IMPACT OF LOWER LIMB STRENGTH AND RESISTANCE TRAINING ON REDUCING RISK OF FALL AMONG PATIENTS WITH ORTHOSTATIC HYPOTENSION

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ABSTRACT

To investigate the effectiveness of lower limb strength and resistance training to reduce the risk of fall among orthostatic hypotension patients.Orthostatic hypotension or Postural hypotension is a common cause due to inadequate blood pressure response with a symptom dizziness leading to risk of fall especially in standing due to decrease in venous pooling and capillary infiltration of plasma in legs. Strength training helps in voluntary contraction to improve venous return. Whereas, resistance training helps in little increase in blood volume. This study was given under the age group of 18 to 30. Females and males were included, who has the symptom of dizziness and reduction in SBP & DBP from supine to standing. Intervention was given for 6 weeks to those who are willingly participated in exercise program. Based on statistical analysis, both Resistance and Strength training interventions were effective in reducing symptoms of orthostatic hypotension. However, resistance training shows much effective significant improvements seen in all outcome measures and also helped in reducing the risk of fall. Resistance training appears to be the more comprehensive and effective intervention for improving both orthostatic hypotension symptoms and fall-related self-efficacy.

KEYWORDS: Postural hypotension, dizziness, resistance, strength, orthostatic.

INTRODUCTION

Postural or Orthostatic hypotension (OH) is defined as a sustained decrease in systolic BP (SBP) ≥20 mm Hg and/or diastolic BP (DBP) ≥10 mm Hg within the first 3 minutes upon standing from a supine position or tilting of the body (head up) at least 60 degrees on tilt table. An abnormally significant drop in blood pressure while standing, known as orthostatic hypotension (1)(2).Blood moves from the chest to the distensible venous capacitance system as a result of orthostatic stress. The central blood volume is quickly decreased by this venous pooling, and this decrease is made worse by enhanced capillary filtration of plasma as a result of the legs' elevated hydrostatic pressure. Heart filling and stroke volume are reduced when the amount of central blood is reduced. In healthy people, standing causes a rise in heart rate, but not enough to offset the drop in stroke volume, resulting in a fall in cardiac output .The main circulatory adaptations to the upright posture is due to the constriction of arterioles and splanchnic venous capacitance vessels caused by arterial baroreflex, which is followed by an increase in systemic vascular resistance to maintain normotension.

Based on the main underlying pathophysiological mechanism, we suggest a unique categorisation of OH that aims to divide many clinical situations into three categories. In this way, OH can be classified as

neurogenic, cardiogenic, or mixed. Orthostatic hypotension can be transient or persistent and can have both neurogenic and non-neurogenic causes. Venous pooling, cardiac pump failure, and hypovolemia are the three non-neurogenic reasons. Chronic orthostatic hypotension, also known as neurogenic orthostatic hypotension, is a symptom of neurological diseases that impede vasoconstriction when standing and impact the baroreflex Patients with neurodegenerative disorders involving intracellular accumulation of misfolded α-synuclein in nerve tissue, spinal cord injuries, or small fibre neuropathies brought on by diabetes, amyloidosis, toxic agents, autoimmune diseases, or paraneoplastic diseases are most likely to experience neurogenic orthostatic hypotension. Although they are more common in the general population, non-neurogenic causes of orthostatic hypotension (such as hypovolemia, polypharmacy, heart failure, arrhythmias, or severe valvular disease) can coexist alongside and exacerbate neurogenic orthostatic hypotension (1)(4). Identification, focused diagnostic testing, treatment of comorbidities, elimination of iatrogenic factors, and the initiation of effective therapies that integrate pharmaceutical and non-pharmacological approaches are all necessary for management, taking into account the individual risk-benefit ratio, underlying aetiology, and severity of symptoms (3).The differential diagnosis of orthostatic hypotension, which can be brought on by a variety of factors such as dehydration, blood loss, medication, or a disorder of the neurologic, cardiovascular, or endocrine systems, is outlined in the less common presentation of neck and shoulder pain, orthostatic dyspnoea, and chest pain. The first step in evaluating suspected orthostatic hypotension is to determine any reversible causes and any underlying medical disorders that may be related. Younger people with orthostatic hypotension typically exhibit persistent autonomic dysfunction when there is no volume depletion. A systolic blood pressure drop of at least 20 mm Hg occurs within 75 minutes of a meal in postprandial hypotension. In as many 50% of patients, postprandial hypotension, or a systolic BP drop of 20 mm Hg within 2 hours after food intake, may accompany neurogenic orthostatic hypotension (5).

Physical counter-manoeuvres (PCMs), or Strengthening exercises, are one type of nondrug therapy used to treat people with Orthostatic Hypotension. PCMs use the voluntary contraction of skeletal muscles to improve venous return. People with Orthostatic Hypotension are initially treated with physical counter-manoeuvres (PCMs). PCMs improve venous return by voluntarily contracting skeletal muscles. Strengthening the muscles in the lower
limbs should be an effective treatment for Orthostatic Hypotension. Lower calf mass has been
linked to an increased risk of OH in community-dwelling older adults, and lower limb
strengthening activities have been shown to extend the upright posture in older adults with orthostatic hypotension. Improved orthostatic blood pressure and venous function are unknown. Strengthening the muscles in the lower limbs should be an effective treatment for OH. Lower calf mass has been linked to an increased risk of OH in community-dwelling older adults, and lower limb strengthening exercises have been shown to improve the duration of the upright position during tilt-testing in older adults with orthostatic hypotension. Similarly, observational studies show a significant correlation between orthostatic intolerance and sarcopenia in the elderly. (7).Resistance training has been suggested as a countermeasure to stop long-duration spaceflight-related muscle atrophy and strength declines. Resistance training has also been suggested to enhance orthostatic tolerance and orthostatic reactions, such as variations in blood pressure or heart rate when standing. Additionally, resistance training is supposed to cause a little increase in blood volume (8).Almost all healthy teenagers and young adults suffer light-headedness and black spots upon standing from a supine position due to falls. About 20% of young children in the general community are reported to experience regular symptoms of light-headedness or even syncope. These orthostatic symptoms that occur just after standing up are caused by a brief drop in systemic blood pressure, which causes cerebral hypoperfusion. Light-headedness episodes happened after rising up and taking around five steps. Syncope happens soon after standing up. It has never been investigated, nevertheless, whether walking a short distance after standing up causes a greater initial drop in blood pressure than remaining still. Functional

recovery and quality of life enhancement are the goals of treatment for young children with severe symptomatic orthostatic hypotension (9). So, the purpose of the study is to evaluate the effectiveness of strength training and resistance training to prevent the risk of fall among orthostatic hypotension.

AIM OF THE STUDY:

The effectiveness of resistance and strength training exercises to reduce the risk of fall among orthostatic patients.

OBJECTIVES OF THE STUDY:

- To assess the baseline risk of falls among individuals with orthostatic hypotension using standardized fall assessment scale ie. modified falls efficacy scale.
- To evaluate the effect of resistance training on reducing fall risk in individuals with orthostatic hypotension.
- To evaluate the effect of conventional strengthening exercises on reducing fall risk in individuals with orthostatic hypotension.
- To compare the effectiveness of resistance training and conventional strengthening exercises in reducing fall risk among individuals with orthostatic hypotension.
- To determine the improvement in lower limb muscle strength following resistance training and strengthening exercises.

BACKGROUND OF THE STUDY:

Postural or Orthostatic hypotension is defined as a sustained decrease in systolic BP (SBP) ≥20 mm Hg and/or diastolic BP (DBP) ≥10 mm Hg within the first 3 minutes upon standing from a supine position or tilting of the body (head up) at least 60 degrees on tilt table. An abnormally significant drop in blood pressure while standing, known as orthostatic hypotension. Orthostatic hypotension or postural hypotension is a common cause due to inadequate blood pressure response with a symptom dizziness leading to risk of fall ,especially in standing due to decrease in venous pooling and capillary infiltration of plasma in legs. Resistance training has been suggested as a countermeasure to stop long-duration spaceflight-related muscle atrophy and strength declines. Resistance training has also been suggested to enhance orthostatic tolerance and orthostatic reactions, such as variations in blood pressure or heart rate when standing. Additionally, resistance training is supposed to cause a little increase in blood volume Strength training helps in voluntary contraction to improve venous return. Whereas, resistance training helps in little increase in blood volume.

NEED OF THE STUDY:

- Orthostatic hypotension increases the risk of falls due to symptoms such as dizziness, and postural instability which may lead to injuries and reduced independence

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- Lower limb muscle weakness contributes significantly to fall risk in individuals with orthostatic hypotension , highlighting the importance of effective exercise interventions to improve strength and stability.

HYPOTHESIS:

NULL HYPOTHESIS

There is no significance difference between lower limb strength training and resistance training to reduce the risk of fall among orthostatic patients.

ALTERNATE HYPOTHESIS

There is a significance difference between lower limb strength training and resistance training to reduce the risk of fall among orthostatic patients.

REVIEW OF LITERATURE:

1.Dihogo Gama de Matos et.al., 2026.Evalauted a study on "Can Progressive Strength Training Counteract Frailty and Improve Short-Term Autonomic Compensatory Responses During Active Standing Orthostatic Stress? This study concluded that, showed a significant reduction over time, with improvements in both 8 weeks and 12 weeks relative to the pre-test. However, no statistically significant change was observed between the 8- and 12-week assessments.

2.Dihogo Gama De Matos et.al, 2025. Evaluated a study on "The influence of age, sex, frailty and progressive strength training on short term integrative dynamic cardiovascular and autonomic compensatory responses to orthostatic stress". This research concludes that, older adults showed delayed BP regulation, lower short-term compensatory responses, HRV indexes, and CBG compared to young adults

3.Pramod Srikant Kshirasagar et.al, 2025. Conducted study on "Association between Fall Risk and Orthostatic Hypotension in the Elderly in a Skilled Nursing, (BMFRAS)". Concluded that, Systolic and diastolic blood pressures decreased significantly from supine to standing (both $p < .001$). Orthostatic hypotension was more prevalent among fallers than non-fallers. Orthostatic Hypotension is strongly linked to falls among SNF residents.

4.Yusuf, et.al,2025 conducted a study on "Improving Orthostatic Hypotension Screening in Fall Prevention: A Two-Cycle Audit on Falls Assessment and Lying and Standing Blood Pressure Measurements. This study concluded that, after targeted interventions, compliance significantly improved, demonstrating that clinical audits are an effective tool for enhancing adherence to fall prevention guidelines and improving patient care

5.Joana Schauermann et.al…2024. Conducted a study on "Effect of Strength training on orthostatic hypotension in Parkinsons disease:". This study concluded that - Targeted leg muscle strength training did not significantly improve orthostatic "maximal systolic blood pressure change" during head-up tilt in this preliminary study.

6.Aldis H. Petriceks BA, et.al...2023 Evaluated a study on "Timing of orthostatic hypotension and its relationship with falls in older adults". Concluded that, Orthostatic hypotension was most prevalent and symptomatic immediately within 1–2 min after standing, but more informative for fall risk after 4.5 min. Clinicians may consider both intervals when assessing for orthostatic hypotension.

7.Linda Li-Chuan Lin et, al., 2022 Conducted a study on "Effects of Resistance Training Intensity on Heart Rate Variability at Rest and in Response to Orthostasis in Middle-Aged and Older Adults". Later concluded that there was - No adverse events related to resistance exercise were noted during the study. There were no significant differences between groups for age, body weight, body height, or body mass index at initial presentation.

8.Paul Claffey et,al,,, 2022. Evaluated a study on "Asymptomatic orthostatic hypotension and risk of falls in community-dwelling older people. a large population-based nationally representative sample of community-dwelling older adults aged ≥50 years". This study shows that, there were no significant differences between those with symptomatic and asymptomatic OH in terms of age, sex, heart disease, frailty status and chronic disease burden.

9.Svenja Husch, et,al.. 2022. Conducted a study on "Effect of strength training on orthostatic hypotension in Parkinson's disease—a pilot study". concluded that there are no evidence-based trials describing the extent of therapy and effects of strength training on OH and cognition in PD.

METHODOLOGY:

STUDY DESIGN: Comparative study.
STUDY SETTING: Shri Isari Velan Mission Hospital, Thazhambur.

SAMPLE SIZE: 30 samples

STUDY SAMPLING METHODS: Simple Random Sampling.

STUDY DURATION: 6 weeks.

INCLUSION CRITERIA:

- Study was conducted from 18 to 30 years of age.
- Both Male and females were included throughout the study.
- Participants must be fulfilling the diagnostic criteria for orthostatic hypotension (dizziness and reduction in SBP & DBP from supine to standing condition).
- Subjects who are willingly to participate in exercise program during the study.
- Participants who are committed to 6 weeks duration of the study.

EXCLUSION CRITERIA:

- Any neurological conditions like diabetic neuropathy etc.
- Bone disorders
- Recent Any ligament tears in the lower limb.
- Unhealed lower limb fractures.
- Any psychological conditions
- Recent Post-operative conditions in the lower limb

OUTCOME MEASURES:

- Orthostatic hypotension questionnaire (OHQ)

  a)Orthostatic hypotension symptom assessment

  b)Orthostatic hypotension daily activity scale.

- Modified falls efficacy scale (MFES)

PROCEDURE:

A total 30 patients who fulfilled the inclusion and exclusion criteria were recruited for the study and written informed consent was obtained along with procedures were also explained.

These patients underwent baseline screening before the starting of procedures, then are equally divided into 2 groups, such as Group A & Group B.

Group A consists of 15 subjects, was given Resistance training, and Group B consists of 15 subjects was given, Strength training, by simple random sampling method.

INTERVENTION

- **GROUP A - RESISTANCE TRAINING.**

1.PARALLEL SQUAT USING DUMBBELLS-2 to 3 sets, 8 to 10 repetitions. Moderate resistance- 3 to 4 times per week.

2.STANDING LEG CURLS USING RESISTANCE BANDS-2 to 3 set ,8 to 10 repetitions each, 3-4 times per week.

3.INCLINED HEEL RISE ON A RAISED SURFACE-2 to 3 Sets ,8– 10 repetitions, 3 to 4 times per week

4.SEATED HEEL RISE USING RESISTANCE BANDS-2 to 3 sets, 8 to 10 repetitions, 3 to 4 times per week.

5.LEG PRESS USING QUADRICEPS CHAIR ALONG WITH WEIGHTS-2 to 3 sets, 8 to 10 repetitions, and for moderate resistance – 3 to 4 times per week.

6. **SEATED LEG EXTENSIONS-**2 to 3 sets, 8 to 10 repetitions, 3 to 4 times per week.

- **GROUP B - STRENGTH TRAINING**

1.ANKLE PUMPS WITH RESISTANCE BAND VERSION-2 to 3 sets, 8 to 10 repetitions, moderate resistance, 3 to 4 times per week.

2. **CLAMSHELL EXERCISE USING RESISTANCE BANDS AROUND KNEES-**2 to 3 sets, 8 to 10 repetitions, 3 to 4 times per week

3. WALL SITS / ISOMETRIC QUADRICEPS EXERCISE

Initially, hold for 10 to 20 seconds, 8 to 10 repetitions

Intermediate, hold for 30 to 45 seconds, 3 to 4 repetitions

Advanced, hold for 60 seconds or more, adding weights and dumbbells

Along with rest is given 30 to 60 seconds between holds

4. GLUTE BRIDGES WITH RESISTANCE BAND AROUND KNEES

Hold for 10 seconds, 8 to 10 repetitions, 2 to 3 sets.3 to 4 times per week.2 to 3 sets, 8 to 10 repetitions, 3 to 4 times per week.

5. MARCHING IN PLACE USING RESISTANCE BAND-2 to 3 sets, 8 to 10 repetitions, 3 to 4 times per week.

6.ISOMETRIC HIP ADDUCTION EXERCISE-3 sets, 8 to 10 repetitions, 3 to 4 times per week.

DATA ANALYSIS:

"COMPARISON OF ORTHOSTATIC HYPOTENSION QUESTIONAIRE (OHQ) BETWEEN GROUP A (RESISTACE) AND GROUP- B IN PRE TEST AND POST TEST." -TABLE 01.

OHQ-1	GROUP A		GROUP B		t TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	2.087	0.541	2.16	0.519	18.059	P<0.001
POST TEST	1.996	0.537	2.145	0.519	11	P<0.001

(*-P >0.005, **P<0.001)

The above table reveals the mean, standard deviation (SD), t -test and p value of the orthostatic hypotension questionnaire (0HQ) score between (Group A) & (Group B) pre test and post test test.

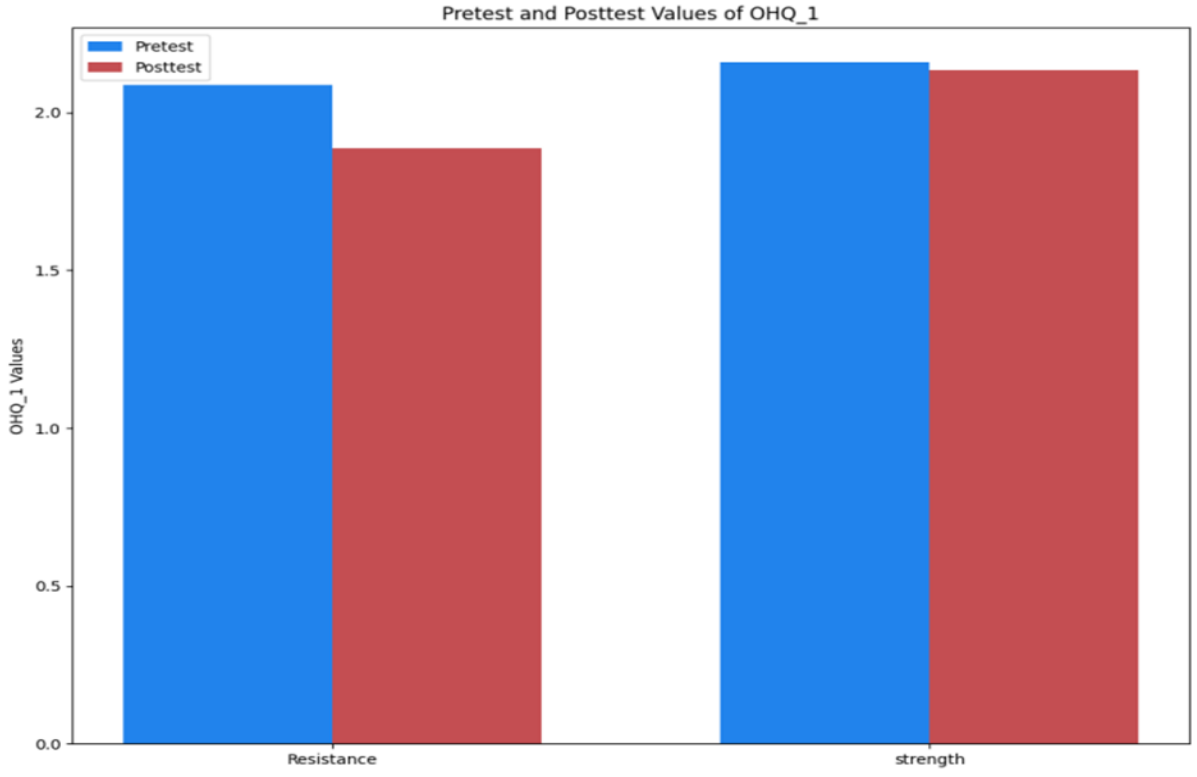
This table shows that ,there is a significant difference in pre-test values in orthostatic hypotension questionnaire between Group A &Group B , (P <0.001)

This table shows that there is a significant difference in post test values in orthostatic hypotension questionnaire between Group A &Group B, (P <0.001)

Both the group shows that, there is a significant reduction in orthostatic hypotension symptoms, as indicated by decreases in OHQ1 (mean difference = 0.091, p < .001)

GRAPH-01

"COMPARISON OF ORTHOSTATIC HYPOTENSION QUESTIONAIRE (OHQ) BETWEEN GROUP A AND GROUP- B IN PRE TEST AND POST TEST."



"COMPARISON OF ORTHOSTATIC HYPOTENSION QUESTIONAIRE (OHQ) BETWEEN GROUP A (RESISTANCE) AND GROUP- B (STRENGTH) IN PRE TEST AND POST TEST." - TABLE 02.

OHQ -2	GROUP A		GROUP B		t – TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	1.887	0.541	2.134	0.519	25.87	P<0.001
POST TEST	1.793	0.548	2.117	0.521	6.614	P<0.001

(*-P >0.005, **P<0.001)

The above table reveals the mean, standard deviation (SD), t -test and p value of the orthostatic hypotension questionnaire (0HQ) score between (Group A) & (Group B) pre test and post-test test.

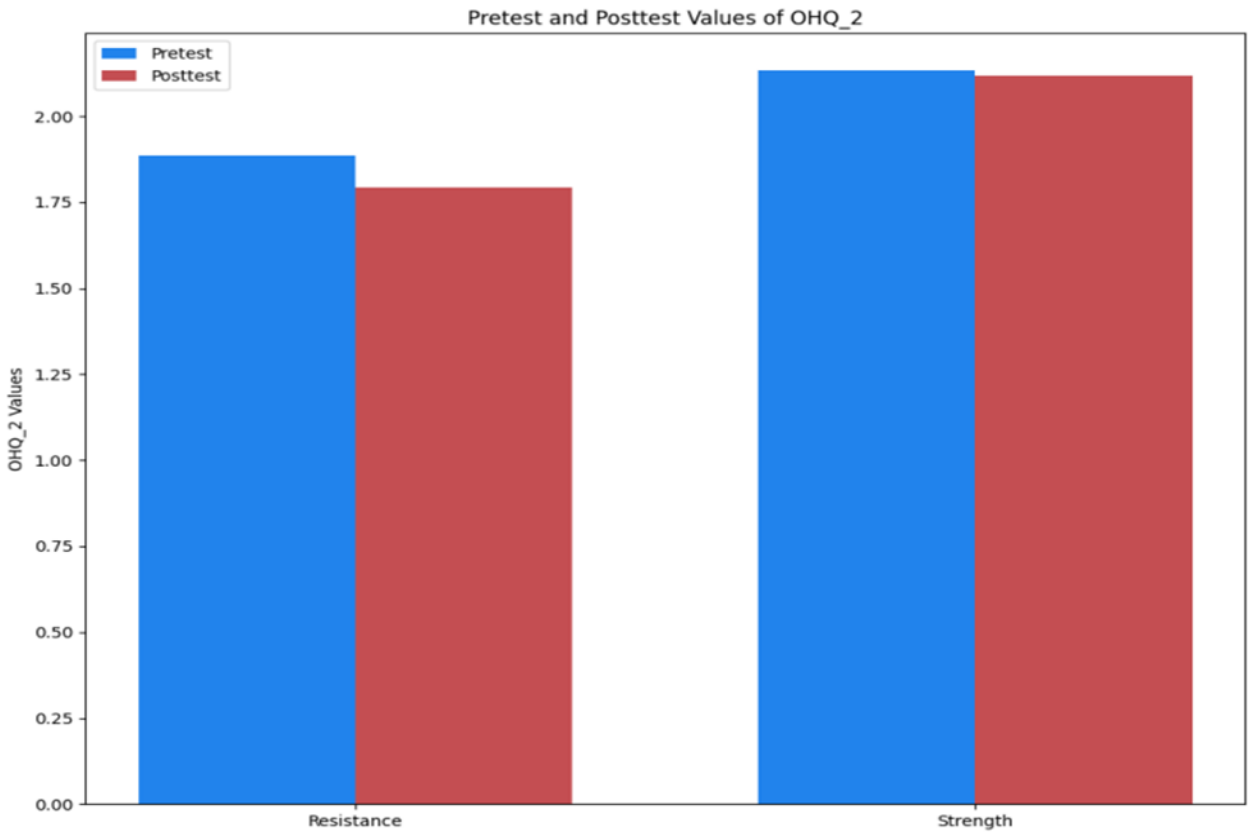
This table shows that ,there is a significant difference in pre-test values in orthostatic hypotension questionnaire between Group A &Group B, (P <0.001)

This table shows that there is a significant difference in post-test values in orthostatic hypotension questionnaire between Group A &Group B, (P <0.001)

Both the group shows that, there is a significant reduction in orthostatic hypotension symptoms, as indicated by decreases in OHQ 2 (mean difference = 0.017, p < .001), both with large effect sizes.

GRAPH -02

"COMPARISON OF ORTHOSTATIC HYPOTENSION QUESTIONAIRE (OHQ) BETWEEN GROUP A AND GROUP- B IN PRE TEST AND POST TEST."



"COMPARISON OF MODIFIED FALLS EFFICACY SCALE (MFES) BETWEEN GROUP A (RESISTANCE) AND GROUP- B (STRENGTH) IN PRE TEST AND POST TEST." TABLE 03

MFES-1	GROUP A		GROUP B		t- test	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	6.92	0.528	6.793	0.584	-10.717	P<0.001
POST TEST	7.047	0.526	6.807	0.581	-6.325	P<0.001

(*-P >0.005, **P<0.001)

The above table reveals the mean, standard deviation (SD), t -test and p value of the MFES score between (Group A) & (Group B) pre test and post test test.

This table shows that ,there is a significant difference in pre test values in modified falls efficacy scale between Group A &Group B , (P <0.001)

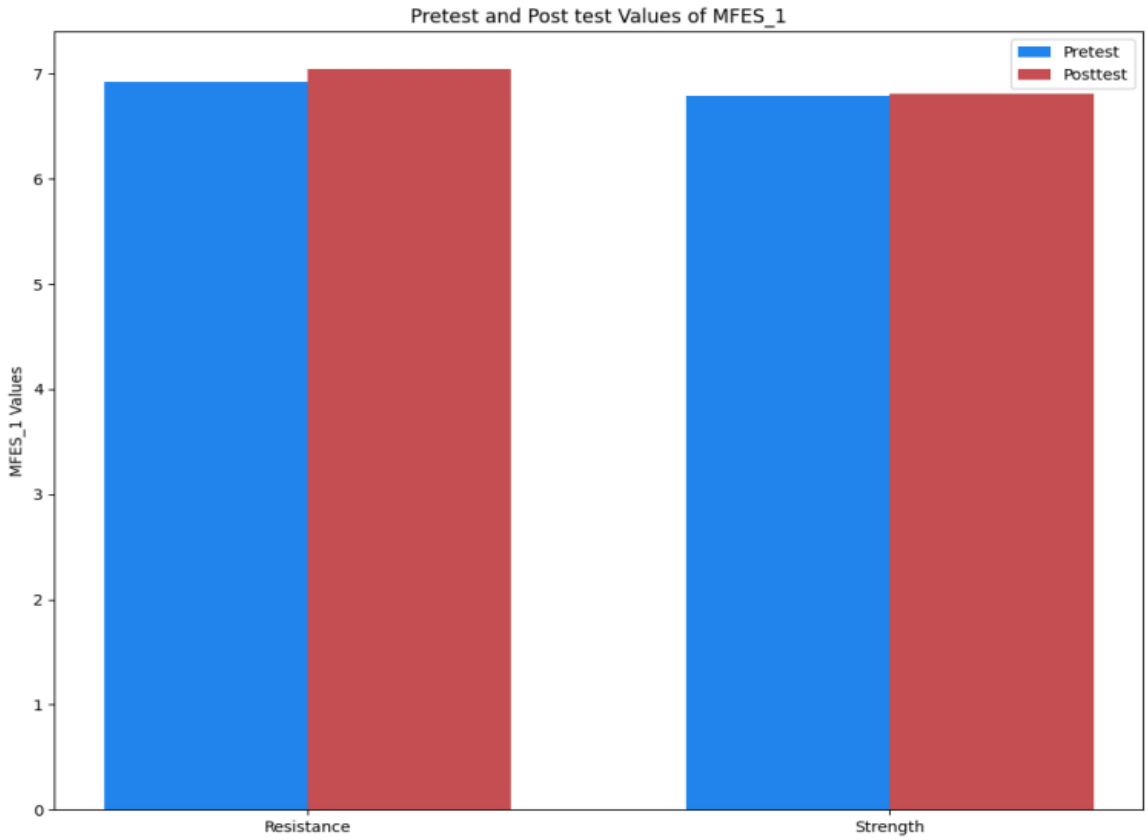
This table shows that there is a significant difference in post test values in modified falls efficacy scale between Group A &Group B , (P <0.001).

In addition, fall-related self-efficacy significantly improved, with increases observed in MFES1 (mean difference = -0.127, p < .001)

and MFES2 (mean difference = -0.160, p = .009). These changes were associated with large to very large effect sizes.

GRAPH -03

"COMPARISON OF MODIFIED FALLS EFFICACY SCALE (MFES) BETWEEN GROUP A AND GROUP- B IN PRE TEST AND POST TEST."



"COMPARISON OF MODIFIED FALLS EFFICACY SCALE (MFES) BETWEEN GROUP A (RESISTANCE) AND GROUP- B (STRENGTH) IN PRE TEST AND POST TEST." TABLE 04

MFES-2	GROUP -A		GROUP -B		t - test	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE-TEST	7.18	0.505	6.793	0.584	-3.003	P=0.009
POST- TEST	7.34	0.617	6.807	0.581	-6.325	P<0.001

(*-P >0.005, **P<0.001)

The above table reveals the mean, standard deviation (SD), t -test and p value of the MFES score between (Group A) & (Group B) pre test and post test test.

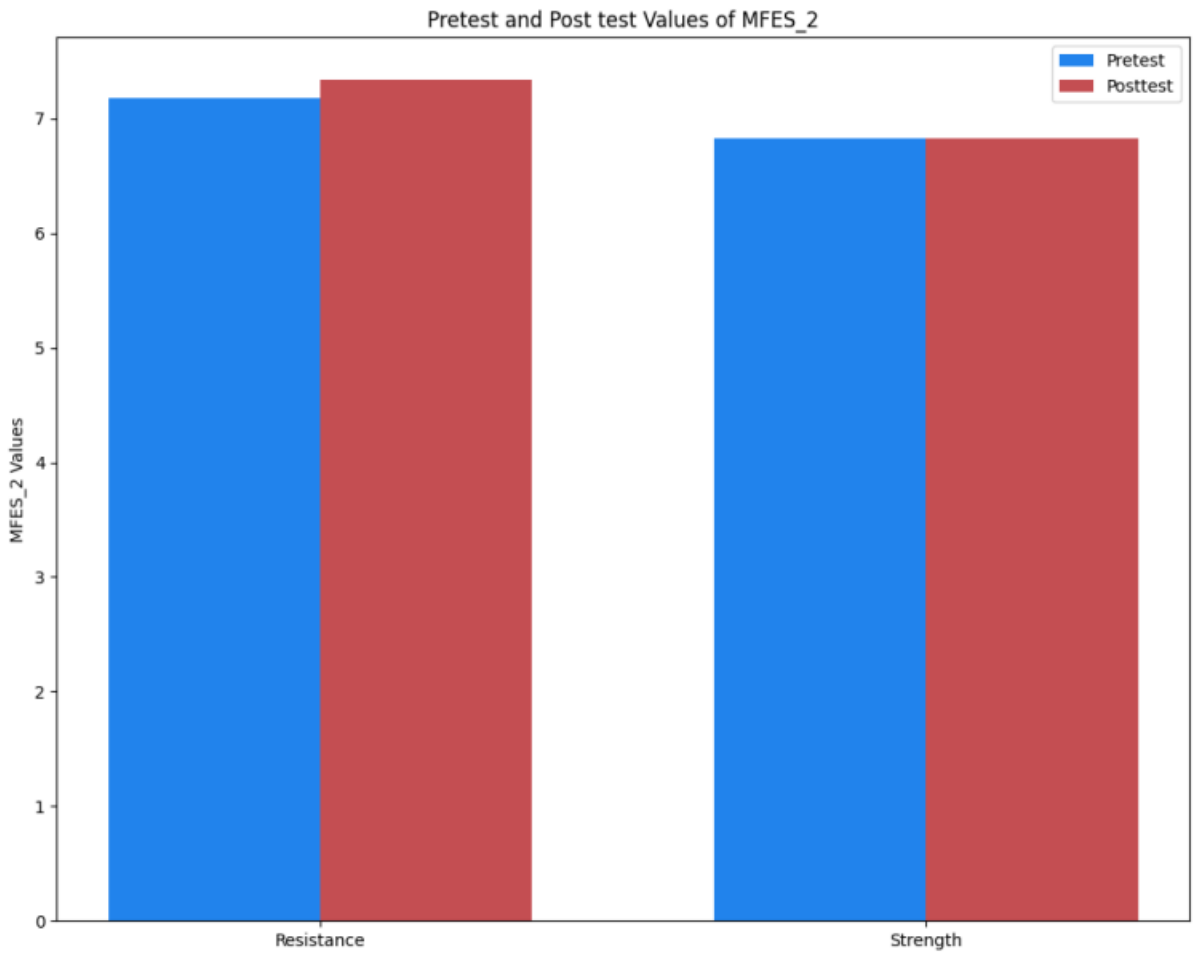
This table shows that ,there is a significant difference in pre-test values in modified falls efficacy scale between Group A &Group B , (P <0.001)

This table shows that there is a significant difference in post-test values in modified falls efficacy scale between Group A &Group B , (P <0.001).

In addition, fall-related self-efficacy significantly improved, with increases observed in MFES2 (mean difference = -0.160, p = .009). These changes were associated with large to very large effect sizes.

GRAPH-04

"COMPARISON OF MODIFIED FALLS EFFICACY SCALE (MFES) BETWEEN GROUP A AND GROUP- B IN PRE TEST AND POST TEST."



RESULT:

In table 01, On Comparing mean values of GROUP A and GROUP -B on orthostatic hypotension questionnaire scores shows in post test mean but GROUP -A shows (0.091), lesser mean value is more effective than GROUP B (0.015) at P<0.001, Hence null hypothesis is reject

In table 02, On Comparing mean values of GROUP A and GROUP B on orthostatic hypotension questionnaire scores shows in post-test mean but GROUP -A shows (0.093), lesser mean value is more effective than GROUP B (0.017) at P<0.001, Hence null hypothesis is rejected.

In table 03, On Comparing mean values of GROUP A and GROUP B on modified falls efficacy scale scores shows in post-test mean but GROUP -A shows (0.127,) lesser mean value is more effective than GROUP B (0.013) at P<0.001, Hence null hypothesis is rejected.

In table 04, On Comparing mean values of GROUP A and GROUP B on modified falls efficacy scale scores shows in post-test mean but GROUP -A shows (0.160), lesser mean value is more effective than GROUP B (0.013) at P<0.001, Hence null hypothesis is rejected.

Hence GROUP -A is more effective among other group.

DISCUSSION:

This study was done for six weeks, pre and post test values were collected. The baseline screening was done by measuring the blood pressure through sphygmomanometer where there was a reduction in SBP <20mmhg, and DBP <10mmhg in first three minutes ,are used to select the sample under the inclusion criteria..Here, Orthostatic Hypotension Questionnaire (OHQ) and Modified Falls Efficacy Scales (MFES) are used as outcome measures.

According to this study, the lower limb resistance training and strength training was given . Resistance exercises were resulted more significantly in improving balance by reducing orthostatic hypotension symptoms.

A total of 30 young adults were randomly divided into two groups respectively, each group divided into 15 each, GROUP -A Resistance training and GROUP -B Strength training . After 6 weeks of post intervention tests are conducted for both groups, where they were asked to fill the same orthostatic hypotension questionnaire and modified falls efficacy scales again.

The pre and post test values were statistically calucalated and graphed. The calucalated pre and post test intervention data showed a significant difference between both the groups. Though both interventions followed by Group A and B were effective, interventions followed by Group A are more effective than compared with Group B.

The outcome of the analysis has proven that resistance training is more effective than strength training by reducing the symptoms of orthostatic hypotension by reducing risk of fall. The data that was collected showed that resistance exercise showed much improvement in the reducing risk of fall in the orthostatic hypotension patients.

CONCLUSION:

Based on statistical analysis, Both resistance and strength training interventions were effective in reducing symptoms of orthostatic hypotension. However, resistance training demonstrated superior efficacy, as reflected by consistently larger effect sizes and statistically significant improvements across all outcome measures, including both components of fall efficacy (MFES1 and MFES2).

In contrast, strength training showed comparatively smaller effects and failed to produce significant improvement in MFES2.

Therefore, resistance training appears to be the more comprehensive and effective intervention for improving both orthostatic hypotension symptoms and fall-related self-efficacy.

LIMITATIONS OF THE STUDY:

- Small sample size.
- The duration of the study is short.
- Long term follow up of the patients was not possible.
- Study was done between 17 – 30 years of age.

RECOMMENDATIONS OF THE STUDY:

- Large sample size can be used for further study.
- Different age group can be analysed.
- Long duration studies can be done.
- Regular and long term follow up is recommended.

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