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Original Article

Physiotherapy Section

Effects of Resistance Exercise using Thera-band with Weighted Cuff Resistance on Fall Risk and Balance among the Geriatric Population: A Randomised Controlled Trial

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ABSTRACT

Introduction: Balance impairments and an increased fall risk are common concerns among individuals with various health conditions. Resistance exercise has shown potential in improving balance and reducing fall risk.

Aim: To determine the effects of home-based Thera-Band resistance training in reducing the risk of falls among the geriatric population and to compare it with weight-cuff resistance training.

Materials and Methods: A Randomised Controlled Trial (RCT) was conducted at the Amity Institute of Health and Applied Science, Noida, India, from November 2022 to April 2023. The intervention period spanned four weeks, and a total of thirty-three subjects were enrolled in the study. The participants were divided into three groups: Group A, Group B, and Group C. Group A performed resistance exercises using weight cuffs combined with standard balance training, Group B performed resistance training with Thera-Band combined with standard balance training, and Group C received standard balance exercises alone. The effects of the interventions on fall risk reduction were assessed using the Berg Balance Scale (BBS), Timed Up and Go (TUG), and Fall Efficacy Scale (FES) among the geriatric population. Paired t-tests were employed to compare pre- and post-intervention data within each group, determining significant changes within each group over the intervention period. Analysis of variance (ANOVA) was utilised to assess between-group effects of the different interventions.

Results: The FES scores were assessed pre- and post-intervention for each group. Group B (Thera-Band) demonstrated significantly better outcomes in fall efficacy compared to Group A (Weight-cuff) ($p<0.01$) and Group C ($p<0.01$). For balance assessment using the BBS, both Group A and Group B showed better results compared to Group C ($p<0.01$). In terms of mobility assessed through the TUG test, Group B exhibited substantial improvement compared to both Group A and Group C ($p<0.05$). Improvements in fall efficacy, balance, and mobility were seen in Group B (Thera-Band).

Conclusion: Home-based resistance training using Thera-Band was found to be the most effective method for reducing the risk of falls in the geriatric population, followed by weight-cuff resistance training in combination with conventional balance training. Thera-Band is not only effective but also more convenient, hassle-free, and cost-effective. The geriatric population should be provided with more multi-mode exercises that are easy to perform and have been found to be effective and helpful at their advanced age.

Keywords: Ageing, Berg balance scale, Fall efficacy scale, Timed up and go test

INTRODUCTION

Fall in the elderly is one of the most frequently seen and important factors contributing to disability, especially in the geriatric population [1]. According to epidemiological research, 11% of the global population is over 60 years old, and this figure is expected to rise to 22% by 2050 [2]. Fear of falling is a recognised geriatric phenomenon that can lead to additional functional deterioration in elderly individuals who are already frail [3]. Falling is a multifaceted and complex phenomenon. Aging causes several changes in gait, including reduced gait velocity and step length, a broader base, and a decline in lower limb power [4]. Identifying fall risk factors is crucial for implementing effective and individually tailored preventive methods. Some fall risk factors are permanent, while others can be modified through corrective measures [5]. History of falls, poor balance, weakened muscles, vision problems, polypharmacy, psychotropic substances, functional limitations, age over 80, female gender, incontinence, cognitive impairments, arthritis, diabetes, and pain are the main risk factors for falls [6].

Other significant risk factors leading to falls include impaired muscle power and strength of the lower limb muscles, reduced postural control, impaired gait, and fall-associated medications [7]. Both genders have an equal risk of falling, but research in some countries has found that men are more prone to fatal injuries from falls, while women are more likely to suffer non-fatal injuries [8]. Strategies can be like patient education, training, creating a safer home environment, prioritising fall-related research, and developing effective protocols to reduce fall risk can be implemented [1]. Home exercise interventions can improve physical function and muscular strength [9]. Multimodal strength training has shown positive impacts in reducing the rate of falls in frail older adults compared to unimodal exercises [10].

Resistance training is an effective and safe method for improving balance and gait in older individuals [11]. Studies have demonstrated the effectiveness of elastic band resistance training in improving balance, gait function, flexibility, and accident avoidance in elderly residents of rural areas [1,12,13]. Combining elastic resistance with conventional physical therapy can provide even greater benefits. Elastic band resistance exercise can be a simpler and more effective tool for improving balance, gait function, flexibility, and fall prevention in senior individuals living in rural areas [14,15].

Currently, there is a lack of research focusing on home-based resistance training programs using Thera-Band specifically tailored for geriatric patients to improve their balance. This study contributes to the existing knowledge regarding effective home-based interventions

for enhancing balance and reducing fall risk in the geriatric population. Previous research has demonstrated the significance of resistance training in enhancing balance among geriatric individuals. Introducing Thera-Band resistance training in the home setting can provide a practical solution for geriatric individuals to address their balance issues. By incorporating Thera-Band exercises into their daily routine, geriatric patients can improve their strength and balance, resulting in a reduction in fall incidents and improved overall functional capacity.

Therefore, this study was designed with the aim to determine the effect of home-based Thera-Band resistance training on BBS among geriatric patients. Secondly, to determine the effect of home-based Thera-Band resistance training on the TUG test among geriatric patients. The study also aims to determine the effect of weight cuff and Thera-Band resistance training exercises on fall risk and balance among the geriatric population and to compare the effects of resistance training exercises with standard training exercises.

MATERIALS AND METHODS

An RCT was conducted from November 2022 to April 2023. The trial was associated with the Amity Institute of Health and Applied Sciences, Noida, India.

Ethical clearance for the study was obtained from the Institutional Review Board of the Amity Institute of Health and Applied Sciences with approval number NTCC/MPT-Neurology/22-23/February2023/03 and CTRI NUMBER-CTRI/2023/02/049998. Written informed consent was obtained from all participants prior to their inclusion in the study. Participants were provided with detailed information about the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time.

Sample size calculation: was determined using a power analysis. with a significance level of 0.05, power of 80%, and effect size of 0.5 [1], the required sample size was calculated to be 33 participants.

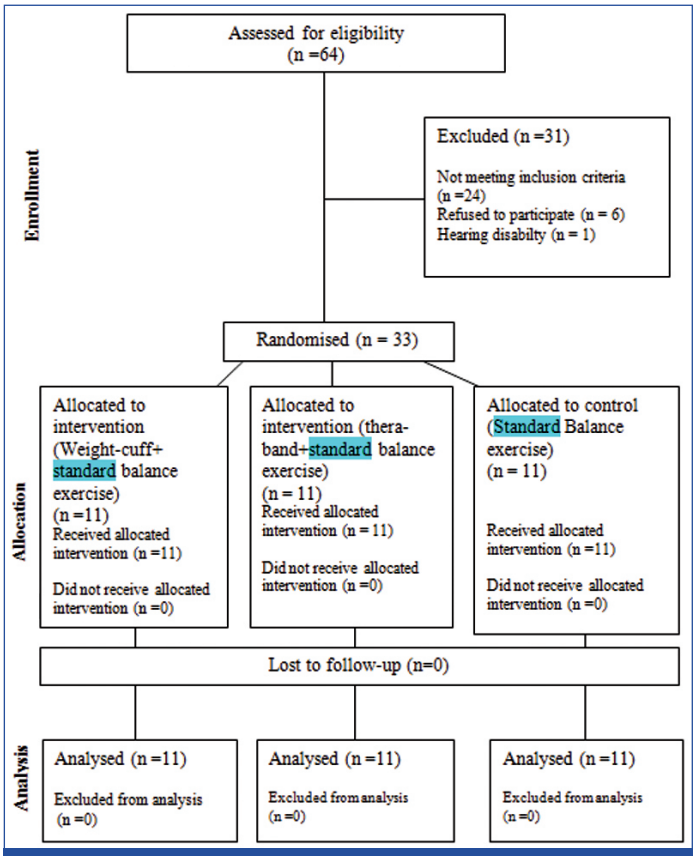
Inclusion criteria: The individuals aged between 60 and 70 years, having a FES score of at least 70, and able to comprehend and adhere to the exercise program's instructions were included. Participants who were willing to take part in the research and perform the suggested exercises, and were assisted during the exercise by an attendant were also included.

Exclusion criteria: Participants with a history of severe musculoskeletal or neurological conditions that could limit their ability to participate in the exercise program were excluded. Individuals with recent lower limb injuries or surgeries that may impact mobility and exercise performance, as well as those with medical conditions or medications that could significantly affect balance or increase the risk of falls, were excluded. Participants who were unable to provide informed consent or participate in regular exercise sessions due to cognitive impairment or mental health conditions were also excluded. Additionally, those who had participated in any other structured exercise program within the past six months or had contraindications to resistance training exercises or the use of Thera-Bands, such as known allergies or sensitivities, were excluded. Lastly, participants with hearing or visual disturbances were excluded.

Procedure

Participants were randomly allocated into three groups. Randomisation was achieved using computer-generated random numbers, ensuring an equal distribution of participants among the groups. Single blinding was implemented to reduce bias and maintain the integrity of the study, with the participants kept unaware of their group assignment.

These participants were divided into three groups: Group A [11] performed resistance exercises using weight cuffs combined with standard balance training. Group B [11] performed resistance training with Thera-Band combined with standard balance training. Group C [11 participants] served as the control group and received standard balance exercises alone [Table/Fig-1].



[Table/Fig-1]: Consort Flow diagram of enrolment and randomisation of study participants.

All procedures were carried out over a 4-week period, with three sessions per week. The exercise program was designed to be home-based and did not involve direct supervision by the investigators. Instead, participants were provided with detailed instructions, demonstrations, and guidance on how to correctly perform the exercises through visual materials (video) to support their home-based exercise sessions. Participants were given the flexibility to choose a time that suited their schedule and convenience. This approach allowed participants to integrate the exercise program into their daily routine at a time that worked best for them.

Participants in Group A were properly explained about the exercises. Each home exercise session lasted approximately one hour and included weight-cuff resistance exercises of moderate intensity (1 Kg) targeting specific muscle groups, such as knee flexors and extensors, ankle plantar and dorsiflexors, hip abductors, extensors, and flexors. Standard balance exercises were also included, such as standing with one foot in front of the other, walking with one foot in front of the other, standing on the toes and heels with support, walking backwards and sideways, turning around with assistance from a caregiver, bending and picking up objects, climbing stairs, standing up from a sitting position, knee squatting with wall support, and active range of motion exercises for the hip, knee, and ankle. These exercises were performed three days a week for a month [10].

For Group B, the protocol included properly explained exercises with increasing levels of difficulty. Each home exercise session lasted approximately one hour and included Thera-Band resistance exercises of moderate intensity (red color) targeting the same muscle groups as Group A. The standard balance exercises were the same as in Group A. These exercises were performed three days a week for a month. The exercises were performed two times for one set, three days per week for four weeks [1]. However, there was a 5-10 minute break between the resistance training exercises and the standard balance training exercises. During this break,

participants may have had the opportunity to rest and transition between the different components of the exercise session.

The control Group C received standard balance exercises, like standing with one foot directly in front of the other, walking with one foot directly in front of the other, walking on the toes and heels, walking backwards, sideways, and turning around with assistance in the presence of a caregiver. Other exercises included bending and picking up objects, climbing stairs at home, standing up from a sitting position, and knee squatting. These exercises were done three times per week for a month, as was also done by Group A and B.

Post-training re-evaluation of balance was done using BBS [14], mobility was measured using the TUG test [15], and FES [16]. BBS is a validated assessment tool consisting of 14 tasks that measure static and dynamic balance [16]. The TUG test measures the time taken for a person to stand up from a chair, walk a certain distance, turn around, and return to a seated position [17]. FES is a self-reported questionnaire that assesses participants' perceived confidence in performing various activities without falling. Baseline assessments were conducted before the intervention period, and post-intervention assessments were performed immediately after the four-week intervention [18,19].

STATISTICAL ANALYSIS

The collected data was analysed using appropriate statistical methods in Statistical Package for Social Sciences (SPSS) version 28.0. Descriptive statistics were used to summarise the demographic characteristics of the participants. Paired t-tests or Wilcoxon signed-rank tests were used to compare pre- and post-intervention measurements within each group. Analysis of variance (ANOVA) or Kruskal-Wallis tests were used to compare the outcomes between the experimental groups and the control group. Statistical significance was set at $p<0.05$.

RESULTS

The mean age of participants in Group A was 64.64±2.80 years, in Group B it was 64.09±2.95 years, and in Group C it was 65.64±3.26 years. The gender distribution showed a higher proportion of male subjects compared to female subjects in all three groups. Statistically highly significant results were observed for all three groups and all scales of pre-post intervention ($p<0.01$).

For the FES, no significant difference was found among the groups on the 1st day ($p>0.05$). However, in the 4th week, a highly significant difference was observed ($p<0.01$). Group B had a mean FES value of 61.09±4.57, which was significantly better than Group A (69.82±3.12) and Group C (71.45±4.50) in the 4th week.

Regarding the BBS scores, no significant difference was found among the groups on both the 1st day and 4th week ($p>0.05$). Group A had a mean BBS score of 36.09±4.23 SD, Group B had 39.45±3.91 SD, and Group C had 35.45±3.67 SD.

In the TUG test, no significant difference was observed among the groups on the 1st day ($p>0.05$). However, in the 4th week, a statistically significant difference was found ($p<0.05$). The ANOVA test indicated a significant difference among the groups, with Group B showing better results compared to the other two groups.

The results demonstrate significant improvements in falls efficacy (FES) and mobility (TUG) in Group B compared to Groups A and C. However, no significant differences were observed among the groups for the BBS scores.

The mean age of Group A was calculated as 64.64±2.80 SD, Group B as 64.09±2.95 SD, and for Group C it was 65.64±3.26 SD. Analysis of variance (ANOVA) was calculated, and the result was insignificant at the 0.05 level of significance [Table/Fig-2].

In Group A and B, the majority of patients were male with 54%, and the remaining 46% were females. Similarly, in Group B, 64% were males and 36% were females [Table/Fig-3].

Age distribution	Mean (years)	Std. Deviation (years)	F-value	p-value
Group-A	64.64	2.80	0.745	0.483
Group-B	64.09	2.95		
Group-C	65.64	3.26		

[Table/Fig-2]: Comparison of age among study participants.

Gender distribution	Male n (%)	Female n(%)
Group-A	6 (54.0%)	5 (46.0%)
Group-B	7 (64.0%)	4 (36.0%)
Group-C	6 (54.0%)	5 (46.0%)

[Table/Fig-3]: Gender wise distribution of study participants.

For Group A, the mean value on the first day of FES was found to be 75.82, and it was 69.82 after the fourth week. Similarly, for BBS, on the first day, the average value was observed as 31.36, and it was 36.09 at the fourth week. In the TUG scale, the values were calculated as 31.55 on the first day and 27.27 at the fourth week. Paired t-tests were applied for all the scales of pre-post intervention, and the results were statistically highly significant at the 0.001 level of significance [Table/Fig-4].

Group-A	Mean	Std. Deviation	t-value	p-value
FES Day 1	75.82	4.67	6.00	0.001*
FES 4 Week	69.82	3.12		
BBS Day 1	31.36	4.43	12.32	0.001*
BBS 4 Week	36.09	4.23		
TUG Day 1	31.55	6.59	11.90	0.001*
TUG 4 Week	27.27	6.63		

[Table/Fig-4]: Comparison of three scales within the Group-A at pre-post intervention. Test Applied- unpaired t-test, Statistical significance was set at $p<0.05$, *=highly significant at 0.001 level; FES: Fall efficacy score; BBS: Berg balance scale; TUG: Timed up and go

For Group B, the mean value on the first day of FES was observed as 73±4.45 SD, and it was 61.09 after the fourth week. Similarly, for BBS, on the first day, the average value was calculated as 33 with a 4.63 standard deviation, and it was 39.45 at the fourth week. In the TUG scale, the mean values were calculated as 26.55 on the first day and 18.82 at the fourth week. Paired t-tests were applied for all the scales of pre-post intervention, and the results were statistically highly significant at the 0.001 level of significance [Table/Fig-5].

Group-B	Mean	Std. Deviation	t-value	p-value
FES Day 1	73.00	4.45	10.92	0.001*
FES 4 week	61.09	4.57		
BBS Day 1	33.00	4.63	8.55	0.001*
BBS 4 week	39.45	3.91		
TUG Day 1	26.55	4.48	5.76	0.001*
TUG 4 week	18.82	4.40		

[Table/Fig-5]: Comparison of three scales within the Group-B at pre-post intervention. Test Applied- unpaired t-test, Statistical significance was set at $p<0.05$, *=highly significant at 0.001 level; FES: Fall efficacy score; BBS: Berg balance scale; TUG: Timed up and go

For Group C, the mean value on the first day of FES was observed as 74.91, and it was 71.45 after the fourth week. Similarly, for BBS, on the first day, the average value was calculated as 33.27, and it was 35.45 at the fourth week. In the TUG scale, the mean values

were calculated as 26.64 on the first day and 23.73 at the fourth week. Paired t-tests were applied for all the scales of pre-post intervention, and the results were statistically significant at the <0.01 level of significance [Table/Fig-6].

Group-C	Mean	Std. Deviation	t-value	p-value
FES Day 1	74.91	3.96	6.76	0.003*
FES 4 week	71.45	4.50		
BBS Day 1	33.27	3.93	4.20	0.002*
BBS 4 week	35.45	3.67		
TUG Day 1	26.64	4.08	4.55	0.001*
TUG 4 week	23.73	4.52		

[Table/Fig-6]: Comparison of three scales within the Group-C at pre-post intervention.
Test Applied- unpaired t-test, Statistical significance was set at p <0.05, *=significant at 0.001 level; FES: Fall efficacy score; BBS: Berg balance scale; TUG: Timed up and go

The comparison of FES on the 1st day and 4th week between the groups showed that the mean value on the 1st day for Group A was 75.82±4.66 SD, for Group B it was 73.00±4.45 SD, and for Group C, it was 74.91±3.96 SD. ANOVA test was applied, and the result was insignificant at the 0.05 level of significance. Similarly, on the 4th week, the mean and SD for Group A was found to be 69.82±3.12, for Group B it was 61.09±4.57 SD, and for Group C, it was 71.45±4.50 SD. ANOVA test was applied with an F-calculated value of 20.11, and the result was statistically highly significant at the 0.001 level of significance [Table/Fig-7].

FES	Group-A Mean±SD	Group-B Mean±SD	Group-C Mean±SD	F-value	p-value
Day one	75.82±4.66	73.00±4.45	74.91±3.96	1.19	0.317
Fourth week	69.82±3.12	61.09±4.57	71.45±4.50	20.11	0.001*

[Table/Fig-7]: Comparison of FES on one week and fourth week of between the groups.
Test Applied- ANOVA, Statistical significance was set at p<0.05, *=highly significant at 0.001 level; FES: Fall efficacy score

The comparison of BBS on the 1st day and 4th week between the groups showed that the mean value on the 1st day for Group A was 31.36±4.43 SD, for Group B it was 33.00±4.63 SD, and for Group C it was 33.27±3.93 SD. ANOVA test was applied, and the result was insignificant at the 0.05 level of significance. Similarly, on the 4th week, the mean and SD for Group A was found to be 36.09±4.23 SD, for Group B it was 39.45±3.91 SD, and for Group C it was 35.45±3.67 SD. ANOVA test was applied with an F-calculated value of 3.27, and the result was statistically non significant at the 0.05 level of significance [Table/Fig-8].

BBS	Group-A Mean±SD	Group-B Mean±SD	Group-C Mean±SD	F-value	p-value
Day one	31.36±4.43	33.00±4.63	33.27±3.93	0.623	0.543
Fourth week	36.09±4.23	39.45±3.91	35.45±3.67	3.27	0.052

[Table/Fig-8]: Comparison of BBS on one week and fourth week of between the groups.
Test Applied- ANOVA; Statistical significance was set at p<0.05; BBS: Berg balance scale

The comparison of TUG on the 1st day and 4th week between the groups showed that the mean value on the 1st day for Group A was calculated as 31.54±6.59 SD, for Group B it was 26.54±4.48 SD, and for Group C it was 26.64±4.08 SD. ANOVA test was applied, and the result was insignificant at the 0.05 level of significance. Similarly, on the 4th week, the mean and SD for Group A was found to be 27.27±6.63 SD, for Group B it was 18.82±4.40 SD, and for Group C it was 23.75±4.52 SD. ANOVA test was applied with an F-calculated value of 7.10, and the result was statistically significant at the 0.05 level of significance [Table/Fig-9].

TUG	Group-A Mean±SD	Group-B Mean±SD	Group-C Mean±SD	F-value	p-value
Day one	31.54±6.59	26.54±4.48	26.64±4.08	3.37	0.050
Fourth week	27.27±6.63	18.82±4.40	23.73±4.52	7.10	0.003*

[Table/Fig-9]: Comparison of TUG on one week and fourth week of between the groups.
*=Significant at <0.01 level; Test Applied- ANOVA; Statistical significance was set at p<0.05; TUG: Timed up and go

DISCUSSION

Thera-Band resistance training was found to be highly significant in decreasing the chance of falls, while resistance training using a weight cuff was also effective. Standard balance training alone was found to be the least effective. The mean age of the participants was around 64-65 years, and there were both male and female participants, unlike previous research that has focused on female subjects [20,21]. Pre- and post-analysis were performed for the weight cuff resistance training group, which was significant.

The superiority of the Thera-Band resistance training group, as evidenced by better outcomes in the BBS, FES, and TUG test, highlights the importance of incorporating Thera-Band exercises in balance training programs for elderly individuals. This result was consistent with previous research that has emphasised the positive effects of resistance training, including Thera-Band exercises, on balance and mobility [22]. The superiority of Thera-Band resistance training may be attributed to its specific design and properties, which allow for customised and progressive training. They are adaptable, making them suitable for people of different strength levels and offering a tough yet secure training approach. Thera-Band exercises also support proprioception, functional movements, and neuromuscular activation, all of which are essential for enhancing balance and reducing falls [23].

The inclusion of both male and female participants in this study is noteworthy as it provides a more comprehensive understanding of the impact of the interventions on different genders. Previous research has predominantly focused on female subjects, limiting the generalisability of the findings [23]. By including both genders, this study contributes to the knowledge base regarding fall prevention interventions in elderly individuals.

Thera-Band resistance training outperformed weight cuff resistance training and conventional balance training in terms of fall efficacy, balance, and mobility parameters, according to the findings of this study. These results supported the hypothesis that Thera-Band exercises' special qualities would make them more beneficial than conventional therapies [23,24]. In contrast, standard balance training alone showed relatively limited effectiveness compared to the other interventions. This may be due to the lack of progressive resistance and targeted muscle strengthening inherent in Thera-Band resistance training. Standard balance training often focuses on static balance exercises, whereas Thera-Band exercises offer a more dynamic and versatile approach [24].

In comparison to the other intervention groups, the Thera-band resistance training group showed more favourable outcomes in terms of fall efficacy and TUG test results. This finding has several causes. First, the resistance training offered by Thera-band exercises is more focused and gradual, enhancing muscular strength and balance. The elastic qualities of Thera-band provide a range of resistance levels and the ability to target specific muscle areas important for balance and mobility. The participants' confidence in their ability to prevent falls and perform functional movements has increased due to this targeted and gradual resistance training [24]. These workouts often involve movements in multiple directions, which challenge balance and coordination. By performing a wider variety of movements, Thera-band users improved their overall balance and functional mobility, leading to improved fall efficacy ratings and TUG test outcomes.

The similarity in BBS ratings in both intervention groups can be attributed to several factors. Firstly, since the exercise regimens and intensities were identical for both intervention groups, it is possible that their levels of balance improvement were equivalent. The exercises in both regimens likely focused on the same muscle areas and balance systems, resulting in similar outcomes. The short intervention period of four weeks may have contributed to the lack of major differences in BBS scores. To observe significant changes in BBS scores, longer intervention times would be required, especially if baseline scores were already relatively high.

Although several earlier studies [1,2,17-21] have demonstrated the effectiveness of resistance training using Thera-band, only a few have focused on weight cuff resistance training in the geriatric population [24]. Resistance training using Thera-band was found to be the most efficient for enhancing performance in terms of functioning, balance, and mobility, as reported by many other researchers [1,2,20,21]. Previous studies have also shown that incorporating multiple types of exercises is more effective in reducing the risk of falls compared to a single type of balance exercise, which has been observed in other research as well [11]. Researchers have also focused on the overall factors that contribute to the decrease in balance and lead to falls [7]. Falls are caused by multiple factors, both intrinsic and extrinsic [2], and therefore, multi-mode exercise training needs to be applied. It has also been observed that geriatric patients benefit from home exercises in their own environment [25], which increases their confidence and helps them become independent while staying at home. Many participants in previous studies had a fear of falling due to their previous history of falls [18]. Therefore, reducing the fear of falling by having them exercise in the same environment where they fear falling the most is essential. This study will be helpful for the rural population who are unable to find a clinic in their area and for people who find it difficult to come to the clinic due to a lack of caregiver. The results acknowledge that task-specific balance training may yield better results than traditional balance training in terms of increasing balance, mobility, and fall efficacy among elderly individuals at high risk of falls.

Four studies reported employing resistance equipment [2,20,22,26], a study using rubber bands, a couple of studies using both body weight and machinery [26], a single research using a mix of pneumatic equipment as well as balancing exercises [27], and a single research using body weight and free weights [25]. Therefore, many studies have used resistance training and elastic bands to train balance and reduce fall risk.

Limitation(s)

Firstly, the study duration of four weeks may not capture the long-term effects and sustainability of the interventions. Future studies could consider longer follow-up periods to assess the durability of the observed improvements. Secondly, future research with larger sample sizes would enhance the reliability of the results. Thirdly, the study did not collect specific information on the participants' exercise habits or activity levels. Thus, the researchers don't know how many participants, if any, were regular exercisers, or how their exercise habits may have affected the findings. Furthermore, the researchers did not gather information on the participants' personal reasons for diet habits and social wellness. Lastly, time constraints may have limited the ability to follow-up with participants or conduct longer-term evaluations, thereby limiting the overall scope of the study.

CONCLUSION(S)

This study examined the impact of home-based Thera-Band resistance training on fall risk reduction among older adults. The findings indicate that Thera-Band resistance training, when combined with conventional balance training, can lead to significant improvements in fall efficacy and mobility measures. These outcomes demonstrate the potential of Thera-Band resistance training in combination with balance training to successfully lower fall risk and enhance mobility in older individuals.

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