Multicomponent physical exercise on body composition, cardiorespiratory capacity and balance in people with vestibular hypofunction: preliminary results of the Exervest study

Asier Lekue-Madinabeitia[1,2], Gontzal Rodríguez-Arietaleanizbeaskoa[3], Maitane Ruiz-Rios[2,4], Mikel Tous-Espelosin[2,4], Pablo Corres[2,4], Antonio Moreno-Rueda[1,2], Sara Maldonado-Martin[2,4]

[1]ENT department, Hospital Universitario de Araba. OSIARABA. Vitoria-Gasteiz. Araba/Álava. País Vasco. [2]Instituto de Investigación Sanitaria Bioaraba. Vitoria-Gasteiz, Araba/Álava. [3]Physical education and sport department. Faculty of education and sport - Physical activity and sport sciences section. Universidad del País Vasco (UPV/EHU). Vitoria-Gasteiz. Araba/Álava. [4]Society, sport and physical exercise research group (GIKAFIT). Physical education and sport department. Faculty of education and sport - Physical activity and sport sciences section. Universidad del País Vasco (UPV/EHU). Vitoria-Gasteiz. Araba/Álava.

doi: 10.18176/archmeddeporte.00192

Received: 31/10/2024
Accepted: 30/11/2024

Summary

Objectives: This study aimed to analyse the effects of a multi-component exercise programme in people with vestibular hypofunction (VH) on body composition, cardiorespiratory fitness (CRF), and balance.
Material and method: People with VH (n = 45) were randomised into a control care group (CG, treatment as usual) and an exercise group (EG, 2 days per week, 60 min/day, with a multi-component programme including aerobic endurance, resistance training, and balance). Before and after eight weeks of intervention, all participants were assessed for body composition [body mass (BM), fat mass (FM), and fat-free mass (FFM)], CRF with a peak cardiopulmonary exercise test [peak oxygen consumption (VO_{2peak})] and balance with the Modified Dynamic Gait Index (MDGI) test.
Results: After the intervention EG decreased %FM ($P = 0.041$, $\Delta = -4.4\%$) and increased %FFM ($P = 0.041$, $\Delta = 2.2\%$), increased VO_{2peak} both in relative ($mL \cdot kg^{-1} \cdot min^{-1}$, $P = 0.007$, $\Delta = 9.9\%$) and absolute values ($L \cdot min^{-1}$, $P = 0.007$, $\Delta = 10.5\%$), and presented higher values in the MDGI test ($P = 0.008$, $\Delta = 4.1\%$). In contrast, the CG showed no significant changes in body composition nor MDGI test, and decreases were observed in absolute VO_{2peak} ($L \cdot min^{-1}$, $P = 0.016$, $\Delta = -11.1\%$), with no significant changes in relative values.
Conclusion: In conclusion, a multi-component exercise programme improves body composition, CRF, and balance in people with VH. A healthy lifestyle based on regular exercise should be recommended and implemented to reduce the effects of the disease and the sedentary lifestyle generated by the symptoms or the possible occurrence of other diseases.

Key words:
Vestibular hypofunction. Exercise. Cardiorespiratory fitness. Body composition. Balance.

Ejercicio físico multicomponente sobre la composición corporal, capacidad cardiorrespiratoria y equilibrio en la hipofunción vestibular: resultados preliminares del estudio Exervest

Resumen

Objetivos: El objetivo de este estudio fue analizar los efectos de un programa de ejercicio físico multicomponente en personas con hipofunción vestibular (HV) en la composición corporal, capacidad cardiorrespiratoria (CCR) y equilibrio.
Material y método: Personas con HV (n = 45) se aleatorizaron en un grupo de atención control (GAC, tratamiento habitual) y en un grupo de ejercicio físico (GEF, 2 días por semana, 60 min/día, con un programa multicomponente incluyendo resistencia aeróbica, fuerza y equilibrio). Antes y después de ocho semanas de intervención se valoró a todas las personas participantes la composición corporal [masa corporal (MC), masa grasa (MG) y masa libre de grasa (MLG)], la CCR con una prueba pico de esfuerzo cardiopulmonar [consumo pico de oxígeno (VO_{2pico})] y el equilibrio con la prueba *Modified Dynamic Gait Index* (MDGI).
Resultados: Después de la intervención GEF disminuyó el %MG ($p = 0{,}041$, $\Delta = -4{,}4\%$) y aumentó el %MLG ($p = 0{,}041$, $\Delta = 2{,}2\%$), incrementó el VO_{2pico} tanto en valores relativos ($mL \cdot kg^{-1} \cdot min^{-1}$, $p = 0{,}007$, $\Delta = 9{,}9\%$) como absolutos ($L \cdot min^{-1}$, $p = 0{,}007$, $\Delta = 10{,}5\%$), y presentó valores superiores en la prueba MDGI ($p = 0{,}008$, $\Delta = 4{,}1\%$). En cambio, el GAC no presentó cambios significativos en la composición corporal, ni prueba MDGI, y se observaron descensos en el VO_{2pico} absoluto ($L \cdot min^{-1}$, $p = 0{,}016$, $\Delta = -11{,}1\%$), sin cambios significativos en valores relativos.
Conclusión: En conclusión, un programa de ejercicio físico multicomponente en personas con HV parece mejorar la composición corporal, CCR y equilibrio. Se debería recomendar y aplicar un estilo de vida saludable basado en la práctica regular de ejercicio físico para reducir los efectos de la propia enfermedad, el sedentarismo generado por los síntomas o la posible aparición de otras enfermedades.

Palabras clave:
Hipofunción vestibular. Ejercicio físico. Capacidad cardiorrespiratoria. Composición corporal. Equilibrio.

Correspondence: Asier Lekue-Madinabeitia
E-mail: asieriagoba.lekuemadinabeitia@osakidetza.eus

Introduction

The vestibular system is a sensory system which involves communication between the ocular system, postural muscles, brainstem, cerebellum, cortex and peripheral vestibular apparatus. The last entry in the list consists of small structures in the inner ear which detect head movement and gravitational forces on the body. This information is processed in the brain so the individual can keep balance, correctly process visual images and orient themselves spatially when moving[1]. Vestibular hypofunction (VH) is a partial or total disorder of the central vestibular system (brainstem, cerebellum and vestibular-cerebellar connections) or peripheral vestibular system (labyrinth or vestibular nerve) which can cause disabling symptoms, both static (oblique deviation, postural asymmetries) and dynamic (dizziness, balance disorders, ataxia, lateropulsion, oscillopsia)[2].

VH severely affects the functioning and daily life of people who suffer from it. Symptoms such as ataxia (i.e. lack of coordination and instability when walking) or oscillopsia (i.e. visual disturbances) involve an increased risk of falls. These symptoms impair people's ability to perform daily activities, thus worsening their quality of life and negatively impacting their personal, social and economic well-being[2]. Such disabilities affect their self-confidence and generate fear and/or anxiety when taking part in different social activities. As a consequence, people with VH tend to limit physical activity (PA) and lead a sedentary life so as not to trigger the aforementioned symptoms. This not only worsens their VH but also opens the door to the possible appearance of other medical problems[3].

Such sedentary behaviour and physical inactivity is associated with an increased risk of chronic non-communicable diseases, a lower quality of life and increased mortality[4]. Behaviour of this kind can have several negative effects on health, such as an unhealthy increase in fat mass and decrease in cardiorespiratory capacity (CRC) and fat-free mass, thereby hampering balance and increasing the number of falls. It can also worsen a person's quality of life, so PA could be a good adjuvant treatment for people with VH[5].

For people with VH, vestibular rehabilitation has been determined to be effective in stimulating the development of mechanisms which correct alterations in spatial orientation and balance, thus improving their quality of life[6]. Previous studies of vestibular rehabilitation through physical therapy have involved habituation or repetition exercises, static and dynamic balance exercises, postural control altering visual input (closed eyes, virtual reality) and somatosensory input (foam rubber), walking exercises and general fitness exercise to improve postural and gaze stability[7]. However, programmes should be individualised and tailored to the characteristics of the damage and the functional capacity of each patient. Therefore, following a supervised physical exercise programme is of vital importance if you want to generate adherence to PA and end the aforementioned sedentary lifestyle[8].

So, taking into account the benefits of PA, it is important to hit on a good training methodology for people with VH. These recommendations were made by WHO and are classified depending on age and health condition. WHO determines that adults aged ≥18 years with chronic conditions should perform between 150 and 300 minutes of moderate-intensity aerobic PA per week and/or between 75 and 150 minutes of vigorous-intensity aerobic PA per week, or an equivalent combination of moderate- and vigorous-intensity activity each week. It also recommends muscle strengthening activities involving moderate- or greater-intensity strength exercises at least two days a week, and people aged ≥65 years, in addition to the above, should do functional balance and fall prevention exercises at least three days a week[9]. So a multicomponent physical exercise programme combining strength, endurance, balance and gait training could be the most beneficial for increasing lean body mass, CRC and balance, and, consequently, for maintaining autonomy, decreasing the risk and number of falls, and improving quality of life[10]. Interventions that combine high-intensity interval training (HIIT) and muscle strength training have more beneficial effects than any other type of physical exercise when it comes to increasing lean body mass and CRC, in turn reducing the risk of morbidity and mortality[11]. HIIT is a training method based on repeated bouts of high-intensity exercise in alternation with bouts of low- to moderate-intensity or recovery exercise. HIIT may have added advantages compared to continuous moderate-intensity exercise as it leads to greater CRC improvement and produces peripheral muscle changes which result in fewer negative symptoms of training[12]. What is more, considering that lack of time is the biggest obstacle to doing regular PA, low-volume HIIT (10 minutes or less at high intensity) could be a better option for aerobic training, achieving greater physiological stimuli, compared to a programme of light-moderate intensity exercise at a greater volume[13]. Retro-walking (i.e. walking backwards) has also been related to vestibular improvement and greater quality of life. It has been observed that backward movements reduce the load falling on the joints of the extremities and increase muscle power. Also, as a person walks backwards, they move without relying on their sight, which further develops their other senses, mainly hearing, and increases balance and proprioception[14]. All physical exercise design should be based on the FITT principle (Frequency, Intensity, Time and Type) and organise workouts by adjusting these variables. However, there is an absence of studies determining an adequate protocol which considers the FITT principle and the PA recommendations for the general population integrating a multicomponent physical exercise programme for people with VH. Therefore, the main objective of this study was to analyse the effects of a multicomponent physical exercise programme on people with VH in terms of body composition, CRC and balance.

Materials and method

The EXERVEST study protocol was published in a previous article[15]. The sample of the present study included 45 adults (57.3 ± 9.9 years) with chronic UVH or BVH who used the ENT service at the university

hospital run by the Araba/Álava public health service. All the participants met the inclusion and exclusion criteria with a favourable report from the Araba/Álava public health service's Research ethics committee (File 2021-095). After signing the informed consent forms, they were randomised into two groups: the physical exercise group (EXG, $n = 25$) and the attention control group (ACG, $n = 20$). All the subjects recruited were assessed at two points in time, before (T0) and after (T1) the eight weeks of intervention, to analyse the variables considered in the study.

Balance and risk of falls were assessed using the *Modified Dynamic Gait Index* (MDGI)[6]. To assess body composition, fat mass (FM) and fat-free mass (FFM) were measured by bioelectrical impedance analysis (Tanita, BF 350 and Tanita, BC-418 MA, Amsterdam, The Netherlands). To analyse CRC and determine peak oxygen consumption (VO_{2peak}) and ventilatory thresholds (VT), a peak symptom-limited cardiopulmonary exercise test was conducted on a Lode Excalibur cycle ergometer with electronic brake (Groningen, The Netherlands) under controlled laboratory conditions. The protocol started at 40 W (~70 rpm), with gradual increments of 10 W every minute until exhaustion. Gas and ventilation analyses, and electrocardiogram monitoring were performed with the ErgoCard Medisoft S.S system (Belgium Ref. USM001 V1.0 system), calibrating before each test according to the manufacturer's instructions. It was assumed that VO_{2peak} had been achieved when two or more of the following items were obtained:

- >85 % of age-predicted maximum heart rate (HR).
- Perceived maximum fatigue (>18 on the Borg scale).
- Peak respiratory exchange ratio ≥1.10.
- Omission of increment in oxygen uptake and/or HR with increases in work rate[17].

The measurements of the first and second ventilatory thresholds (VT1 and VT2) were carried out using the standardised V-slope and ventilatory equivalent methods[17]. After reaching peak exertion, the participants remained at rest on the bike for five minutes to recover with electrocardiogram and blood pressure monitoring. Three ranges of physical exercise intensity were determined by identifying the two VTs: R1, light to moderate with HR values below VT1; R2, moderate to vigorous with HR values between VT1 and VT2; and R3, vigorous to severe with HR values higher than those associated with VT2 up to HR_{peak}.

Before the intervention, all anti-vertigo drugs were withdrawn from the participants. The ACG only performed the home vestibular rehabilitation exercises that are usually prescribed in consultation with this type of patients, particularly focused on complex visual and postural environments. The EXG exercised two non-consecutive days a week for eight weeks under the supervision of physical exercise specialists. Each session included a standardised 15-min warm-up with joint mobility and gait technique exercises, and a 5-min cool-down with basic stretching and controlled-breathing exercises. The central part of each training session consisted of:

- A low-volume aerobic HIIT programme on the bicycle (15 min of total volume) plus five minutes of retro-walking on the treadmill at R1-R2.
- Timed circuit training (45/20 seconds per exercise) with nine balance and endurance exercises which included postural control and integration of major muscle groups and basic motor patterns, including four core exercises at the end.

Statistical analysis

The normality of the variables was determined using the Shapiro-Wilk test. In addition to age and body mass (BM); the rest of the variables were considered non-normal distributions. Descriptive statistics were calculated for all the variables. The data were expressed as mean ± standard deviation (SD) when normality was met and as median ± interquartile range when there was non-normal distribution. An independent samples t-test was carried out on all the parametric variables to determine if there was a significant difference between the groups, using Student's t-test for those that followed a normal distribution and the Mann–Whitney U test when they did not. Cohen's d was calculated to describe the standardised mean difference in the effect sizes between the groups. The effect sizes were interpreted as small ($d = 0.2$), medium ($d = 0.5$) and large ($d = 0.8$) based on Cohen's benchmarks (1988). The two-sample t-test was used to determine if there were significant differences in the data recorded within each group between before and after the intervention. Analysis of variance (ANOVA) was used to examine the delta (Δ) score for each group (EXG, ACG). The data were analysed according to the intention-to-treat principle. Statistical significance was set at $p \leq 0.05$. All the statistics were analysed using SPSS 25.0.

Results

Before the intervention (Table 1), it was observed that there were no significant differences between the groups (EXG *vs*. ACG) in any of the variables analysed. Both the men (31.6 ± 7.8%) and the women (34.8 ± 7.7%) had obesity values in relation to the FM percentage (%FM)[18]. The values of VO_{2peak} taking the age (57.3 years) and sex of the participants into account indicated that the men were in the 40th percentile ($VO_{2peak} = 23.0 \pm 10.0$ mL·kg^{-1}·min^{-1}) and the women in the 80th percentile ($VO_{2peak} = 21.0 \pm 7.0$ mL·kg^{-1}·min^{-1})[19]. According to the mean results of the MDGI test (60.0 ± 6.0), the participants were not at risk of falling[20].

Analysing the post-intervention values (Table 2), while in the EXG there were significant increases in the FFM percentage (%FFM) ($p = 0.041$, Δ = 2.2%), VO_{2peak}, both in relative (mL·kg^{-1}·min^{-1}, $p = 0.007$, Δ = 9.9%) and absolute (L·min^{-1}, $p = 0.007$, Δ = 10.5%) values, and MDGI ($p = 0.008$, Δ = 4.1%), and a significant decrease in the %FM ($p = 0.041$, Δ = -4.4%); the ACG showed significant decreases in absolute VO2peak (L·min^{-1}, $p = 0.016$, Δ = -11.1%), without changes in the other variables. So the comparative analysis of the changes between the two groups after the intervention showed differences in VO_{2peak}, both in relative (mL·kg^{-1}·min^{-1}, $p < 0.001$, Z = -3.217) and absolute (L·min^{-1}, $p < 0.001$, Z = -3.534) terms, and in MDGI ($p = 0.01$, Z = -2.346), with significant increases in EXG compared to ACG.

Table 1. Pre-intervention analysis of the EXERVEST study population.

	All (n = 45)	EXG (n = 25)	ACG (n = 20)	*p*	Cohen's *d*
Age (years)	57.3 + 10.0	55.0 + 8.5	60.1 + 11.1	0.043	0.52
BM (kg)	75.0 + 16.6	77.3 + 15.7	72.0 + 17.6	0.146	0.32
FM (%)	33.7 + 7.8	33.5 + 7.1	33.9 + 8.7	0.441	0.05
FFM (%)	66.3 + 7.8	66.5 + 7.1	66.1 + 8.7	0.441	0.05
VT1 ($mL \cdot kg^{-1} \cdot min^{-1}$)	12.0 + 6.0	12.0 + 5.5	12.0 + 5.5	0.766	0
RER_{peak}	1.1 + 0.1	1.12 + 0.15	1.1 + 0.07	0.083	0.17
VO_{2peak} ($mL \cdot kg \text{--} 1min^{-1}$)	22.0 + 10.0	22.0 + 8.0	22.5 + 11.0	0.945	0.05
VO_{2peak} ($L \cdot min^{-1}$)	1.6 + 0.7	1.6 + 0.6	1.5 + 1.1	0.283	0.11
MDGI	60.0 + 6.0	61.0 + 17.0	60.0 + 5.0	0.426	0.08

ACG: Attention control group; EXG: Physical exercise group; BMI: Body mass index; BM: Body mass; FM: Fat mass; FFM: Fat-free mass; MDGI: Modified Dynamic Gait Index; RER_{peak}: Peak respiratory exchange ratio; VT1: Ventilatory threshold 1; VO_{2peak}: Peak oxygen consumption.

Table 2. Post-intervention analysis of the EXERVEST study population.

		EXG (n = 16)		ACG (n = 14)		*p*
			$P_{T0\text{-}T1}$		$P_{T0\text{-}T1}$	
BM (kg)						
	T0	78.8 ± 17.1		70.5 ± 15.3		
	T1	77.9 ± 16.4	0.064	70.2 ± 15.9	0.365	0.258
FM (%)						
	T0	31.7 ± 7.3		35.7 ± 6.5		
	T1	30.3 ± 8.1	0.041	33.8 ± 8.4	0.231	0.426
FFM (%)						
	T0	68.2 ± 7.3		64.2 ± 6.5		
	T1	69.7 ± 8.1	0.041	66.2 ± 8.4	0.231	0.427
VT1 ($mL \cdot kg^{-1} \cdot min^{-1}$)						
	T0	14.9 ± 5.8		13.6 ± 4.6		
	T1	16.3 ± 6.1	0.183	12.8 ± 2.7	0.591	0.180
RER_{peak}						
	T0	1.11 ± 0.07		1.09 ± 0.07		
	T1	1.07 ± 0.09	0.064	1.07 ± 0.08	0.223	0.758
VO_{2peak} ($mL \cdot kg^{-1} \cdot min^{-1}$)						
	T0	25.2 + 7.2		24.6 + 6.5		
	T1	27.7 + 8.3	0.007	22.3 + 6.7	0.054	<0.001
VO_{2peak} ($L \cdot min^{-1}$)						
	T0	1.9 + 0.5		1.8 + 0.7		
	T1	2.1 + 0.5	0.007	1.6 + 0.6	0.016	<0.001
MDGI						
	T0	48.3 + 19.1		52.4 + 16.4		
	T1	50.3 + 18.7	0.008	51.9 + 15.5	0.428	0.010

ACG: Attention control group; EXG: Physical exercise group; BMI: Body mass index; BM: Body mass; MDGI: Modified Dynamic Gait Index; RER_{peak}: Peak respiratory exchange ratio; VT1: Ventilatory threshold 1; VO_{2peak}: Peak oxygen consumption.

Discussion

The objective of this study was to analyse the effects of a multi-component physical exercise programme on people with VH in terms of body composition, CRC and balance. The main outcomes were:

- The ACG maintained the baseline body composition values, while the EXG had a lower FM% and a higher FFM%.
- The EXG had greater CRC in both relative and absolute terms, while the ACG maintained CRC relative values but had lower CRC in absolute terms.
- Regarding balance, no changes were observed in the ACG, while the EXG obtained higher values in the MDGI test.

Body composition in terms of FM% and FFM% are related to PA and lifestyle, with sedentary people or people with low levels of PA having more noxious values because they give rise to a positive energy balance, leading to an increase in fat build-up[21]. Like this study, a physical exercise programme combining strength training and HIIT also led to improvements in FM% and FFM%[22]. The reason for this is that this type of training leads to improvements in skeletal muscle capacity for the uptake and oxidation of fatty acids, and for increasing both glycogen content and utilisation[11]. Indeed, it has been shown that a large amount of abdominal and total fat is lost through HIIT[23]. It has also been shown that, if we add retro-walking with shorter steps to this training, the step speed increases, as do, in turn, muscle power and energy consumption[14]. Although aerobic endurance training results in greater caloric expenditure, strength training can change the distribution of body fat and increase muscle mass by activating type II or fast-twitch fibres, leading to better metabolic control[24]. This leads to a decrease in the pro-inflammatory proteins associated with physical inactivity and secreted by adipose tissue, called cytokines, which inflame the tissue and participate in the accumulation of fat, giving rise, potentially, to different metabolic diseases, such as atherosclerosis. At the same time, there is an increase in myokines, proteins secreted by the muscle which counteract the effects of cytokines and regulate muscle growth and lipid metabolism[25].

Regarding CRC, the results of this intervention show that it improved in the EXG in terms of both relative ($mL \cdot kg^{-1} \cdot min^{-1}$, $p = 0.007$, $\Delta = 9.9\%$) and absolute ($L \cdot min^{-1}$, $p = 0.007$, $\Delta = 10.5\%$) values, while the relative values of the ACG remained stable and its absolute values got worse (Table 2). People with VH tend to limit PA and lead a sedentary life so as not to trigger the symptoms. This worsens their CRC and, consequently, increases the risk of other medical problems, such as cardiovascular diseases[3]. Several studies have shown that HIIT training is related to an increase in VO_{2peak}, due to mitochondrial biogenesis, and to the change in its composition, favouring aerobic metabolism capacity. This is due to the oxygen deficit that occurs after each acceleration close to the recovery interval; this new start to achieve high intensity activates the anaerobic metabolism, producing a physiological remodelling as a product of work in a hypoxic condition and activating the receptor gamma coactivator 1-alpha (PGC-1), considered the regulator of mitochondrial biogenesis at muscle level[26].

Low-volume HIIT also increases angiogenesis, the appearance of the GLUT4 protein in skeletal muscle and type I and II muscle fibre recruitment, and, consequently, glucose absorption, and improves endothelial function, blood pressure, muscle oxidative capacity, ejection fraction, stroke volume, peripheral vascular function and ventricular relaxation, resulting in an overall increase in myocardial contractile function[13]. As a result of these improvements, the cardiovascular system is strengthened and blood circulation stimulated, improving the transport and utilisation of oxygen throughout the body and, consequently, CRC[27]. Along these same lines, HIIT is also recommended for patients in poor physical condition not able to perform exercise of long duration because they cannot withstand high volumes of training[28].

In addition to aerobic training, strength training has been shown to be very beneficial for improving CRC. Increasing muscle mass also improves endothelial function, vasodilator capacity, blood pressure, microcirculation, cholesterol clearance, glucose absorption, myokine secretion, cytokine blockade and oxidative enzymes, and leads to an increase in type II muscle fibres. This achieves an improvement in blood flow and greater oxygenation throughout the body, leading to greater VO_{2peak} levels.

Finally, this intervention sought to improve balance and the risk of falls, given that an altered perception of position or movement is one of the main symptoms of the condition[6]. Although all the participants' MDGI values were already in normal ranges at the beginning of the study (Table 1), the results indicate that, after the intervention with physical exercise, the EXG significantly improved on its initial values, showing better balance, while the ACG's values did not change (Table 2). Previous studies integrating retro-walking into their intervention have also observed improvements in balance in people with a damaged vestibular system or loss of balance[14]. When we walk backwards, the break in the flow of visual data further stimulates the proprioceptive sensory system, that is, we move without depending on our sight, developing to a greater extent other senses such as hearing, as well as balance. Therefore, the body position and movement information the brain receives plays an important role in improving balance[14]. Retro-walking could improve joint proprioception, lower muscle strength and balance[30].

In this study's intervention with physical exercise, different balance, gait and strength exercises were also integrated to recover postural control and balance. Balance exercises in people with VH aim to improve the use of visual and somatosensory information as the main systems for postural control, taking the place of their damaged vestibular function and, therefore, increasing balance and decreasing the risk of falling. Exercises such as "single leg balance on bosu ball", in which the body rocks, serve to better control the centre of gravity and balance[7]. VH generates symptoms such as dizziness, blurred vision, decreased dynamic visual acuity and, consequently, imbalance. This inability to walk can worsen functionality and balance, increasing dependence and isolation. Therefore, walking exercises are crucial to improve gaze stability and dynamic visual acuity in people with VH, developing a safer

pattern and different mechanisms which correct alterations in spatial orientation and dynamic postural balance[31]. We know that strength training can help improve balance, which is, in part, related to increased muscle strength[32].

The balance of the EXG taking part in the multicomponent physical exercise programme involving retro-walking and different balance, gait and strength exercises improved, reducing the risk of falls (Table 2).

It should also be mentioned that this intervention with people with VH involved several limitations. These include the small size of the sample, which was because the study was yet to be completed. This negatively influenced data collection because the power of sample size necessary for the data obtained to be representative of the population had still not been reached. Poor adherence to PA programmes due to lack of motivation and time also reduced the number of completed sessions, affecting the results of the study. The short duration of the study (8 weeks) may also have neglected the long-term effects of the PA programme, as many benefits require more time to develop fully. Finally, the difficulty in controlling external variables such as sleep, diet and thermogenic activity not associated with exercise may also have borne an influence on the effects of the intervention.

Conclusion

A multicomponent exercise programme for people with VH could be effective in improving body composition, CRC and balance, variables which tend to worsen due to physical inactivity. Therefore, a healthy lifestyle should be recommended and applied in this population, based on the regular practice of PA to reduce the effects of the disorder itself, the sedentary lifestyle generated by the symptoms or the possible appearance of other medical problems..

Funding

Fundación Vital Fundazioa (VITAL21/24, BAFV22/012).

Conflict of interest

The authors declare that they are not subject to any type of conflict of interest.

Bibliography

1. Khan S, Chang R. Anatomy of the vestibular system: a review. *NeuroRehabilitation.* 2013;32:437–43.
2. Tapia-Egoavil R, Cabrera-Iturrizaga ML, López-Soria J. Frecuencia de atenciones por disfunción vestibular periférica en hospitales de nivel III, Perú. *Rev Medica Hered.* 2019;30:87–93.
3. Hall CD, Herdman SJ, Whitney SL, Anson ER, Carender WJ, Hoppes CW, *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.
4. Alòs F, Puig A. Inactividad física y sedentarismo. J Artic. 2022;18:66–75. Disponible en: https://salutpublica.gencat.cat/web/.content/minisite/aspcat/promocio_salut/suma_salut/noticies/activitat_fisica/02_Los-principales-problemas-de-salud_Febrero_22.pdf
5. Salinas Martínez F, Cocca A, Mohamed K, Viciana Ramírez J. Actividad física y sedentarismo: repercusiones sobre la salud y calidad de vida de las personas mayores. *Retos.* 2010;17:126–9.
6. Osakidetza. Tratamiento farmacológico del vértigo periférico. ¿En qué casos? *Inf Farmacoter.* 2023;31.
7. Benito Orejas JI, Aylagas Andrés MJ, Martín Moratinos C, Gallardo Chaparro I, Pérez Hickman L, Aladro Abad V, *et al*. Terapia física en la hipofunción vestibular unilateral y bilateral. *Rev ORL*. 2019;11:51.
8. Warburton DER, Bredin SSD, Charlesworth SA, Foulds HJA, McKenzie DC, Shephard RJ. Evidence-based risk recommendations for best practices in the training of qualified exercise professionals working with clinical populations. *Appl Physiol Nutr Metab.* 2011;36:232–65.
9. Organizacion Mundial de la Salud. Directrices de la OMS sobre actividad física y hábitos sedentarios. *J Chem Inf Model.* 2020;1:1–17. Disponible en: https://www.who.int/es/publications/i/item/9789240014886
10. Izquierdo M. Prescripción de ejercicio físico. El programa Vivifrail como modelo. *Nutr Hosp*. 2019;36:50–6.
11. D'Alleva M, Vaccari F, Graniero F, Giovanelli N, Floreani M, Fiori F, *et al.* Effects of 12-week combined training versus high-intensity interval training on cardiorespiratory fitness, body composition and fat metabolism in obese male adults. *J Exerc Sci Fit.* 2023;21:193–201.
12. Ross LM, Porter RR, Durstine JL. High-intensity interval training (HIIT) for patients with chronic diseases. *J Sport Heal Sci.* 2016;5:139–44.
13. Gibala MJ, Little JP, Macdonald MJ, Hawley JA. Physiological adaptations to low-volume, high-intensity interval training in health and disease. *J Physiol.* 2012;590:1077–84.
14. Korkmaz C, Toy AB. The effect of retro walking training on dynamic balance in sedentary individuals with hearing impairment. *Int J Educ Lit Stud*. 2023;11:164–9.
15. Ruiz-Rios M, Lekue A, Pinedo-López J, Tous-Espelosin M, Arratibel-Imaz I, García-Tabar I, *et al.* Supervised multi-component exercise as an adjuvant program for people with unilateral and/or bilateral chronic vestibular hypofunction: EXERVEST study protocol. *Contemp Clin Trials Commun.* 2023;36:1–8.
16. Matsuda PN, Taylor CS, Shumway-cook A. Evidence for the validity of the Modified Dynamic Gait Index across diagnostic groups. *Phys Ther.* 2014;94:996–1004.
17. Mezzani A, Hamm LF, Jones AM, McBride PE, Moholdt T, Stone JA, *et al*. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: A joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation. *Eur J Prev Cardiol.* 2013;20:442–67.
18. Bautista M, Guadarrama R, Veytia-López M. Prevalencia de obesidad según los indicadores: porcentaje de grasa corporal, índice de masa corporal y circunferencia de cintura. *Nutr Clín Diet Hosp.* 2020;40:18–25.
19. Kaminsky LA, Imboden MT, Arena R, Myers J. Reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing using cycle ergometry: data from the fitness registry and the importance of exercise National Database (FRIEND) Registry. *Mayo Clin Proc*. 2017;92:228–33.
20. Torchio A, Corrini C, Anastasi D, Parelli R, Meotti M, Spedicato A, *et al.* Identification of Modified Dynamic Gait Index cutoff scores for assessing fall risk in people with Parkinson disease, stroke and multiple sclerosis. *Gait Posture.* 2022;91:1–6.
21. Phillips CM. Metabolically healthy obesity across the life course: epidemiology, determinants, and implications. *Ann N Y Acad Sci*. 2017;1391:85–100.
22. Garcia-Pinillos F, Laredo-Aguilera JA, Munoz-Jime Nez M, Latorre-Roman PA. Effects of 12-week concurrent high-intensity interval strength and endurance training program on physical performance in healthy older people. *J Strength Cond Res.* 2019;33:1445–52.
23. Cress M, Porcari J, Foster C. Interval Training. *ACSM's Heal Fit J*. 2015;19:3–6.
24. Strasser B, Arvandi M, Siebert U. Resistance training, visceral obesity and inflammatory response: a review of the evidence. *Obes Rev.* 2012;13:578–91.
25. Huh JY. The role of exercise-induced myokines in regulating metabolism. *Arch Pharm Res.* 2018;41:14–29.
26. MacInnis MJ, Gibala MJ. Physiological adaptations to interval training and the role of exercise intensity. *J Physiol.* 2017;595:2915–30.
27. Pelliccia A, Sharma S, Bäck M, Gati S, Börjesson M, Caselli S, *et al.* Guía ESC 2020 sobre cardiología del deporte y el ejercicio en pacientes con enfermedad cardiovascular. *Rev Esp Cardiol.* 2021;74:488–93.

28. Achttien RJ, Staal JB, van der Voort S, Kemps HMC, Koers H, Jongert MWA, *et al.* Exercise-based cardiac rehabilitation in patients with coronary heart disease: a practice guideline. *Netherlands Hear J.* 2013;21:429–38.

29. Paluch AE, Boyer WR, Franklin BA, Laddu D, Lobelo F, Lee DC, *et al.* Resistance exercise training in individuals with and without cardiovascular disease: 2023 update. A scientific statement from the American Heart Association. *Circulation*. 2024;149:E217–31.

30. Alghadir AH, Anwer S, Sarkar B, Paul AK, Anwar D. Effect of 6-week retro or forward walking program on pain, functional disability, quadriceps muscle strength, and performance in individuals with knee osteoarthritis: A randomized controlled trial (retro-walking trial). *BMC Musculoskelet Disord.* 2019;20:4–13.

31. Herdman SJ, Hall CD, Schubert MC, Das VE, Tusa RJ. Recovery of dynamic visual acuity in bilateral vestibular hypofunction. *Arch Otolaryngol - Head Neck Surg*. 2007;133:383–9.

32. Palheta de Lima K, Nascimento da Silva C, Ferreira de Seixas N, de Santana Maneschy M, Nascimento Lima B, Vilela Junior G, *et al.* Efecto del entrenamiento resistido sobre el equilibrio y control postural en personas con párkinson: una revisión sistemática. *Rev Cient Soc Esp Enferm Neurol.* 2022;56:18–28.