The effect of an exercise program using balance training on the efficiency of the vestibular system in the elderly

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Introduction and research problem:

Sports are very important in old age, but a person's strength and endurance decline, and his body's flexibility decreases significantly when he exceeds 55 years of age. A study conducted in the 1970s, examining the nature and extent of physical disability that affects the elderly, indicated that 62% of women between the ages of 75 and 85 had difficulty kneeling or bending. 66% of them were unable to lift weights exceeding 4.5 kilograms. 42% were unable to hold on for more than 15 minutes.

This decline was considered a natural and inevitable result of aging, until a study was published in 1994 that showed that it is possible to overcome the functional decline that affects the elderly, through exercise, even in the oldest and most frail women, where a group of elderly people between the ages of 72 and 98 years, practiced resistance exercises 3

times a week for ten weeks, and at the end of this period they were able to lift heavier weights, climb more stairs, and walk faster and farther compared to the other group of elderly people, who continued to decline and lose muscle. In the same context, a ten-year study on healthy aging indicated that exercising at an advanced age (at the age of seventy and eighty) improves physical fitness, even in people who have never exercised before. Therefore, it is recommended that the elderly move their muscles while they are still able to do so, to live longer and better lives.

Balance exercises help reduce the risk of falling, which can lead to major complications that threaten the elderly. A recent study indicated that practicing yoga twice a week for eight weeks improves balance and walking, thus significantly reducing the risk of falling in the elderly (10).

Both "Mohamed El-Sayed El-Amin" (2009) (8), "Fathi Ahmed Ibrahim" (1993) (5), and "Nevitt MC (1998) (20)" explain that the results of studies conducted on the elderly, such as the study of "Herbert Devrles" and the study of "Mac Ars", call for the importance of practicing aerobic activities regularly, as the ability to maintain balance plays an important role in the ability to stand, sit, and walk properly, and balance is achieved through the integration of the sensory and motor systems together, as these studies have proven that they work to protect against genetic diseases, heart diseases, increased blood sugar levels, diabetes, low bone density, osteoporosis, joint roughness, and many diseases of lack of movement, hypokinetic diseases (7: 95), (4).

"Ali Jalal El-Din" (2007) indicates that the vestibular nervous system plays an important role in forming motor skills and experiences, especially those related to By rotating or changing the body's positions in space, many sports activities and exercises that affect the vestibular system,

such as rolling and rotations, are considered factors that lead to raising the level of the functional state of the vestibular system as it becomes more stable for vestibular stimuli, and the level of stability of the vestibular system increases to practice these sports (3: 323).

Balance is a dual characteristic, as it includes two sub-characteristics, which are static balance and dynamic balance. Therefore, to develop balance in general, these two sub-characteristics must be developed.(325 :2)

"Howe Ti et al." (2007) (17), quoting (Winter 1995), states that balance is the ability to maintain the projection of the body's center of mass (COM) within controllable limits of the base of support, as is the case in standing or sitting, or in moving to a new base of support, as is the case in walking. The base of support consists of the area between all points of contact of the body with another surface; Contact points also include body extensions through assistive devices such as canes and frames. Balance is an integral component of daily (functional) activities; however, the control of balance is highly complex and multifactorial.

Research objective:

The research aims to design a program using motor balance exercises for the elderly and to identify: -

1- The effect of the program is on the functional efficiency index of the vestibular system for the elderly.

Research hypotheses:

1- There are statistically significant differences between the average scores of the pre- and post-measurements in the functional

efficiency index of the vestibular system in the research sample in favor of the post-measurement.

Research Items:

1. **Balance:** It is defined by Muhammad Hassan Alawi and Muhammad Nasr al-Din Radwan (2001) (9) as the ability to maintain balance during motor performance.

It is defined by Essam Ahmed Helmy (2015) as the ability of an individual to move from one place to another while maintaining the center of gravity of his body and the tools he carries or uses at the center of his base of support, no matter how small the area of this base is, and no matter how much external factors interfere that negatively affect maintaining balance (2: 308).

2- **Motor balance:** It means the individual's ability to maintain the body's position in stability or movement, as this requires complete control of the organic systems from the nervous and muscular aspects (2: 308).

3- **Elderly People:** The elderly are the individual whose strength and vitality tend to decrease with increasing exposure to diseases, especially diseases of old age, and an increase in his feeling of fatigue and stress, lack of movement, lack of productivity or retirement from work (1: 7).

4- Vestibular Apparatus: It is considered the real balance organ in the inner ear and is responsible for sensing the body's position, thus maintaining the body's balance in the states of stability and movement (1: 7).

5- Functional efficiency: It is the ability of the organ to perform its work more than usual with less effort and for a longer period and its ability to recover quickly after stopping work (19: 5).

Previous studies:

1- "**Mustafa Masoud Abdel Salam**" study (2023) (11) entitled "A proposed program to improve the functional efficiency of the vestibular system on the balance associated with the level of performance of the aerobic gymnastics group", and the study aimed to improve the performance of the aerobic gymnastics group for young girls through a training program to develop the functional efficiency of the vestibular system and its effect on the static and dynamic balance and the level of skill performance of the individual and group aerobic gymnastics group. The sample was selected intentionally from gymnastics players at Smouha Sports Club and Ashab Al-Jiyad Club due to the presence of the selected skills within the compulsory requirements set by the technical committee emanating from the Egyptian Gymnastics Federation on the aerobic gymnastics group, and the sample included (16) players.

2- "**Hani Rizk Eid**" study (2015) (13) entitled "The effect of a rehabilitation program to develop the efficiency of the vestibular system on the postural control of the hearing impaired", this research aimed to design a rehabilitation program to develop the efficiency of the vestibular system for the hearing impaired from (9-12) years. To identify the effect of the program by improving the indicators of balance of both types (static motor) and physiological for the hearing impaired from (9-12) years, and the indicators of

postural control and the postural state for the hearing impaired from (9-12) years. The researcher used the experimental method, applying the pre-post measurements on one experimental group to implement the rehabilitation program. The research sample was deliberately selected from the students of Al Amal School for the Deaf and Hard of Hearing in Kafr El Sheikh, aged (9-12) years, who suffer from hearing impairment (mild-moderate) according to the medical diagnosis and have noticeable postural deviations represented by (tilted neck - dropping one shoulder - slight lateral thoracic curvature - knocking of the knees), and its strength reached (10) students, and the rehabilitation program was applied for a period of (3) months at a rate of four training units per week. The results of the study showed that the rehabilitation program has a positive effect on improving the indicators of balance in its two types (static - dynamic) and physiological for the hearing impaired from (9-12) years old, the research sample. The rehabilitation program has a positive effect on improving the indicators of postural control and the postural condition of the hearing impaired from (9-12) years old, the research sample.

3- **Halmagyi GM, et al** study (2017) (16) study titled "Video Head Impulse Testing", the study aimed to identify the video head impulse test, the progress from the head impulse protocol (HIMPs) to the new alternative - the funnel head impulse protocol (SHIMPs), the physiological basis of the head impulse test, the practical aspects and potential pitfalls of the video head impulse test, the problems of vestibulo-ocular reflex gain calculations, the head impulse test in central vestibular disorders, and to stay informed of new clinical disease patterns arising from the video head impulse test.

4- **Mona Saleh Al-Ansari's** study (2009) (12) entitled "Measuring balance among the elderly in the Kingdom of Bahrain using the Berg Balance Scale according to health status, body mass index and some selected demographic variables", and the study aimed to translate the Berg Balance Scale (BBS), which is considered one of the most widely used scales designed to measure balance among the elderly, in order to achieve the objectives of measuring the balance element among the elderly of both sexes in the Kingdom of Bahrain using the Arabic version of the Berg Balance Scale, calculating the scientific coefficients (validity and reliability) for the Arabic version, and the researcher used the descriptive method for its suitability to the nature of the research. The sample was selected from the elderly of both sexes who frequent nursing homes in the Kingdom of Bahrain (Youko Parents' Home in Muharraq Governorate, and Al-Manar Elderly Care Home in the Central Governorate), and the size of the research sample was 84 elderly, including 34 men and 50 women, whose ages ranged between 60 - 92 years. The research results indicated that the Berg Balance Scale is a good scale for measuring balance among the elderly, and at the same time the total scores can be used His tests to predict people who are at risk of falling accidents from others, according to the recommendations of the scale designers (Berg, et al, 1989. (6)

5- "**Reham Ali Muhammad**" study (2020) (21) entitled "The effect of central vestibular stimulation versus peripheral vestibular stimulation on recovery outcomes in patients with peripheral vestibular disorders", sixty patients (of both sexes) aged between (30-60) years were registered who were diagnosed with unilateral peripheral

vestibular weakness. They were randomly divided into three groups; Group A, B, C. Group A received repetitive transcranial magnetic stimulation in addition to a vestibular rehabilitation program, treatment sessions were conducted three times a week for four consecutive weeks. Vestibular dysfunction was assessed using videonystagmography, dizziness severity was measured using the Dizziness Handicap Inventory (DHI), dynamic balance was measured using the Berg Balance Scale (BBS), postural stability was measured using computerized dynamic posture imaging (CDP), while participation in daily activities was assessed using the Vestibular Disorders Activities of Daily Living Scale (VADL). The study findings were that there was a significant improvement in aqueductal palsy, BBS score, and there was a significant improvement in visual and vestibular component scores of the CDP after treatment in groups A and B only, with group A showing greater improvement.

6- **Kammerlind A-SC, Håkansson JK, Skogsberg MC** study (2001) (18) entitled "Effects of balance training on elderly people with non-extreme vertigo and unsteadiness". The study aimed to: Evaluate the effect of group balance training on elderly people with non-extreme vertigo and unsteadiness: a randomized controlled study conducted at the Department of Ear, Nose and Throat, University Hospital, Sweden. Twenty-three elderly people with non-extreme vertigo and/or unsteadiness were randomly divided into a training group and a control group. The results of the study indicated: The training group significantly improved in standing on one leg with eyes open, walking forward on a line, and walking speed, in three out of six tests on dynamic posture planning and in the reduction of

vertigo and unsteadiness measured using the visual analogue scale. No changes were observed in the control group. Balance training in elderly people with non-extreme vertigo and unsteadiness appears to improve objective and perceived balance.

Research Methodology:

The researcher used the experimental method due to its suitability to the nature of the research using the experimental design for one experimental group following the (pre-post) measurement.

Research Community:

The research community is represented by elderly women who suffer from balance disorder and vestibular dysfunction and their ages range between 65-70 years and who visit Minya University Hospital to conduct the necessary medical examinations.

Research sample:

The research sample was selected from the research community intentionally, residing in Minya city, and the number of sample members was (10).

Tests and measurements used in the research:

Medical test: Video head impulse test (HVIT)

Data collection tools and means:

- Pure tone audiometry
- Video head impulse test (VHIT)
- Magnetic resonance imaging of the brain and ear MRI Petrous and brain with centrist
- Restameter device to measure height in centimeters
- Dynamometer device to measure muscle strength
- Spirometer device to measure vital capacity

- Blood pressure measuring device
- Medical scale to measure weight (kg)

Preparing the training program:

Table (1)

Significance of statistical differences between the averages of the pre- and post-measurements of the group under study in the functional efficiency index of the vestibular system for the elderly (n = 10)

Test	Pre-			Post-			(Z)	Significance level
	Arithmetic average	Rank Average	Sum of ranks	Arithmetic average	Rank Average	Sum of ranks		
HIT	0.73	0.00	.00	0.87	5.50	5.0	2.80**	0.005

Table (Z) value at level (0.05) = 1.96 (0.01) = 2.58

* Significant at level (0.05) ** Significant at level (0.01)

It is clear from Table (1) the following:

There are statistically significant differences between the average ranks of the pre- and post-measurements of the group under study in the functional efficiency index of the vestibular system for the elderly in favor of the post-measurement.

Table (2)

Percentage improvement rates between the pre- and post-measurements for the group under study in the functional efficiency index of the vestibular system for the elderly (n = 10)

Test	Pre-	Post-	percentage improvement
VHIT	0.73	0.87	19.18%

Table (2) shows the following: The percentage of improvement between the pre- and post-measurements of the group under study in the functional efficiency index of the vestibular system for the elderly was (19.18%), which indicates the effect of the program based on using motor balance exercises for the elderly in improving the functional efficiency index of the vestibular system for the elderly in the group under study.

Discussion of the results:

It is clear from Tables (1, 2) that there are statistically significant differences between the averages of the pre- and post-measurements of the research sample members in the functional efficiency index of the vestibular system for the elderly in favor of the post-measurement, as the calculated (Z) value is greater than the tabular (Z) value.

The average pre-measurement of the video head impulse test (VHIT) was (0.73), and the average post-measurement was (0.87), and the percentage improvement rate for the test was (19.18%).

The researcher attributes this result to the physical training program that was applied, especially the motor balance training on the research sample represented by the elderly, which had a clear positive impact on improving the functional efficiency of the vestibular system for the sample members under study.

Wiesmeier Isabella K., et al (2017) (23) Balance training reduced hyperactive sensory responses and restored vestibular orientation in older

adults, and older adults significantly reduced their hyperactive postural responses and approached those of younger individuals. This study suggests a significant benefit of continuous balance training in older adults, even without any sensorimotor deficits.

Ricci, N.A., Aratani, M.C., Caovilla, H.H. et al (2012) (22) This study aimed to compare the effectiveness of two vestibular rehabilitation protocols (traditional vs. multimodal) on functional ability and body balance control in older adults with chronic dizziness due to vestibular disorders. It was found that virtual reality protocols are effective in reducing dizziness and its consequences. Since the Cawthorne and Cooksey VR protocol has already been recognized as effective, modifying it with the inclusion of other postural control components could improve its performance for older individuals with chronic dizziness to reduce dizziness symptoms, functional disability, and body imbalance, and prevent falls in this population.

The results of this study are also consistent with the study of **Darja Rugelj (2010)** (14) who showed that participants in the training group achieved a higher score on the Berg Balance Scale (BBS), were able to stand longer on a compatible surface with their eyes open and closed and were faster in both the four-square and ten-meter walking tests. The results of the study indicate that specifically targeted functional balance training is effective in relation to the functional activities of the vestibular system.

Duque, G., Boersma, D., Loza-Diaz, G., Hassan, et al (2013) (15) evaluated the effectiveness of a novel virtual reality training system on balance, falls, and fear of falling in a group of community-dwelling older adults. Participants showed significant improvements in vision and

performance. In addition, 9 months after their initial assessment, the BRU training group showed significant reductions in both falls and fear of falling levels. As expected, subjects in the usual care group showed a reduction in the number of falls; However, this reduction was significantly higher in the BRU training group, suggesting an additional and beneficial effect of this intervention on fall prevention at this age.

Continuous balance training has a significant benefit in reducing hyperactive sensory responses and restoring vestibular orientation in elderly people without any sensorimotor deficit. Balance training is also very effective in improving functional status and reducing the risk of falls in elderly women.

Conclusions:

Considering the research objectives and results, within the limits of the research sample and its characteristics, and based on the statistical treatments, training program, and available research tools, and after presenting and interpreting the results, the researcher was able to reach the following conclusions:

1- Motor balance training has a positive effect on improving the functional efficiency of the vestibular system under study.

2- Motor balance training has a positive effect on improving the physiological variables (blood pressure - vital capacity - pulse rate) under study.

3- The training program has a positive effect on improving the results of the physical variables (static balance - moving balance - muscular strength - neuromuscular coordination - accuracy - flexibility) under study.

Recommendations:

1- The researcher recommends the necessity of practicing the proposed training program due to its positive effects on improving the symptoms associated with loss of balance in the elderly.

2- The necessity of holding awareness seminars through communication or direct meetings with the elderly.

3- Conducting other similar studies that address other variables not addressed by the current study.

4- The necessity of addressing the research problem, but with larger sample numbers so that the results can be generalized.

5- The need for more research to evaluate the long-term consequences of such training on the elderly.

6- I am interested in presenting more studies specific to the elderly category due to the scarcity of research that addressed this age group.

7- Conducting more interdisciplinary studies in cooperation with faculties of human medicine to diagnose and treat loss of balance and the problem of recurrent falls in the elderly.

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