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A systematic review about the effects of the vestibular rehabilitation in middle-age and older adults

Revisão sistemática sobre os efeitos da reabilitação vestibular em adultos de meia-idade e idosos

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Abstract

Objective: To summarize the results of clinical trials on vestibular rehabilitation (VR) in middle-aged and elderly people with vestibular disorders. **Methods:** A search for relevant trials was performed in the databases LILACS, EMBASE, MEDLINE, SciELO, Cochrane, ISI Web of Knowledge and virtual libraries of theses and dissertations. Randomized controlled trials published in the last 10 years and written in English, Portuguese or Spanish were included. The methodological quality of the studies was assessed by the PEDro scale. Results from the included studies were analyzed through a critical review of content. **Results:** Nine studies were included in the review. Four studies reported on participants aged over 40 years (middle-aged and elderly) and five studies consisted exclusively of elderly subjects (over 60 years). Findings of vestibular dysfunction were diverse and the most common complaints were body imbalance or postural instability (3 studies), and vertigo or dizziness (3 studies). The Visual Analogue Scale (VAS) was the most commonly used instrument to assess subjective perception of symptoms of vestibular dysfunction (4 studies). According to the PEDro scale, four studies were considered to be of good quality. The most common experimental intervention was the Cawthorne & Cooksey protocol (4 studies). For most outcome measures, the studies comparing VR with another type of intervention showed no differences between the groups after the therapy. **Conclusions:** The studies included in this review provide evidence for the positive effects of VR in elderly and middle-aged adults with vestibular disturbances.

Key words: vestibular diseases; rehabilitation; older adults.

Resumo

Objetivo: Sistematizar os resultados de ensaios clínicos sobre reabilitação vestibular (RV) em indivíduos de meia-idade e idosos com distúrbios vestibulares. **Métodos:** A busca de publicações sobre a RV em indivíduos com distúrbios vestibulares foi realizada nas bases de dados LILACS, EMBASE, MEDLINE, SciELO, Cochrane, ISI Web of Knowledge e bibliotecas virtuais de teses e dissertações. Foram selecionados ensaios clínicos aleatórios e controlados dos últimos 10 anos em língua inglesa, portuguesa e espanhola. A qualidade metodológica dos estudos foi avaliada pela escala PEDro. A análise dos resultados dos estudos foi feita por meio de revisão crítica dos conteúdos. **Resultados:** Nove estudos foram revisados na íntegra, sendo a faixa etária dos participantes acima de 40 anos (n= 4) e composta exclusivamente por idosos (n=5). Os achados de disfunção vestibular foram diversificados, sendo os mais comuns queixa de desequilíbrio corporal ou instabilidade postural (n=3) e queixa de vertigem ou tontura (n=3). A Escala Visual Analógica (EVA) foi o instrumento mais utilizado para avaliar a percepção subjetiva da sintomatologia da disfunção vestibular (n=4). A escala PEDro revelou que quatro dos artigos apresentaram delineamento de boa qualidade para a condução do estudo experimental. A proposta de intervenção mais utilizada foi o protocolo de Cawthorne & Cooksey (n=4). Os estudos que compararam a RV com outro tipo de intervenção não apresentaram, na maioria dos desfechos analisados, diferença entre os grupos após a terapia. **Conclusão:** Estudos aleatorizados controlados disponibilizaram evidências de efeitos positivos da RV em idosos e adultos de meia-idade com distúrbios vestibulares.

Palavras-chave: tontura; doenças vestibulares; reabilitação; idosos.

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Introduction

The maintenance of body balance depends on the harmonious interaction among the information generated by the sensory systems (visual, somatosensory and vestibular), the central nervous system (CNS) processing, and the proper execution by the motor system (neuromuscular). The integration of the sensory information by the CNS triggers reflexes such as the vestibulo-ocular reflex (VOR) and the vestibulo-spinal reflex, which act on visual field stabilization and maintenance of the standing posture during body and cephalic movements. In situations of sensory information conflict, specially due to vestibular dysfunction, the signs and symptoms of body balance impairment become frequent[1,2].

The complaining of vertigo or other types of dizziness in subjects with vestibular dysfunction are generally expressed as postural instability, increase in postural sway, reduction in the limits of stability, gait impairments, falls, and reduction in functional capacity[2,3].

Dizziness is the sensation of impairment in body balance, while vertigo is a sensation of rotary-type spatial disorientation. Vertigo and other dizziness from vestibular origin are present in 5% to 10% of the world's population, representing the most common symptoms after the age of 65 years-old, and affecting 80% of the older adults attending geriatric outpatient settings[4].

The dizziness in older adults is considered a multi-factorial geriatric syndrome originated from changes inherent to the aging process and/or from pathological conditions, that result in instability and greater predisposition to falls[4]. After the age of 40 years, it is possible to observe microscopic synaptic changes in the vestibular nerve; at the age of 50 years, there is an increase in the degeneration of the vestibular receptors in the ampullary crest of semicircular canals and macular region of saccule and utricle; at the age of 60 years, among several alterations, there is an increase in friction among the fibers of the vestibular nerve and a decrease in conduction velocity of the electrical stimuli in the vestibular nerve[4].

Vestibular rehabilitation (VR) is a therapeutic tool used in patients with body balance disorders of vestibular origin. Its proposed action is based on central mechanisms of neuroplasticity, known as adaptation, habituation and substitution, aiming a vestibular compensation[5]. The aim of VR exercises is to improve the vestibule-visual interaction during cephalic movement and to increase static and dynamic postural stability in conditions that produce conflicting sensory information.

VR has a positive effect in improving static and dynamic balance, gait, self-confidence, quality of life, and in reducing symptoms of dizziness, anxiety and depression[4,5]. VR can promote complete healing in 30% of patients and improvement of different degrees in 85% of patients[6]. There are several protocols of VR described in the literature, and the most frequently used ones are those of Cawthorne & Cooksey, Herdman, Italian Association of Neuro-Otology, and Norré[39]. However, there is a paucity of information on the effectiveness of the various VR protocols in middle-aged and elderly adults, given the peculiarities of vestibular disorders in this population.

This systematic review aims to provide a summary of the evidence on the effects of VR in middle-aged and elderly people with vestibular disorders.

Methods

A literature search was conducted on November 2008 in the electronic databases LILACS, EMBASE, MEDLINE, SciELO, Cochrane Library, ISI Web of Knowledge, and in three virtual libraries of theses and dissertations (Universidade de São Paulo (USP), Universidade Estadual de Campinas (UNICAMP) e Universidade Estadual Paulista (UNESP). Potentially relevant studies were identified by the following search strategy: ("aged" OR "elderly" OR "middle aged" OR "older people") AND ("vestibular diseases" OR "vestibular disorder") AND ("vestibular rehabilitation" OR "exercises" OR "balance training" OR "balance exercises" OR "virtual reality rehabilitation" OR "rehabilitation"). The search was limited by language (English, Portuguese or Spanish) and by date of publication (from November 1998 to November 2008).

The records retrieved from the search strategy had their titles and abstracts screened for eligibility by two independent reviewers, according to the following inclusion criteria: (1) sample aged over 40 years; (2) participants with vestibular dysfunction; (3) random sampling; (4) experimental group consisting of VR and control group with no treatment/placebo or another type of active intervention; and (5) experimental intervention defined as stimulation exercises for restoration of vestibular and body balance function, through vestibular neuroplasticity. Studies not specifying the exact age range of the participants were excluded, as were studies investigating pharmacological interventions, or electrophysiological or repositioning maneuvers not associated with vestibular exercises.

After the screening of titles and abstracts, the full texts of potentially eligible studies were screened, and those meeting the inclusion criteria had the relevant data extracted using a standardized form that included the following items: sample characteristics, primary and secondary outcomes, trial design, characteristics of the interventions and effects of the interventions.

The primary outcomes were selected according to the practicality and clinical relevance in outpatient clinics and rehabilitation centers; these included the subjective evaluation of the intensity of dizziness and body imbalance, clinical tests to assess balance and gait, and questionnaires and/or scales for measuring the impact of vestibular disorders in activities of daily living. The secondary measures chosen were laboratory tests assessing body balance, gait and visual acuity, doppler ultrasound and scales used to assess symptoms secondary to vestibular disorders (e.g. depression and anxiety).

The PEDro scale was used to assess the methodological quality of the included studies. The PEDro scale consists of a list of 11 criteria on validity and interpretation of results of controlled trials[7]. The rating of the methodological quality is done by assigning one point for each criterion of quality that is fulfilled; the first criterion, which refers to the sample eligibility criteria, is not scored. The higher the score on the PEDro scale, the most appropriate the study design, and the greater the possibility of reproducing the data presented. PEDro's website lists the quality ratings of the trials included in their database.

The disagreements between reviewers in the early stages of selection and assessment of the studies were solved by consensus, with divergent issues resolved by a third reviewer. Results of the included studies were analyzed by critical review of content and confrontation with those of other publications on the subject.

Results

One hundred and five studies were retrieved from the initial search strategy. After the title and abstract screening, 28 studies were identified as potentially eligible. However, after full text screening, 19 studies were excluded due to the following reasons: sample outside the pre-specified age range (n=14)[8-21], lack of randomization (n=4)[22-25], and sample with no complaints or vestibular disorders (n=1)[26]. Thus, nine randomized controlled trials were eligible for inclusion in this review and had their content critically analyzed. A synopsis of the main study characteristics and results of the included trials is shown on Table 1.

Sample characteristics

The sample sizes ranged from 14[27] to 215[28] subjects randomized to either VR or the control intervention. In four studies, participants aged over 40 years (middle-aged and elderly)[27,29-31]; in five studies, samples consisted exclusively of elderly subjects (over 60 years)[28,32-35]. The samples were composed of participants from both genders, but with a predominance of women[28,29,31,33-35]. The data on vestibular dysfunction were variable among the studies, with the most common complaints being body imbalance or postural instability[28,32,35], and dizziness or vertigo[31,33,35]. The topography of the vestibular dysfunction was rarely reported, with the most common being vestibular hypofunction[27,29]. To obtain the topographic diagnosis of the vestibular syndrome, studies employed electronystagmography[29,30,32] and other tests such as tone threshold audiometry[28,32], rotatory chair test[27,29,33], and the investigation of the brainstem electric response audiometry[28]. Diet was not controlled in any of the studies, and only one study[27] restricted the use of anti-vertigo drugs during treatment with VR.

Outcomes

Primary outcomes: The subjective perception of vestibular dysfunction symptoms was assessed in the majority of the studies[27,28,30-33,35], and the Visual Analogue Scale (VAS)[27,31,32,35] was the instrument most commonly used for this purpose. Other frequently used outcomes included static[28,30-33,35] and dynamic[30,31,33,35] body balance. Functional scales that evaluate the impact of dizziness in activities of daily living and in quality of life were applied in four studies[30,32-34], with the Dizziness Handicap Inventory (DHI) being the most commonly used[30,33].

Secondary outcomes: The laboratory tests used in the studies were computerized posturography[28,32,35] force platform for the assessment of gait[29], computerized test of visual acuity[27], and intracranial ultrasonography with doppler mapping[28].

Trial design and methodological quality

All studies were clinical controlled trials, with random allocation of participants to study groups. The effectiveness of VR was analyzed by the change in outcomes (pre- to post-treatment) between the VR group and the no treatment or placebo groups[27,28,30,31,33-35], or between the VR group and the other active treatment group[29,32]. The studies from Vereecke et al.[30] and from Hansson, Mansson and Håkansson[31] conducted a follow-up analysis after the intervention period.

The assessment of the quality revealed that four studies (44%)[27,30,33,35] were of good quality, and consequently yielded scientific evidence of higher level (Table 2).

Intervention protocol

The experimental intervention most commonly used was the VR protocol from Cawthorne & Cooksey[28,32-34]. In most studies, participants were instructed to perform home exercises, which were assisted by information leaflets[27-30,33]. In three studies[27,28,30], the exercises were performed exclusively at home, from three[30] to five[27] times a day, and visits to guide the progression of treatment were made to the therapist weekly[27], or every three weeks[30]. In the other studies[28,29,33], home exercises

Table 1. Characteristics and results of trials on vestibular rehabilitation in middle-age and older adults.

Study	Sample	Outcomes	Trial Design	Intervention	Effects observed
Simoceli, Bittar and Sznifer[32]	Age: above 65 years-old. Diagnosis: body imbalance. Inclusion criteria: symptoms of body imbalance for three months or more. Groups: n = 39 (sample lost to follow-up = 7) EG: n = 16 CG: n = 16	1) "Disability Index" Scale. 2) VAS of the imbalance symptom. 3) Limits of stability by dynamic posturography: - latency for movement onset; - velocity of movement; - end point of the center of mass displacement; - maximum displacement of the center of mass; - directional control of movement.	Randomized controlled trial.	EG: VR (Cawthorne & Cooksey protocol). Schedule: 2 times/day (total = 60 days). CG: exercises for VOR adaptation (Tusa and Herdman protocol). Schedule: 2 times/day (total = 60 days).	- EG and CG showed statistically significant within-group reductions on Disability Index. - VAS with 100% improvement in EG and 87.5% in CG. - No between-group differences on the limits of stability after intervention. - Significant improvement in CG regarding the center of mass displacement.
McGibbon et al.[29]	Age: 41 to 81 years-old. Diagnosis: unilateral and bilateral vestibular hypofunction. Inclusion criteria: subjects with body imbalance without VR in the last 6 months. Groups: n = 53 (sample lost to follow-up = 17) n = 36 (20 women and 16 men) 59.5 ± 11.5 years-old EG: n = 17 (56.9 ± 11.6 years-old) CG: n = 19 (61.7 ± 11.3 years-old)	1) Gait analysis (force platform): - dynamic function of gait (gait velocity, step length, step width and posture duration); - neuromuscular function of lower limbs (mechanical energy waste at ankle, knee, hip and total); - trunk stability by the center of mass (anteroposterior, lateral, angular sagital and frontal velocity of the trunk).	Randomized controlled trial.	EG: Protocol of VR. - Ocular and cephalic exercises during static and dynamic functional activities. - Training of VOR. - Training of vertical balance (base of support, sensory information, addition of cephalic and trunk movements). - Discussion about the symptoms and home-based exercises. Schedule: group sessions, once a week, 70 minutes duration (total: 10 weeks) CG: Tai Chi Chuan Protocol. - Warming up (stretching); - Tai Chi positions (reduction of the base of support, trunk extension and arms rotation in challenging positions) and meditation (diaphragmatic breathing). - Discussion about the symptoms and home-based exercises. Schedule: group sessions, once aweek, 70 minutes duration (total: 10 weeks)	- No difference between groups in neuromuscular function measures and trunk stability. - Significant improvement in EG for posture duration and step length. - Significant improvement in CG for gait velocity and step length. - Significant reduction in mechanical energy at hip and increase at ankle for the CG. - Significant increase in trunk velocity during gait after the intervention in CG. No significant difference in EG.

Table 1. Continuation.

Johansson et al.[33]	Age: above 65 years-old. Diagnosis: chronic dizziness. Inclusion criteria: older adults (65 to 80 years-old) with recurrent vertigo for at least 1 month. Groups: n = 22 (16 women and 6 men) 71.8 ± 5.2 years-old (sample lost to follow-up = 3) GE: n = 9 GC: n = 10	1) Fast Gait in 10 meters (duration). 2) Romberg: tandem position. 3) Time spent in cephalic rotation exercises. 4) DHI. 5) Vertigo Symptom Scale, short version (VSS). 6) Spielberger's Trait Anxiety Inventory (STAI-t). 7) Beck Depression Inventory (BDI).	Randomized controlled trial.	EG: VR protocol associated to behavioral therapy. - VR by the exercises of Yardley and of Cawthorne & Cooksey. - Behavioral therapy with relaxing exercises. - Discussion about the symptoms and home-based exercises. Schedule: 5 group sessions, 1-2 hours duration (total: 7 weeks with phone contact in the middle of the intervention). CG: waiting list without any type of intervention.	- Improvement in gait test in EG in relation to CG after treatment. - No difference in Tandem position between groups. - Significant improvement in two movements provocative of dizziness (inclined head with opened eyes and inclined head with fixed eyes) in EG after treatment. - Improvement in DHI scores in EG in relation to CG. - VSS, STAI-t, BDI: no difference between groups.
Herdman et al.[27]	Age: 46 to 73 years-old. Diagnosis: bilateral vestibular hypofunction. Inclusion criteria: subjects with bilateral vestibular hypofunction and dynamic visual acuity improper for the age. Groups: n = 14 63.6 ± 9.4 years-old (sample lost to follow-up = 1) EG: n = 8 63.6±9.4 years-old CG: n = 5 63.6±10.8 years-old	1) Evaluation of dynamic visual acuity by computerized test. 2) VAS of the "grade" of oscillopsia and intensity of body imbalance. 3) Vestibular function (Gain on the VOR) through the caloric proof and the rotator chair test.	Randomized controlled trial.	EG: Protocol of VR. - Exercises for ocular and cephalic adaptation. - Exercises for gait and body balance. - Recommendations for home-based exercises according to patients' symptoms. Schedule: weekly sessions to learn the exercises to be performed at home from 4 to 5 times/day (total: 6 weeks) CG: Protocol of placebo exercises. - Ocular exercises without labirintic stimulation (stationary head); - Exercises for gait and body balance; - Recommendation for home-based exercises according to patients' symptoms. Schedule: weekly visits to learn the exercises to be performd at home 4 to 5 times/day (total: 6 weeks)	- Significant improvement of the EG on dynamic visual acuity after intervention. - Absence of significant changes in vestibular function by the VOR in both groups after intervention. - Absence of correlation between the variables age, VAS of oscillopsia and VAS of body imbalance with visual acuity after intervention.

Table 1. Continuation.

Prasansuk et al.[28]	Age: above 60 years-old. Diagnosis: vestibular or imbalance symptoms. Inclusion criteria: symptoms of body imbalance, vertigo or dizziness in the last 6 months. Groups: n = 265 (sample lost to follow-up = 50) n =215 (161 women and 54 men) 67.4 ± 6.0 years-old EG: n = 110 (79 women and 31 men) (67.2 ± 6.4 years-old) CG: n = 105 (82 women and 23 men) (67.6 ± 5.5 years-old)	1) Numeric scale of vestibular imbalance symptoms (0-10 points). 2) Questionnaire regarding the protocol of exercises (easiness of execution, benefits and severity of the symptoms). 3) Posturography. 4) Doppler Ultrasound.	Randomized controlled trial. Assessments done at the 8th and 20th weeks of treatment.	EG: Protocol of VR. - Exercises (Cawthorne & Cooksey protocol with emphasis on cephalic movements). - Handbook with the protocol of home-based exercises. Schedule: 20 weeks. CG: - 8 weeks without exercise practice. - Last 12 weeks, same protocol of EG. Schedule: 12 weeks.	- No difference between groups after 8 weeks on intracanial doppler ultrasound and BERA. - EG had significant improvement in blood flow at internal carotid artery. - Number of abnormal cases on posturography statistically higher in CG in relation to EG at the 8th week. - No difference in the numerical scale of symptoms after the 20th week. - 19.3% of the sample reported total cure after the exercises.
Vereeck et al.[30]	Age: above 50 years-old. Diagnosis: acoustic neuroma. Inclusion criteria: indication for surgery for acoustic neuroma removal. Groups: n = 57 (sample lost to follow-up = 4) n = 53 EGElderly: n = 11 (58.5 ± 6.2 years-old) EGyoung: n = 11 (40.8 ± 7.4 years-old) CGElderly: n = 15 (60.0 ± 6.6 years-old) CGYoung = 16 (41.6 ± 5.9 years-old)	1) DHI. 2) Static Balance (Romberg, Romberg in unstable surface, Romberg in Tandem position and Single Leg Stance). 3) TUGT. 4) Tandem Gait. 5) DGI.	Randomized controlled trial. Assessment done before and after surgery (1st acute, 3rd, 6th, 9th and 12th weekcompensation) and follow-up (6 months and 1 year after surgery).	EGYoung and EGElderly: - Genneral instructions before and after surgery. - Increasing daily activities gradually. - Hospital exercises after surgery (3 to 5 days). - Individualized handbook of VR after discharge. Exercises (ocular stability, gait, sensibilization to movement and static balance) performed 3 times/day for at least 30 minutes. Progression was done at each visit to rehabilitation center (every 3 weeks, for a total of 12 weeks). Schedule: individualized treatment, home-based nature, no therapist supervision. CGYoung and CGElderly: General instructions before and after surgery. -Increasing daily activities gradually. - No home-based exercises after discharge.	- General comparison between CGElderly/CGYoung with EGElderly/CGYoung showed statistical difference on tandem gait in the acute and compensation phases. - No differences between the young groups in any recovery phase. - Improvements in EGElderly present in all measures and phases, except on DHI in the acute phase, and in tandem gait and static balance in the follow-up in relation to the CGElderly. - Improvements in all 4 groups after the acute and compensatory phases. - No differences between groups at follow-up. - 6 weeks after surgery, only EGElderly reached the initial results in all tests. - After 12 weeks, all groups reached their previous levels of function. - The beneficial effects remained after 1 year from surgery in all groups.

Table 1. Continuation.

Resende et al.[34]	Age: above 60 years-old. Diagnosis: BPPV Inclusion criteria: older adults (60 years-old or more) with BPPV. Groups: n = 16 (16 women) EG: n = 8 Average age of 70.5 years-old CG: n = 8 Average age of 69.3 years-old	1) Vestibular Disorders Activities of Daily Living Scale (Dimensions: physical, locomotion and instrumental).	Randomized controlled trial.	EG: VR (protocol of Cawthorne & Cooksey). Schedule: group sessions, 2 times/week (total = 5 weeks). - 40mg of Gingko-Biloba every12h for30 days. CG: did not perform exercises. - 40mg of Gingko-Biloba every 12h for 30 days.	- EG with significant improvement in the 3 dimensions of the scale after intervention. - CG without significant differences in the dimensions of the scale during the study period. - Scale of activities of daily living significantly improved inEG in relation to CG after intervention.
Kammerlind, Håkansson e Skogsberg[35]	Age: above 65 years-old. Diagnosis: vertigo of non-peripheral origin and postural instability. Inclusion criteria: Older adults with vertigo of non-peripheral origin, and/or instability, whom did not take part in balance training. Groups: n = 67 (sample lost to follow-up = 44) n=23 EG: n = 11 (6 women and 5 men) (71.5 ± 4.3 years-old) CG: n = 12 (7 women and 5 men) (71.8 ± 3.5 years-old)	1) VAS of the vertigo and instability levels. 2) Static balance with opened and closed eyes (Romberg, Romberg in tandem position and one leg stance). 3) Gait analysis (forward, backyard and fast). 4) Dynamic posturography: sensory organization test.	Randomized controlled trial.	EG: Protocol of VR: - Warming up. - Training of balance in different situations. - Flexibility, strengthening and balance exercise in stable surface. - Relaxing. Schedule: group sessions, 2 times/week with 60 minutes duration (total: 8 weeks) CG: Did not perform any type of exercise.	- EG with significant improvement in single leg stance with opened eyes, forward, backward and fast gait. - One leg stance with opened eyes significantly improved in EG in relation to CG. - Vertigo symptoms and instability assessed by VAS significant improved in EG (within-group and between-group analyses). - Conditions 3, 4 and 6 of posturography significantly improved in EG. - Conditions 1, 3, 4 and 6 of posturography significantly improved in EG in relation to CG.
Hånsson, Mansson and Håkansson[31]	Age: above 50 years-old. Diagnosis: Dizziness from central origin and dizziness related to aging. Inclusion criteria: subjects (50 years-old or more) with dizziness from central origin caused by the aging process. Groups: n = 57 (sample lost to follow-up = 15) n = 42 (30 women and 12 men) Average age of 77 years-old EG: n = 23 CG: n = 19	1) Static balance with opened and closed eyes (Romberg, Romberg in tandem position and one leg stance). 2) Dynamic balance: - Stop walking when talking; - Gait tandem; - Gait in eigth. 3)VAS of the dizziness complaint	Randomized controlled trial (3 months of follow-up).	EG: Protocol of VR with exercises of body balance, eyes and cephalic movements in unstable surface. Schedule:group sessions, 2 times/week for 45 minutes (total: 6 weeks) CG: Did not receive any type of intervention.	- Rigth one leg stance with closed eyes significantly improved in EG in relation to CG after 6 weeks of intervention. - After 3 months, single leg stance tests significantly improved in EG in relation to CG. - No between-group differences in other tests. - EG improved in 80% of the tests and worsened in 5%;CG improved in 30% of the tests and worsened in 55%.

BDI = Beck Depression Inventory; BERA = Brainstem Electric Response Audiometry; BPPV = Benign Paroxismal Positional Vertigo ; CG = Control Group; DGI = Dinamic Gait Index; DHI = Dizziness Handicap Inventory; EG = Experimental Group; STAI-t = Spielberger's Trait Anxiety Inventory; TUGT = Time Up and Go Test; VAS = Visual Analogue Scale ; VOR = Vestibulo-Ocular Reflex; VR = Vestibular Rehabilitation; VSS = Vertigo Symptom Scale, short version.

Table 2. Analysis of the methodological quality of the randomized studies on vestibular rehabilitation in middle-age and older adults, according to the Pedro Scale.

	Simoceli, Bittar e Sznifer[32*]	McGibbon et al.[29]	Johansson et al.[33]	Herdman et al.[27]	Prasansuk et al.[28]	Vereeck et al.[30]	Resende et al.[34]	Kammerlind, Håkansson e Skogsberg[35]	Hånsson, Mansson e Håkansson[31]
1 - Inclusion criteria	-	YES	YES	YES	YES	NO	YES	YES	YES
2 - Random allocation	-	YES	YES	YES	YES	YES	YES	YES	YES
3 - Concealled allocation	-	NO	NO	NO	NO	NO	NO	YES	NO
4 - Group similarity at baseline	-	YES	YES	YES	YES	YES	YES	YES	NO
5 - Blinding of participants	-	NO	NO	YES	NO	NO	NO	NO	NO
6 - Blinding of therapists	-	NO	NO	NO	NO	NO	NO	NO	NO
7 - Blinding of assessors	-	NO	YES	YES	NO	YES	NO	NO	NO
8 - Outcome measures in 85% of sample	-	NO	YES	YES	NO	YES	NO	YES	YES
9 - Intention-to-treat analysis	-	NO	NO	NO	NO	NO	NO	NO	NO
10 - Comparison between groups	-	YES	YES	YES	YES	YES	YES	YES	YES
11 - Measures of central tendency and dispersion	-	YES	YES	YES	YES	YES	YES	YES	NO
Total score	-	04	06	07	04	06	04	06	02

*Study not yet rated by PEDro.

complemented the therapy performed in the rehabilitation center. In most studies, exercises were performed in groups[29,31,33-35] and were administered weekly[29,33] or twice a week[31,34,35]. The total treatment duration varied between the minimum of five[34] to the maximum of 20 weeks[28,30].

Most studies compared the VR protocol with a control group formed by participants who did not perform any type of exercise[28,30,31,33-35], or who performed placebo exercises[27]. In the study of McGibbon et al.[29], the control group performed Tai Chi Chuan, and in the study of Simoceli, Bittar and Sznifer[32], the protocol of Tusa and Herdman was used for comparison with traditional VR.

Effects of Intervention

The studies that compared VR with other type of active intervention[29,32] showed no difference between groups in most outcome measures after therapy. In the study of Simoceli, Bittar and Sznifer[32], the group that performed the protocol of Cawthorne & Cooksey (experimental) and the group that performed the protocol of Tusa and Herdman (control) for adaptation of the VOR showed improvements in VAS and in the functional scale, but no difference was found in the limits of stability measured by dynamic posturography after the interventions. In the study comparing VR exercises with Tai Chi Chuan[29], there was also no evidence of significant between-group differences in the parameters of neuromuscular function and trunk stability after the interventions.

Considering the control group, the proposed intervention through home exercises[27,30] showed higher gains in dynamic visual acuity[27], Timed-Up-and-Go Test (TUGT)[30] and Dynamic Gait Index (DGI)[30], but no significant difference was found for the stabilization of VOR[27], tandem gait[30], static balance[30] and DHI[30].

In the study by Hansson, Mansson, and Håkansson[31], in the follow-up period of three months, the intervention group remained with a significant improvement in the one leg stance test in comparison to the control group. Another study[30] that examined the effects of VR six months and one year after the intervention found that both groups (experimental and control) reached their previous functional levels and maintained the gains obtained in the period. In the same study, the control group, which did not perform any exercise, showed functional values similar to those of the VR group after surgery for removal of acoustic neuroma. However, in the early stages, the recovery of elderly participants in the VR group was superior to that of participants in the control group.

Among the studies that used the protocol of Cawtorne & Cooksey, there was a significant improvement in the experimental group in DHI[33], gait speed[33], in the number of abnormal cases in posturography[28], and in the scale of activities of daily living and vestibular disorders[34]. However, after the intervention, no between-group differences were found in the limits of stability[32], functional scale[32], VAS[32], doppler ultrasound of the internal carotid arteries[28], tandem position[33], or in the psycho-cognitive scales Vertigo Symptom Scale (VSS), Spielberger's

Trait Anxiety Inventory (STAI- t) and Beck Depression Inventory (BDI)[33].

Of the four studies[27,31,32,35] that evaluated the symptoms of dizziness through the VAS, two[32,35] found a significant improvement after intervention. Regarding static balance, there was an improvement in two[31, 35] of the six studies[28, 30-33,35] that examined this outcome; similarly, only two studies[33,35] showed results favoring the experimental intervention in terms of gait[29-31,33,35].

None of the studies included in this review reported adverse effects related to VR.

Discussion

Randomized controlled trials evaluating the effects of VR are scarce in the literature, particularly in the middle-aged and elderly population. However, despite the shortage in numbers, the studies included in this review showed positive results in favor of VR regarding the outcomes postural control, functional capacity and quality of life in elderly and middle-aged adults with complaints or diagnosis of vestibular syndrome. However, the methodological differences among the included studies made it difficult to establish what is the best protocol, time of intervention, or other ideal parameters.

While four studies were found to be of adequate quality according to the PEDro scale, they did not present allocation concealment or blinding of participants, therapists and assessors. This can sometimes lead to biased results and thus the strength of the evidence coming from these studies is decreased. The study of Simoceli, Bittar and Sznifer[32] had not been rated for quality at PEDro's website by the time this review was conducted, but the study shows methodological problems similar to those of the other included studies. Moreover, the sample size of some studies[27,32,33,35] may have been insufficient to ensure the external validity of the results found. Due to the variability in assessments and interventions, it was not possible to perform a meta-analysis of the results.

The included studies generally reported on both middle-aged and elderly adults in order to enable a broader discussion on the effects of VR, since the structural and physiological changes in the vestibular system begin to emerge at the age of 40 years[4]. Several studies were excluded from this review because their samples consisted of a combination of youth, adult and senior participants. This fact reinforces the necessity of future studies with homogeneous samples, involving exclusively the elderly population, because this is a group with peculiar physical and functional characteristics.

The diversity of the inclusion criteria among the studies had limited their comparison. Grouping subjects by the topography of the vestibular syndrome can be uncertain, since elderly subjects may present normal caloric test, even in the presence of vestibular symptoms[6]. Additional tests, such as those assessing the brainstem electric response audiometry and tone threshold audiometry, do not characterize the vestibular disorders according to the functional aspects of body balance. Thus, these tests have little significance for clinical monitoring in the elderly population. In the other hand, the computerized posturography is used to quantify the postural control in upright stance in either static or dynamic. Thus, grouping elderly subjects according to a single cause of vestibular dysfunction can be challenging, since many of them may present multiple conditions leading to the manifestation of dizziness[6]. Despite these difficulties, working with homogeneous samples allows greater control of confounding factors that interfere with the evaluation of VR effectiveness. The proper identification of vestibular dysfunction and its causes is essential to implement the best type of treatment[6].

It is estimated that in 20% of the elderly patients the vestibular dysfunction is due to vascular problems[36]. The main circulatory disorders that can cause impairment of the peripheral or central auditory and vestibular systems are hyper- or hypotension, heart failure, myocardial infarction, arrhythmia, hypersensitivity of the carotid sinus reflex, aortic stenosis and atherosclerosis[36]. One of the included studies[28] used intracranial doppler ultrasound mapping and found a reduction in the blood flow of the internal carotid, ophthalmic and basilar arteries in elderly patients with complaints of chronic dizziness and body imbalance. The authors observed a significant increase in blood flow in the carotid artery after eight weeks of VR.

Among the outcomes investigated, the VAS was the instrument most commonly used to assess the subjective perception of patients regarding the intensity of dizziness[31,35], oscillopsia[27], postural instability[35] and/or body imbalance[27,28,32]. Other subjective instruments used to measure the impact of dizziness on quality of life and on activities of daily living in elderly people were the DHI[30,33], Disability Index[32], VSS[33] and the Vestibular Disorders Activities of Daily Living Scale[34]. The objective measures, such as balance tests, can reveal major limitations in performance. However, subjective measures consider the perception of the individual regarding the impact of symptoms that are difficult to quantify objectively, such as the impact of dizziness on everyday life.

The postural control was assessed through tests of static[30,31,33,35] and dynamic[30,31] balance, functional scales[30], and computerized posturography[28,32-35]. The static balance tests (Romberg and its higher sensibility versions) are practical and can be easily applied, but they do not evaluate the functional aspects of body balance and mobility. The dynamic and functional tests, such as DGI and TUGT, were used in one of the studies[30] and they evaluate the individual performance in tasks based on the basic and instrumental activities of daily living, as well as on characteristics of balance, gait and mobility. Although functional tests are useful for the delineation of functional prognosis, they have a limited role in determining muscle shortening or weakness, or lack of motor coordination, which are important signs for the planning of a personalized treatment. On the other hand, these signs can be assessed by computerized posturography performed during the laboratory evaluation of body balance. Among the outcomes evaluated in three studies[28,32,35] using computerized posturography, stood out the limits of stability[32], the latency until the beginning of movement[32], the displacement of the center of pressure[28,35] and the influence of sensory interaction on body balance[28,35]. The computerized posturography complements the conventional tests for the diagnosis of vestibular disorders, and it is important for an adequate clinical management, documentation and monitoring of treatments concerning body balance disorders[30].

The literature is consistent in stating that individualized or group VR exercises, performed at the clinic and daily at home, minimize the sensory conflict in elderly patients with dizziness and body imbalance[27-35]. Age is not considered a limiting factor for the final response to treatment. A retrospective study observed a similarity in the effectiveness of individualized VR performed in young and elderly participants on the symptoms and quality of life[37].

In the included studies, there was no comparison of effectiveness between individualized and group VR, or between home-based and clinic-based exercises. However, the most commonly used form of VR was the group VR[28,29,31,33-35] and home exercises[27-30,33]. These strategies appear to be appropriate given the high demand and costs of providing health care to the elderly population. In a systematic review on the effects of VR in adults with unilateral peripheral vestibular dysfunction, rehabilitation protocols focusing on education and home-based exercises showed satisfactory results[38]. However, according to Herdman[39], individualized VR exercises lead to the remission of symptoms in 85% of patients with vestibular disorders, while generic exercises lead to the complete resolution of symptoms in 64% of the cases.

The interventions used in most studies were the protocol of Cawthorne & Cooksey[28,32-34], the adaptation exercises of Herdman[39] and static and dynamic body balance exercises[27,29-31,35]. These interventions aim to promote visual stabilization during cephalic movements, to improve postural stability in situations where sensory conflicts arise, to minimize sensory sensitivity to cephalic movements, and to improve static and dynamic body balance. Among the studies that used the protocol of Cawthorne & Cooksey[28,32 -34], there was a significant improvement in dynamic balance in relation to the control group, as observed in the posturography and in the scale of activities of daily living. No between-group differences were found in the outcomes limits of stability, tandem position, and psycho-cognitive scales or VAS. These results may be due to the fact that the Cawthorne & Cooksey protocol does not include exercises that address the proprioceptive information together with visual information, or the modification of the base of support and other sensorimotor components.

The duration and frequency of the exercise protocols were largely variable among the studies, precluding the elucidation of the optimal procedures for an effective VR protocol. However, after VR, most authors showed a reduction or remission of the symptoms of dizziness, oscillopsia or postural instability, and a gradual disappearance of the static and dynamic body imbalance.

The Tai Chi exercises used in McGibbon's study[29] were effective according to the laboratory evaluation of gait in elderly people with vestibular hypofunction, when compared to VR. Tai Chi is a form of Chinese gymnastic of high adherence among the elderly, which is capable of increasing the gains in fitness, strength and balance, and of preventing falls in this population[40, 41].

The somato-psychic consequences of dizziness caused by vestibular disorders may include anguish, anxiety and panic attacks, fear of going out alone, interference with daily life activities and feelings of being out of reality, depersonalization and depressive humor[42]. One of the included studies showed that cognitive-behavioral therapy associated with VR significantly reduced the dizziness and improved quality of life in elderly participants with vestibular diseases, when compared to participants managed with VR only[33].

This systematic review summarizes the evidence on the effects of VR for balance disorders and on the assessment tools that can contribute to support the clinical actions of health professionals working in this area. The studies presented here support the use of simple and costless protocols for the management of vestibular disorders in middle-aged and elderly people. However, further high-quality studies are still needed to clarify some doubts regarding the effects of VR for certain diseases, the optimal treatment duration necessary to avoid recurrence of symptoms, and the comparison with protocols of multi-components of postural control.

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