otolaryngol Head Neck Surg. 1990;116:424–7.
[21] Gunduz B, Aydin Y, Guclu Gunduz A, et al. Reliability and validity of the Turkish version of the vestibular rehabilitation benefit questionnaire. Turk J Med Sci. 2021;51:796–8001.
[22] Gencay-Can A, Can SS. Validation of the Turkish version of the fatigue severity scale in patients with fibromyalgia. Rheumatol Int. 2012;32:27–31.
[23] Hall CD, Herdman SJ, Whitney SL, et al. Vestibular rehabilitation for peripheral vestibular hypofunction: an updated clinical practice guideline from the academy of neurologic physical therapy of the American physical therapy association. J Neurol Phys Ther. 2022;46:118–77.
[24] Maslovara S, Butkovic-Soldo S, Peric M, et al. Effect of vestibular rehabilitation on recovery rate and functioning improvement in patients with chronic unilateral vestibular hypofunction and bilateral vestibular hypofunction. NeuroRehabilitation. 2019;44:95–102.
[25] Yardley L, Beech S, Zander L, et al. A randomized controlled trial of exercise therapy for dizziness and vertigo in primary care. Br J Gen Pract. 1998;48:1136–40.
[26] Lehnen N, Kellerer S, Knorr AG, et al. Head-movement-emphasized rehabilitation in bilateral vestibulopathy. Front Neurol. 2018;9:562.
[27] Barrenengoa-Cuadra MJ, Angon-Puras LA, Moscosio-Cuevas JI, et al. [Effectiveness of pain neuroscience education in patients with fibromyalgia: structured group intervention in primary care]. Aten Primaria. 2021;53:19–26.
[28] Meldrum D, Herdman S, Vance R, et al. Effectiveness of conventional versus virtual reality-based balance exercises in vestibular rehabilitation for unilateral peripheral vestibular loss: results of a randomized controlled trial. Arch Phys Med Rehabil. 2015;96:1319–1328.e1.
[29] Krebs DE, Gill-Body KM, Parker SW, et al. Vestibular rehabilitation: useful but not universally so. Otolaryngol Head Neck Surg. 2003;128:240–50.
[30] Macias JD, Massingale S, Gerkin RD. Efficacy of vestibular rehabilitation therapy in reducing falls. Otolaryngol Head Neck Surg. 2005;133:323–5.
[31] Ebrahimi AA, Jamshidi AA, Movallali G, et al. The effect of vestibular rehabilitation therapy program on sensory organization of deaf children with bilateral vestibular dysfunction. Acta Med Iran. 2017;55:683–9.
[32] Whitney SL, Alghadir AH, Anwer S. recent evidence about the effectiveness of vestibular rehabilitation. Curr Treat Options Neurol. 2016;18:13.
[33] Meli A, Zimatore G, Badaracco C, et al. Vestibular rehabilitation and 6-month follow-up using objective and subjective measures. Acta Otolaryngol. 2006;126:259–66.
[34] Sugaya N, Arai M, Goto F. The effect of vestibular rehabilitation on sleep disturbance in patients with chronic dizziness. Acta Otolaryngol. 2017;137:275–8.
[35] Tramontano M, Belluscio V, Bergamini E, et al. Vestibular rehabilitation improves gait quality and activities of daily living in people with severe traumatic brain injury: a randomized clinical trial. Sensors (Basel). 2022;22:8553.
[36] Abasi A, Raji P, Friedman JH, et al. Effects of vestibular rehabilitation on fatigue and activities of daily living in people with parkinson's disease: a pilot randomized controlled trial study. Parkinsons Dis. 2020;2020:8624986.
[37] Ghaffari A, Asadi B, Zareian A, et al. The effects of vestibular rehabilitation on poststroke fatigue: a randomized controlled trial study. Stroke Res Treat. 2022;2022:3155437.