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# Effects of vestibular rehabilitation in the elderly: a systematic review

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## Abstract

**Background** Aging is characterized by gradual physiological changes in body systems. Changes in the vestibular system can occur and cause dizziness, vertigo and imbalance, symptoms that are common in the elderly. Vestibular rehabilitation is a therapeutic resource that has been widely used to improve this condition.

**Aims** To complete a systematic review of the effects of vestibular rehabilitation on the elderly.

**Methods** A search for relevant publications was conducted in SCIELO, PUBMED, MEDLINE, COCHRANE and LILACS databases. Clinical trials and cohort studies

that were written in the English language and published over the course of the last 10 years were selected. The methodological quality of the studies was assessed using the PEDro scale. A critical analysis of the studies was composed.

**Results** Eight studies that involved subjects who were over the age of 60 were selected for inclusion in the systematic review. The most common vestibular dysfunction identified was complaints about dizziness and imbalance. The Dizziness Handicap Inventory was the most frequently used assessment instrument, and the treatment protocol that prevailed was that suggested by Cawthorne and Cooksey.

**Discussion** The PEDro scale showed that only one article was of an acceptable methodological quality and presented satisfactory outcome measures. This was due, in part, to a lack of a hidden randomization, masking of the subject, evaluators and therapists, and lack of outcome measures, which can reduce the quality of the evidence presented in this study.

**Conclusion** Clinical trials indicate that vestibular rehabilitation represents an effective means of treating elderly patients with vestibular disorders; however, evidence of its effectiveness remains lacking.

**Keywords** The vestibular system · Rehabilitation · Elderly · Dizziness

## Introduction

Aging is accompanied by gradual physiological changes in body systems such as reductions in muscle strength, range of motion, reaction time, and changes in balance and sensory systems [1]. The aging process gradually compromises agility. This is due, in part, to the degeneration and

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progressive loss of nerve cells in the peripheral and central vestibular system, resulting in dizziness and vertigo [2, 3].

Vestibular dysfunction is associated with this physiological process of aging [2]. The prevalence of vestibular disorder increases with age and may result in falls, fear of falling, loss of confidence, anxiety and depression [4]. Vestibular disorders have a prevalence ranging from 29 to 45 % in individuals over 70 years of age [5, 6]. Individuals who suffer from vestibular disorders often report significant discomfort because it reduces their ability to perform everyday activities and disrupts the body's balance [2, 3]. Some physiotherapy methods have been employed to improve the quality of life of people who suffer from vestibular disorders; for example, vestibular rehabilitation (VR) [7].

VR is a therapeutic resource that is based on central mechanisms of neuroplasticity, known as adaptation, habituation and substitution, which promote vestibular compensation [8, 9]. Treatment aims to abolish the disabling symptoms through encouraging the adaptation or repositioning of the vestibular system [10, 11]. This tool has demonstrated efficacy in treating the elderly, enhancing quality of life and reducing anxiety levels, amongst others [12].

Components of VR may involve teaching sufferers to bring on the symptoms to 'desensitize' the vestibular system, learning to coordinate eye and head movements, improving balance and walking skills, and helping sufferers to understand the condition and how they can manage it to cope better or become more active [13].

Existing research into the effects of VR has demonstrated positive results. However, such studies have been restricted to a systematic review on the effects of vestibular rehabilitation in a middle-aged and elderly population and have not focused specifically and exclusively on the elderly population [8].

It is envisaged that conducting a systematic review of VR will identify the most up-to-date studies in the area and facilitate ongoing projects to develop appropriate interventions. The general aim of this study was to employ a systematic review of leading scientific evidence to analyze the effects of vestibular rehabilitation on the elderly and how such rehabilitation can improve symptoms of vestibular disorders.

## Methodology

We conducted a systematic review based on the guidelines of the PRISMA protocol [14], which involves a systematic search of the databases, the application of a set of criteria to guide the inclusion or exclusion of studies, and data extraction based on the results.

A search of the existing literature in the SCIELO, PUBMED, COCHRANE, MEDLINE and LILACS databases was performed for the purposes of this review. This was limited to studies that were published in the English language within the last ten years. A direct search of the following keywords was employed: "Vestibular System" and "Vestibular rehabilitation" and "older people" or "vestibular diseases" and "older people" or "vestibular complications" and "rehabilitation".

The publications that resulted from the initial selection strategy were analyzed by the authors and subsequently refined according to the following inclusion criteria: original studies as clinical trials type (randomized or not) or observational (cross-sectional or longitudinal, with or without a control group) published in indexed journals in the selected databases; studies with at least one outcome related to the effects of VR in the elderly; studies with a sample of individuals over 60 years in accordance with the World Health Organization (2002) indications of VR [15]; publications with good methodological quality; and full papers on available databases to confirm the eligibility of the study. The studies with repeated information, age not set, methodological mistakes and those that focused on alternative conditions in addition to VR were excluded.

An exploratory reading of the abstracts, materials and methods, and results of the articles was initially performed before the articles were characterized according to type of study, sample, intervention and main results.

The methodological quality of the articles was later assessed using the PEDro scale. The PEDro scale takes into consideration two aspects of the trial: internal validity and sufficiency of the statistical information. While there are 11 questions in the scale, only ten are scored, and the final score ranges from zero to ten [16]. Each item that meets the criteria required by the scale (except the first) contributes one point to the total score. The final score is obtained by calculating the total of all positive answers. The studies indexed in the database had already been assessed for their methodological quality by members of PEDro, which was maintained; while those that had not been indexed were evaluated independently by consensus of two evaluators.

## Results

The initial database search identified 264 full-text articles that were potentially eligible for inclusion in the systematic review. A review of the abstract of each of these studies resulted in 236 of them studies being excluded from the sample due to the fact that they did not meet the inclusion criteria. A further assessment of the remaining 28 studies in terms of the age of the sample and the research intervention applied resulted in the rejection of an additional 20 articles.

As such, eight articles were finally selected for the purpose of the systematic review (Fig. 1).

Critical analysis of the content of the studies was characterized according to type of study, sample, items evaluated, intervention and main results. The outcomes of this analysis are presented in Table 1.

The most common approach to the studies described in the articles assessed was the clinical trial [17–21] with methodological design choice of the random sample [18, 22] and non-random [17, 19–21, 23, 24], the effects of VR through tests and scales before and after implementation of the intervention [17–24] with a control group, or the intervention group compared with the placebo treatment group.

The application of the PEDro scale revealed that only one study, that by Marioni et al. [22], had methodological quality and obeyed the criteria evaluated with scores greater than or equal to 6 and, as such, was deemed to contain good scientific evidence (Table 2).

The sample sizes ranged from 08 [20] to 240 [21] individuals who participated in the intervention and control groups. In five studies [18–20, 23, 24], the participants were aged 60 or over, and in three studies the subjects were over the age of 65. In most studies, the samples consisted of participants of both genders [17, 19–24]; however, there was a predominance of females and only one study involved a sample of female subjects only [18].

Of the items evaluated, the most commonly used was the *Dizziness Handicap Inventory* (DHI) in both the original and Brazilian version. This was employed in five

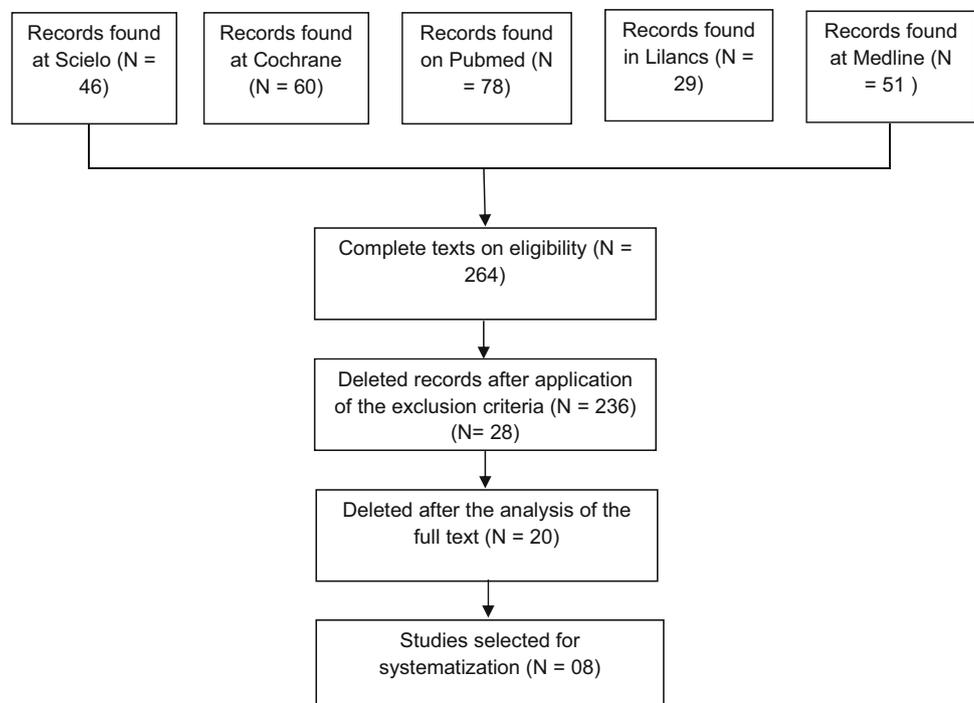
studies [19, 20, 22–24] to verify the impact that dizziness had on the subject's ability to complete everyday activities and their quality of life. The VAS was applied in two surveys [17, 21] to obtain a subjective analysis of the presenting symptoms of vestibular dysfunction. Other scales and tests were applied, but less frequently, including the Berg Balance Scale [18] Romberg [21], and Dix-Hallpike [23], among others. The computerized posturography was the most commonly used laboratory test [21, 22].

The most common RV protocol was that proposed by Cawthorne and Cooksey [17–20, 24]. The majority of the subjects performed the exercises at home [17, 19, 24], returning to the therapist on a fortnightly basis. In the study of Zanardini et al. [20], the protocol was performed under the supervision of a speech therapist in a nursing home twice a day for 2 months. The treatment period ranged from 2 to 3 months, with duration of 60-min repetitions of one to three times per day, or twice or three times a week.

Results of interest were found in the studies that compared the subjects that completed VR exercises with a control group that did not receive VR intervention [18, 21]. These studies revealed that there was significant improvement of balance and dizziness in the group that carried out the VR.

In studies that evaluated the quality of life by the DHI after performing the VR [19, 20, 22–24], there was significant improvement in physical, emotional and functional aspects according to the DHI; however, the functional aspect was more prominent in the research completed by

**Fig. 1** Process of selection of articles for systematization



**Table 1** Characteristics of studies on the effects of RV in the elderly

Author, year	Type of study	Sample	Evaluated items	Intervention	Main results
Bittar, Simoceli, Pedalini and Bottino, 2007 [17]	Open prospective clinical trial	52 individuals aged between 65 and 95 years, of both sexes, suffering from dizziness and imbalance	Visual Analog Scale (VAS)	The study group was treated for clinical diseases, followed by RV with Cawthorne and Cooksey protocols, VOR (vestibulo-ocular reflex) and Norré	The total effectiveness was 84.5 % in the study group, compared with 81.8 % in the control group
Ribeiro and Pereira, 2005 [18]	Prospective clinical study	Women aged between 60 and 69 years indicated for RV. 15 in the experimental group and 15 in the control group selected randomly	Berg Balance Scale	The subjects in the experimental group completed Cawthorne and Cooksey exercises three times a week, for 60 min	In the second evaluation, there were significant differences between the two groups ( $p < 0.005$ ), provided by the improvement in the balance, after the intervention
Mantello, Moriguti, Rodrigues-lúnior and Ferricoli, 2008 [19]	Prospective, longitudinal, observation a clinical trial	40 elderly individuals of both sexes, between 60 and 84 years. 20 in the labyrinth group of vascular origin and 20 in the metabolic group	Quantification of dizziness Scale; Dizziness handicap Inventory (DHI)	Cawthorne and Cooksey protocol at home daily, two to three sessions per day	Both groups showed improvement in assessed quality of life in terms of DHI after treatment; however, there was no effective difference between the two groups
André, Moriguti and Moreno, 2010 [23]	Contemporary longitudinal cohort study	53 individuals aged 60 years, of both sexes, all with BPPV diagnosis. Subjects were divided into three groups	Brazilian DHI; Dix-Hallpike;	Group 1: 23 elderly subjects underwent Epley maneuver, followed by post-maneuver orientation. Group 2: 15 patients submitted to Epley maneuver, without the use of a cervical collar. Group 3: 15 patients submitted to Epley maneuver concomitantly with the use of a mini vibrator	In the Brazilian DHI before and after VR regarding physical, emotional, functional and general, improvement was observed in all aspects surveyed in three groups. In both cases, the number of Epley maneuvers varied from one to three
Bayat et al. 2012 [24]	Analytical study type Cohort	33 patients aged over 60 years with chronic peripheral vestibular dysfunction.	DHI; VNG	Cawthorne and Cooksey protocol. These exercises were administered twice a week for 2 months	DHI ranged from 19.64 to 29.64 points. There was an improvement in all aspects; the most prominent was the functional aspect
Zanardini et al. 2007 [20]	Non-randomized clinical trial	A convenience sample of eight institutionalized elderly subjects, aged from 63 to 82 years; three male and five female, complaining of dizziness	Dizziness handicap inventory (DHI) Brazilian adaptation	Vestibular rehabilitation protocol of Cawthorne and Cooksey. The exercises were performed for 8 weeks, twice a day, in the asylum unit under the guidance and supervision of the audiologist	There was a significant improvement in physical aspects ( $p = 0.00413$ ), functional ( $p = 0.00006$ ) and emotional ( $p = 0.03268$ ) after the VR exercises
Marioni et al. 2013 [22]	Prospective, randomized pilot	28 subjects aged >65 years with vestibular dysfunction	DHI; computerized posturography	Fourteen patients had vestibular rehabilitation assisted by posturography repeating three times a day for 6 weeks (group A). The other 14 patients only performed the same exercises at home (group B)	Computed posturography did not show significant differences between groups A and B. After rehabilitation, group A had significant improvement in DHI in functional and emotional domains; and in group B only the emotional domain
Jung et al. 2009 [21]	Non-randomized clinical trial	240 patients over 70 years with dizziness in a convenience sample	Romberg; posturography; Visual Analog Scale (EVA) ABC Scale	General vestibular rehabilitation therapy (VRT) at home three times a day, was performed in 103 cases (VRT group) and was not performed in the other 46 cases (non-VRT group)	Dizziness improvement was significantly higher in the VRT group than it was in the non-VRT group in terms of verbal analog scale and ABC scale

**Table 2** Analysis of methodological quality of the studies on the effects of RV in the elderly according to Pedro scale

	Bittar, Simoceli, Pedalini and Bottino, 2007 [17]	Ribeiro and Pereira, 2005 [18]	Mantello, Moriguti, Rodrigues-Júnior and Ferricoli, 2008 [19]	André, Moriguti and Moreno, 2010 [23]	Bayat et al. 2012 [24]	Zanardini et al. 2007 [20]	Marioni et al. 2013 [22]	Jung et al. 2009 [21]
Eligibility criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Random allocation	No	Yes	No	No	No	No	Yes	No
Hidden allocation	No	No	No	No	No	No	No	No
Initial similarity between the groups	Yes	Yes	Yes	Yes	No	No	Yes	No
Blind individuals	No	No	No	No	No	No	No	No
Blind therapists	No	No	No	No	No	No	No	No
Blind evaluators	No	No	No	No	No	No	No	Yes
Outcome measures in 85 % of the samples	No	No	No	No	Yes	No	Yes	No
Analysis of intention to treat	No	No	No	No	No	No	Yes	Yes
Comparison between groups	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
recision measures	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Score	1/10	3/10	3/10	3/10	3/10	1/10	6/10	4/10

Bayat et al. [24], and Marioni et al. [22]. In these cases, the DHI indicated that there was an improvement in the functional and emotional aspect of the group that underwent VR assisted by posturography, while the improvement observed in the group that performed VR exercises was limited to the emotional aspect alone.

## Discussion

Following an assessment of the studies using the PEDro scale, only one study demonstrated good scientific evidence. This was due to a number of factors including lack of hidden randomization, masking the subject, evaluators and therapists, and limited outcome measures, which can lead to a decrease in the evidence presented in the study.

The articles included involved samples of elderly subjects over the age of 60 because this is the age group that is most affected by vestibular disorders, complaints of dizziness and balance disorders [12, 25]. These conditions are the consequences of age-related degeneration of various neural structures, including the central vestibular receptor, proprioceptive, cerebellum, and visual pathways.

In addition, a decrease in the number of hair cells in the vestibular organs and the number of fibers in the upper and lower vestibular nerves are observed in the elderly [26]. Many studies were excluded because their samples included young adults, or were heterogeneous.

Of the various vestibular diseases that are in existence, the patients selected for inclusion in the study had labyrinth of vascular and metabolic origin, benign paroxysmal positional vertigo (BPPV) and chronic peripheral vestibular dysfunction. BPPV is one of the otoneurological conditions that has the highest prevalence in the geriatric population and can cause alterations in body balance that directly affect the quality of life of the individuals involved [27, 28]. It is characterized by recurrent short episodes of vertigo that occur when changes in the position of the sufferer's head affect the canal plan [29]. The physiotherapy maneuvers involved in the treatment and diagnosis of BPPV are not the same, regardless of whether the condition is of traumatic origin or not [30].

Previous research has highlighted that the effective maintenance of balance involves a number of central nervous system structures (CNS) and the peripheral nervous system (PNS), among them, the vestibular system (VS)

[18]. The VS transmits information about gravity and body movement and consists of five organs: three semicircular canals (anterior, posterior and horizontal), and two otolithic organs—sacculle and utricle. [31].

VS is integral to human balance, as well as visual and somatosensory systems [12, 32]. Vestibular dysfunction may have an affect on the pathology of any of these components either alone or in combination [4]. This explains its diverse etiology.

Among the items evaluated, the DHI was the most frequently used tool to evaluate the impact of dizziness on the quality of life of a patient who suffered from vestibular dysfunction. This is consistent with other studies described in the literature [33, 34]. This tool is routinely used in clinical settings and has demonstrated greater susceptibility to global health changes. Objective measures, such as static and dynamic balance tests, were used less frequently than the subjective measures, which demonstrated that most studies have often examined the effects of VR on the quality of life and functional capacity of the elderly.

Computerized posturography was employed in two studies to guide the vestibular diagnosis and was conducted before and after VR therapy. The literature concluded that this test is relevant to the clinical symptoms of patients who suffer from vestibular disorders [28].

The literature confirmed that the most widely used VR Protocol is that of Cawthorne and Cooksey, which was employed in five of the selected studies. Its use is common because it is suitable for use with the elderly and involves exercises that are easy to perform, which enhances the motivation and interest of the patient, fundamental factors of good-quality treatment [12, 23]. The first vestibular rehabilitation therapy (VRT), called Cawthorne–Cooksey exercises, was developed by Cawthorne and Cooksey to treat patients with labyrinth injuries resulting from surgery or skull trauma [9, 35]. This protocol promotes visual stabilization of head movements, improves postural stability in situations where sensory conflicts arise, minimizes sensitivity to head movements and improves static and dynamic body balance [8, 11]. Studies that employ this method of treatment have varied in terms of the period and frequency of use; however, the most satisfactory results exhibited an improvement in quality of life, balance and dizziness in the elderly, thus confirming existing data in the literature.

Clinical trial results show that VR is beneficial for older adults in terms of gait, body balance control and activities of daily living [36]. After application of the VR protocol, the positive effects the exercises had on the quality of life of the patients were observed in all aspects [37].

A randomized and controlled study [38] demonstrated evidence that the condition of patients with chronic vestibular dysfunction improved significantly following

vestibular rehabilitation. Improvements were reported in terms of dizziness, postural control, and physical and emotional condition after treatment with VR. The VR application method that was most commonly employed was the exercises that were performed at home and in groups, with physiotherapists providing guidance before and during biweekly face-to-face sessions.

In the literature, it was also possible to see evidence of a significant improvement in the functional, physical and emotional aspects of dizziness, perception and quality of life after vestibular rehabilitation assessed by DHI [20, 38, 39]. This result was also observed in some of the selected studies. The studies that employed the Cawthorne and Cooksey protocol reported significant improvement in the DHI, dynamic balance, posturography and visual analog scale.

A recent protocol in progress [4] to test the effectiveness of an online intervention to assist RV in adults aged 50 or over has been gaining momentum and demonstrates an affordable treatment option that will provide access to a simple and effective version of VR exercises. With a significant increase in the elderly population, new interventions that improve symptoms of dizziness and balance disorders are becoming of increasing importance.

## Conclusion

Vestibular rehabilitation has shown efficacy in the treatment of elderly patients who suffer from vestibular disorders; however, studies that have evaluated the effects of vestibular rehabilitation on the elderly remain relatively limited in terms of evidence to support the effectiveness of such interventions. The results of this systematic review indicated that the use of protocols and low-cost methods of treatment can improve the quality of life and functional capacity of the elderly, in addition to decreasing the incidence of falls in older members of the population. However, the selected studies were limited in relation to the randomization of samples, lack of transparency of the subjects, therapists and assessors involved, and omission of discrete outcome measures. As such, there is a distinct need for further studies in this area.

## Compliance with ethical standards

**Conflict of interest** The authors report no conflict of interest. The authors are solely responsible for the content and writing of the article.

**Statement of human and animal rights** Our study is a review and does not a experimental study with human or animals. However, the studies reported involved human participants. The articles, which us using for this review were approved by the appropriate institutional and/or national research ethics committee and performed in

accordance with the ethical standards as, laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed consent** We observed the informed consent statement on studies related.

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