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Wii Fit plus Balance Board to Improve Balance, Mobility and Confidence in Elderly Fallers: A Randomized Clinical Trial

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Abstract: To see the effect of Wii Fit plus balance board to improve balance, mobility and confidence in community dwelling elderly fallers. This was an experimental study of 50 elderly faller Subjects age 65 years and above having minimum 2 falls in within six months. All the participants were divided into two equal group one experimental and another control group. Experimental group received the strengthening and balance exercises along with Wii fit balance board exercises and control group performed only strength and balance training. Berg Balance Scale, Time up & Go Test and Activity Specific Balance Confidence Scale was used to find out balance, mobility and confidence to measure additional effect of Wii Fit plus balance board training combined with strength & Balance training in elderly fallers staying in old age homes. Wii fit balance board training group had better improvement on BBS (48.64 ±1.77), TUG (12.08 ±1.86) and ABC (1219.60±68.52) as compared to Strength & Balance Training group's BBA (44.72±4.04), TUG (14.12±2.04) and ABC (1114.80±43.40) Scores. Wii Fit balance board exercises combined with strength & Balance training is more effective as compare to balance & strength training alone in elderly fallers.
Keywords: Fall, Wii Fit Balance Board Training, Balance & Strength Training.

INTRODUCTION

Falls are common, disabling and frequently fatal events affecting approximately 30 – 50% of older individuals annually and are a major threat to their health and independence. Studies indicate an annual fall incidence of 300 per 1000 in elderly [1].

Definition of fall adopted by WHO is "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" [2,3].

Approximately 30-50% of people living in long term care institutes fall each year, and 40% of them experienced recurrent falls. [3,4] Studies show that, among community-dwelling older people over 64 years of age, 28-35% fall each year. Those who are 70 years and older, approximately 32%-42% fall each year. The frequency of falls increases with age and frailty level. Older people who are living in nursing homes fall more often than those who are living in the community. Among older adults, the consequences of falling include 31% to 48% having a fear of falling, 19% to 26% reducing activity levels, and fall injuries occurring in 46% to 60% of all falls. Serious occurred in 6% to 14% of fall [5-14]. Deaths from falls also occur for subjects over 65 years of age, with 1 study find out that 2.2 death took place among each 100 fall-injury events leads to admission in acute medical faculty injury [15].

Falls are associated with multiple risk factors and increase with a rise in the number of risk factors. [11, 15, 16] Risk factors for falls have been classified as intrinsic and extrinsic, the intrinsic factors can be physiologic or pathological. Extrinsic factors involve the environment surrounding the person, such as placement of furniture, existence of obstacles, use of assistive walking devices, etc. that may put one at risk for falls [13].

Independent risk factors for falling include the previous falls, balance impairment, decreased muscle strength, visual impairment, fear of fall, polypharmacy (more than 4 medications) or psychoactive drugs, gait

impairment and walking difficulty, depression, dizziness or orthostasis, functional limitations, age older than 80 years, female gender, incontinence, cognitive impairment, arthritis, diabetes, and pain [17-19].

Fear of Falling (FOF) gained recognition as a health problem of older adults in the early 1980's. Tinetti & Powell have described FOF as an ongoing concern about falling that ultimately limits the performance of daily living activities [20]. It is reported to occur in 12% to 65% of older adults (those in the sixth decade of age or older) and is consistently higher among women than men who live independently in the community and do not have a history of falling [21].

FOF is associated with decreased social activities, mobility, and quality of life and an estimated 30-55% of older persons acknowledge being afraid of falling and approximately one third of them report restricting their activities [22].

Fall-prevention has been an area of active research over the past 10–15 years. Various programmes have been tested, and recent meta-analyses of fall prevention have documented the effectiveness of several approaches [23]. Effective approaches include multidimensional risk factor assessment tied to targeted interventions, exercise programmes (which include balance, strength and endurance training), and environmental assessment and modification [24].

Various studies have examined the effect of various types of balance exercises on improving balance function in elderly and have found significant enhancement in one leg standing, functional base of support and the sensory organization test of balance function. Balance improvements were maintained for 6 months [23-25].

Advances in technology have attempted to provide alternatives to traditional exercise through the use of interactive video games with biofeedback that are more engaging than traditional exercise programs. The Wii Fit is an example of active gaming or 'exergaming', which has begun to gain increasing popularity across all ages, including the elderly population. The Wii Fit features yoga, strength training, aerobics, and balance games [26]. The goal of the Wii Fit balance games is to move a virtual representation of the participant on a television screen via displacement of participant Centre Of Pressure over the Wii Balance Board, which is very attentive need constant focus and it provides constant visual and auditory feedback. Most games last between 30s and 3 min and participants are given a game-specific score after playing that is reflective of their overall performance. Currently, there is insufficient evidence to determine whether Wii Fit training improves balance in the elderly population.

This study was conducted with elderly fallers to determine whether balance, mobility & confidence improves more after a 10-week period of exercising with the Wii Fit combined with balance & strength exercises as compared to strength & balance exercises alone, which are not structured as games and do not provide visual feedback about body movements to the participant.

Aim and objectives

To assess the effectiveness of Wii Fit plus balance board to improve functional balance, mobility and confidence in community dwelling elderly fallers.

To assess the effectiveness of Balance & Strength training to improve functional balance, mobility and confidence in community dwelling elderly fallers.

Hypothesis

Experimental Hypothesis

Use of Wii fit plus balance board combined with balance & strength training improves functional balance mobility and confidence in community dwelling elderly fallers.

Null Hypothesis

Use of Wii fit balance board combined with balance & strength training does not improve functional balance, mobility and confidence in community dwelling elderly fallers.

MATERIALS AND METHODOLOGY

Apparatus and equipment

Record or Data Collection Sheet, Consent Form, Wii fit balance board, television set, table, chair, foot stool.

Wii Balance Board (WBB)

Wii Fit Balance Board (WBB), part of the popular video game Wii Fit, has similar features to a laboratory-grade Force Plate in that it comprises four transducers which are used to evaluate force distribution and the subsequent movements in COP. The WBB is mainly used in combination with a video game console and its allied software. The Wii Fit features yoga, strength training, aerobics, and balance games. The player stands over Wii Balance Board, which monitors and tracks the position of the player's COP on the board so that the video monitor can provide the participant with information about their alignment and balance control during the activities. Given the capacity for providing instant feedback and the potential for enhanced motivation levels, this system has already been integrated into the rehabilitation programs of neurological patients with balance defect [27, 28].

Methodology

- Type of Study: Experimental study
- Study Design: Single Blinded Randomized Clinical trial.
- Study Setting: Neuroscience department of Physiotherapy OPD, MGM Hospital Aurangabad, Other hospitals and private clinics of Aurangabad.
- Sample Size: 50
- Group A: 25 Subjects- Conventional PT (Balance and strength training)
- Group B: 25 Subjects Wii fit plus balance board + Conventional PT (Balance and strength training)
- Type of sampling: Simple Random Sampling, Lottery method
- Duration of intervention: 10 weeks
- Duration of study: 1 year

Selection criteria

Inclusion Criteria

- Age 65 to 85 years
- Mini-Mental State Examination (MMSE) score greater than 24
- Independent in ambulatory functions.
- History of at least 2 falls in last 6 months.

Exclusion Criteria

- Any medical condition or disability that prevented participation in an exercise program.
- A medical history that contained current treatment for -1. Cancer, kidney disease, a recent fracture, uncontrolled diabetes and seizure disorder.
- Cardiovascular-related problems that prohibited exercise.
- Neurological disorders with moderate to severe residual deficits (e. g. stroke, multiple sclerosis, late-stage Parkinson disease) Fainting or dizzy spells.
- Any cognitive and behavioral dysfunction

Outcome measures

1. **Berg balance scale (BBS): -** Berg Balance Scale which is a performance-based measure designed to monitor performance during balance activities, and to predict multiple falls in community-dwelling and institutionalized older adults. It is a 14-item list with each item consisting of a five-point ordinal scale ranging from 0 to 4, with 0 indicating the lowest level of function and 4 the highest level of function and takes approximately 20 minutes to complete. The BBS had good reliability and validity in assessing the Balance [29,30].
2. **Timed up and Go Test (TUG): -** The TUG is a widely used performance-based measure of functional mobility in community-dwelling older adults. The TUG had good reliability and validity in assessing the mobility [31, 32].
3. **Activity Specific Balance Confidence Scale (ABC):** -The Activities-specific Balance Confidence Scale (ABC) is a 16-items representing daily activities questionnaire to assess older individual's balance confidence in performing daily activities. Items are rated on a rating scale that ranges from 0–100. Score of zero represents no confidence; a score of 100 represents complete confidence. Overall score is calculated by adding item scores and then dividing by the total number of items. The ABC is a valid and reliable measure of balance confidence and is a suitable measure for use among diverse older adults [33-35].

Procedure

The total 50 patients were divided into two groups. Each group contained 25 Subjects. The strength & balance training with Wii Fit balance board was given to the experimental group and strength and balance training was given to the control group. All Subjects were assessed by berg balance scale, time up and go test and activity specific balance confidence scale Test before and after intervention

Intervention Protocol

Group A

All subjects in this group received balance and strength training exercises. The program consist of warm up exercise and then, individual strengthening and balance exercises done in sitting and standing position.

Balance & Strengthening Training Exercises [36, 37]

Balance training exercises	**Strength/co-ordination exercises**
Balance exercises in a standing, sitting position included hip flexion, side-leg raises, squats, and standing up from a chair and sitting down in the chair without using hands. Aim for a large number of repetitions (initially10, progressing to individual capacity). Warm-up 1. High stepping on the spot for 5 min 2. Standing with a decreased base- for progression: Making it harder: • Feet together and level • Semi-tandem stance • Tandem stance • Stand on one leg • Maintain position for longer 10seconds • Close eyes10seconds Making it easier: • place a table beside the person for hand support 3. Graded reaching in standing- for progression : Making it harder: • Foot placement- narrower, step standing • Reaching further • Reaching in different directions • Reaching down to a stool or the floor • Reaching for heavier objects • Reaching for a full cup of water • Standing on a softer surface e.g. foam rubber mat Stepping while reaching Making it easier: • place a table beside the person for hand support • give feedback to enable the task to be successfully completed (e.g. keep your hips forward) Structure the environment to enhance performance e.g. markers on floor to show foot position, an object to move hips towards. 4. Stepping in different directions- for progression Making it harder: • Narrow foot position, • Longer steps, • Faster steps, • Step over objects • Choice component e.g. step forward with left foot • Incorporate pivoting on the non-stepping foot • Use different colors, numbers of letters or a clock face or coins as targets for variety Making it easier: • place a table beside the person for hand support	1. Sit-to-stand- for progression and variety: Making it harder: • lowering the height • don't use hands to push off, cross arms across chest • changing the nature of the surface (e.g. softer chair) • ask the person to stand up with most weight on one leg- the other leg can be placed in front or on a stool to ensure this • adding weight (either vest or belt) Making it easier: • place a table in front of or beside the person for hand support • Give feedback to enable the task to be successfully completed (e.g. feet back behind your knees, move your shoulders forward) • structure the environment to assist performance e.g. markers on floor to show foot position. 2. Heel raises- for progression and variety: Making it harder: • decrease hand support • hold the raise for longer • One leg at a time • use a wedge to increase the range of motion Making it easier: • place a table on one or both sides of the person for hand support or use their walking aid. 3. Half- squats sliding down a wall- for progression and variety: Making it harder: • increasing step height • adding weight (either vest or belt) • decrease hand support • Step up and over block Making it easier: • place a table on one or both sides of the person for hand support or use their walking aid.

Group B

The participant of group B received balance and strength training exercise combined with Wii Fit balance board which include individual balance Games done on Wii fit balance board in sitting and standing positions.

The balance games on Wii fit balance board are having progression according to the level of difficulty from beginner to expert, the games which experimental

group played was Basic step, Soccer heading, ski slalom and Table tilt.

Wii fit balance board protocol [38]		
Basic step- Time: 2.5 min per game 2 games Total minutes: 5 min with 1-min rest between each step game	Participants follow a step sequence on the television screen by stepping on and off the balance board (forward / backward and side to side) Scoring: number of synchronized steps	Warm up and low- moderate intensity aerobic exercise Dynamic balance Attention and coordination Visual and auditory feedback
Soccer heading Time: 1 min per game, 3 games Total minutes: 5 min with 1-min rest between 2 games	Participants move their center of gravity to strike virtual soccer balls coming at them from the television screen Scoring: number of soccer ball strikes and avoiding diversions	Static balance and quick motor response Attention and coordination Visual and auditory feedback
Ski slalom Time: 1 min per game 3 games Total minutes: 5 min with 1-min rest between 2 games	Participants ski downhill between poles while flexing their knees and shifting their weight Scoring: speed and accuracy with skiing between poles	Static balance and whole-body movement Attention and coordination Visual and auditory feedback
Table tilt Time: variable, depending on performance Total minutes: 5 min	Participants tilt their center of gravity to direct balls into a hole on a shifting platform Scoring: number of balls that enter the hole.	Static balance and motor response Visual and auditory feedback

Level of difficulty first started from beginner level for all subject and later level increased according to achievement of patient.

All the subjects received individual exercise session under direction of physiotherapist and provided by same physiotherapist. Total duration of intervention was 60 minutes, and experimental group missed 20 minutes of regular training on alternate basis to keep total duration 60 minutes only. Both the groups received therapy for 4 days a week for 10 weeks. One physiotherapist who was blinded to study did group distribution & utilized all pre-post-intervention outcome measures in this study.

Ethical Approval and Informed Consent

Before implementing the study, an approval from MGM's Institute of Health Sciences ethical committee was taken before starting the study. The Protocol number of Ethical Committee Approval was MGM-ECRHS/2015/211., Also the Informed consent was taken from all the subjects, who were willing to participate in study.

Data and Statistical Analysis

Paired 'T' test was used to analyze within group analysis for BBS, TUG, and ABC. Unpaired 'T' was used to analyze between group analysis for age, no. of HOF, risk factors, pre and post intervention BBS, TUG, and ABC. Data analysis was performed with SPSS statistical package version 22. The results were statistically significant if the p-value ≤ 0.05.

Levene's Test has been used for Equality of Variances to find out status at pre-intervention and post intervention level. Independent sample t test has been used for between group analysis and paired sample t test for within group analysis.

RESULTS

Total 65 subjects were assessed for eligibility. Out of which 5 were excluded because they were unable to fulfill inclusion criteria, 6 refused to participate in study. Total 54 subjects were randomized and divided in to two groups. Group A & Group B. There was 4 drop out from study, 2 subjects from each group. Out of 50, 25 subjects in each group completed the whole intervention and included for data analysis.

Subjects in both the groups were assessed at baseline level for their balance with BBS, for Mobility with TUG and for confidence with ABC prior to the commencement of the treatment sessions. First, we compared demographic and functional data of the age matched subgroup. Post-test measurements were taken after 10 weeks, after completion of treatment sessions.

Baselines characteristics of both the group are shown in table 1. Characteristic of both the groups were same at the base line level prior to intervention.

Flow Chart (Selection criteria)

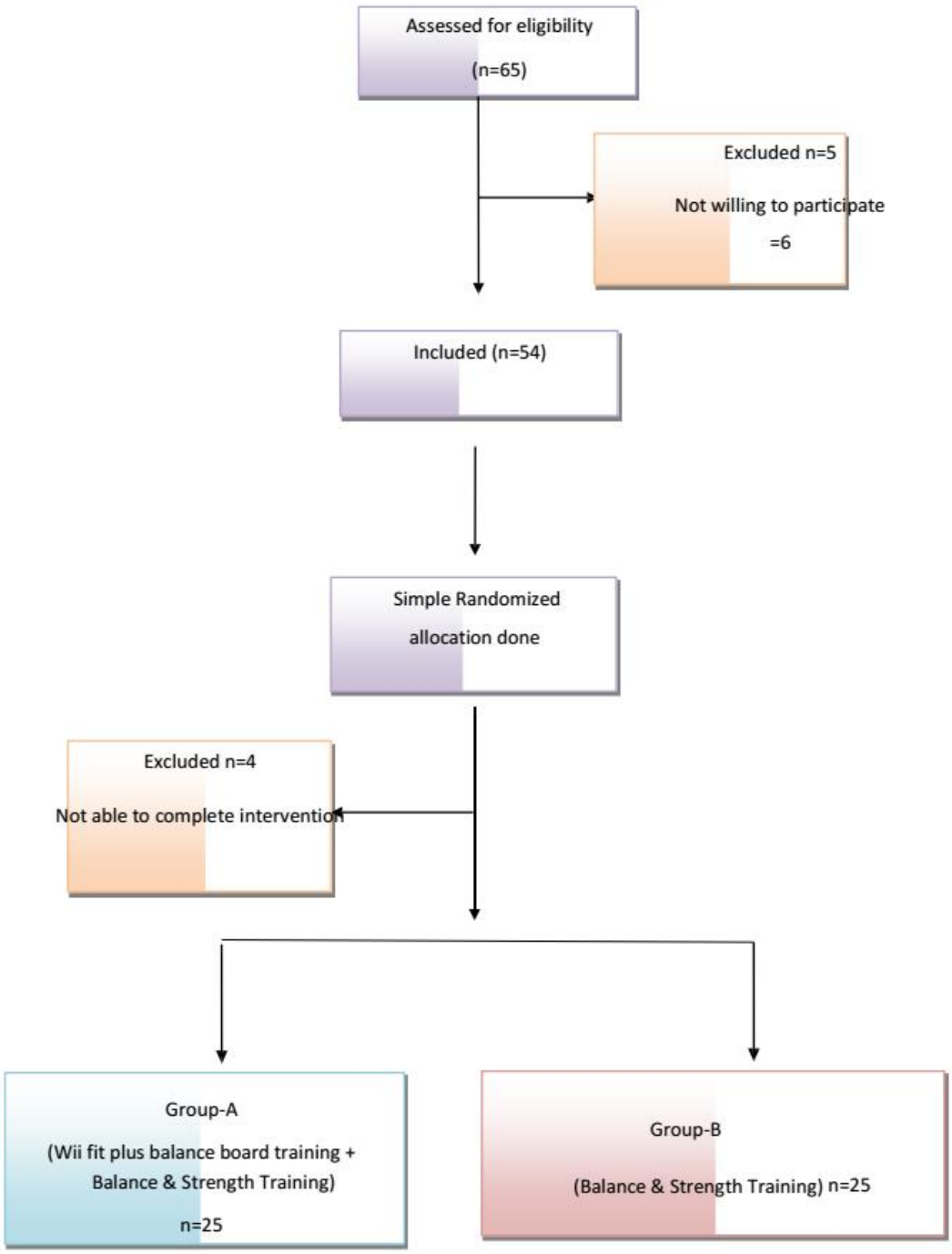

Table-1: Demographic distribution of the population according to Age, gender, risk factors and History of fall

		Group A	Group B	P value
Age		66.64±2.49	68.28±2.92	.038 (N S*)
History of fall		2.28±.54	2.40±.64	.480 (NS*)
Gender	Male	16	10	
	Female	9	15	
Risk factors	Hypertension	17	18	
	Diabetic	8	6	

NS*- Non-Significant

Above table shows demographic data of the population in group A and group B. The groups did not differ regarding age, history of fall and risk factor. Age and history of fall are not significant with p-value 0.038 and 0.480 respectively.

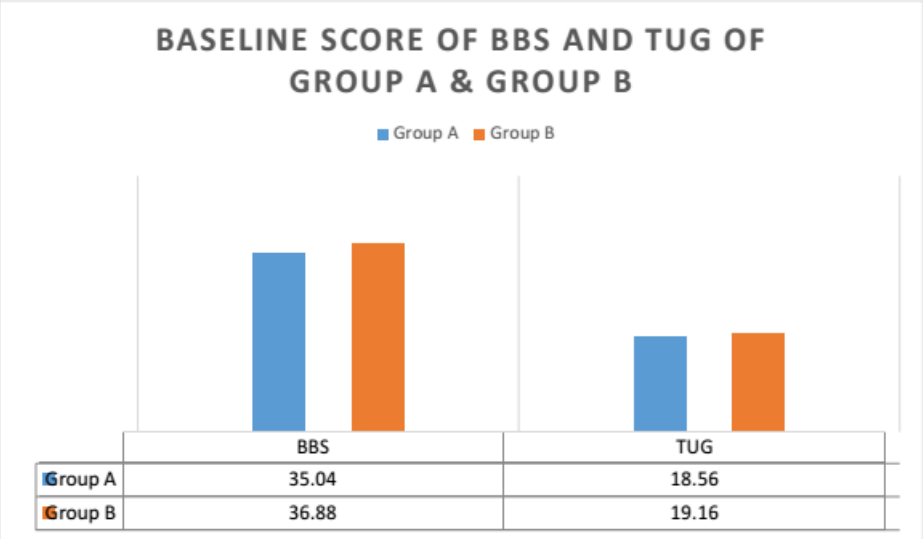

Fig-1: Pre-Intervention Scores of BBS and TUG of Group B
Above graph shows baseline scores of BBS and TUG of Group A & Group B.

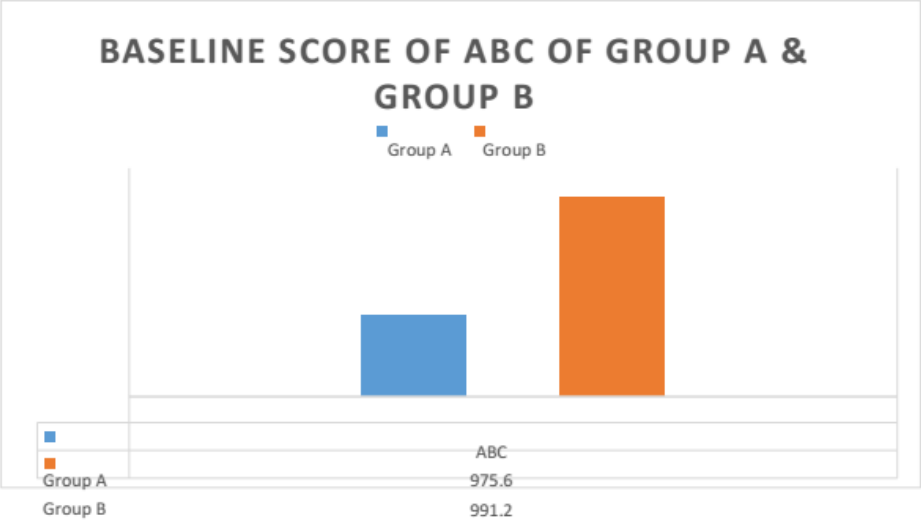

Fig-2: Pre-Intervention Scores of ABC of Group A and Group B
Above graph shows baseline scores of ABC of Group a & Group B

Table-2: Baseline level values of BBS, TUG and ABC between Group A and Group B

	Group a (Mean ±SD)	Group b (Mean ±SD)	P value
BBS	35.04±3.54	36.88±3.24	.061 (NS*)
TUG	18.56±2.63	19.16±2.86	.445 (NS*)
ABC	975.60±50.00	991.20±59.32	.320 (NS*)

NS*- Non-Significant
P<0.05* shows a statistically significant result

The above table shows that groups are matched for their baseline characters. The baseline values for BBS, TUG and ABC are not significant with p-values 0.061, 0.445 and 0.320 respectively.

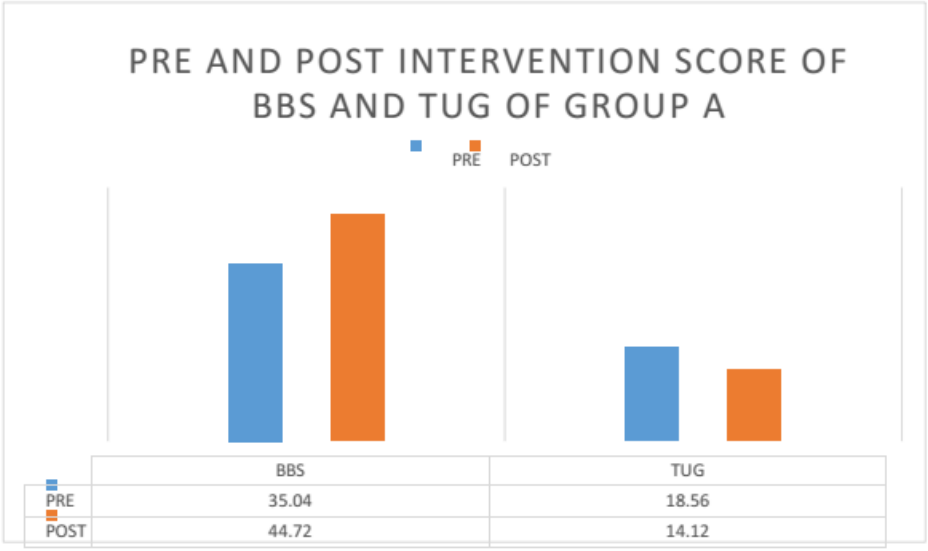

Fig-3: Pre and Post Intervention Scores of BBS and TUG of Group A
Above graph shows pre and post intervention scores of BBS and TUG of Group A

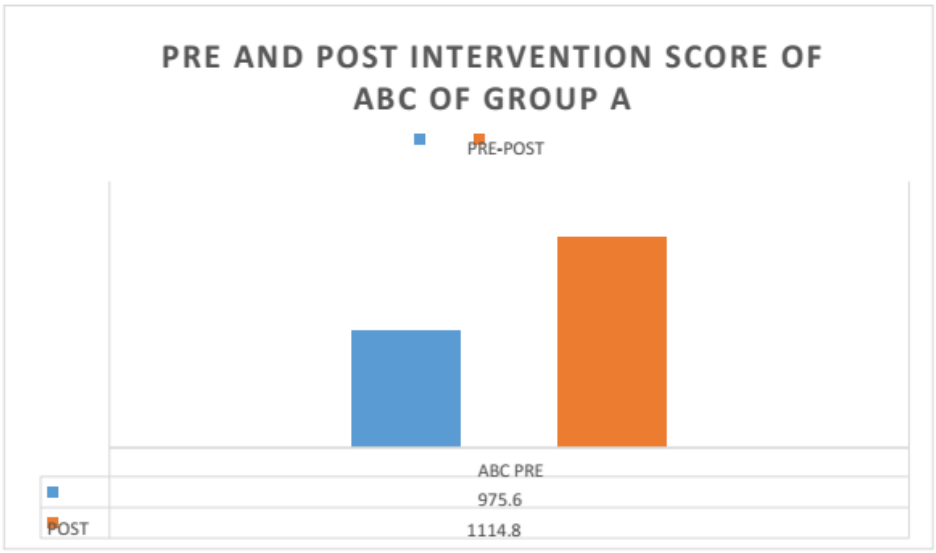

Fig-4: Pre and Post Intervention Scores of ABC of Group A
Above graph shows pre and post intervention scores of ABC of Group A.

Table-3 BBS, TUG and ABC score at Pre and Post Intervention levels of Group A

Group a	PRE (Mean ± SD)	POST (Mean± SD)	P value
BBS	35.04±3.54	44.72±4.04	.000(S*)
TUG	18.56±2.63	14.12±2.04	.000 (S*)
ABC	975.60±50.00	1114.80±43.40	.000 (S*)

S*- Significant
<0.05* shows a statistically significant result

The above table shows pre-& post intervention values of BBS, TUG & ABC of group A. The post intervention values for BBS, TUG and ABC are significant with p-values 0.000, 0.000 and 0.000 respectively.

Table-4: BBS, TUG and ABC score at Pre and Post Intervention level of Group B

GROUP B	PRE (Mean ± SD)	POST (Mean ± SD)	P value
BBS	36.88±3.24	48.64 ±1.77	.000 (S*)
TUG	19.16±2.86	12.08 ±1.86	.000 (S*)
ABC	991.20±59.32	1219.60±68.52	.000 (S*)

S*- Significant

P<0.05* shows a statistically significant result

The above table shows pre-& post intervention values of BBS, TUG & ABC of group B. The post intervention values for BBS, TUG and ABC are significant with p-values 0.000, 0.000 and 0.000 respectively.

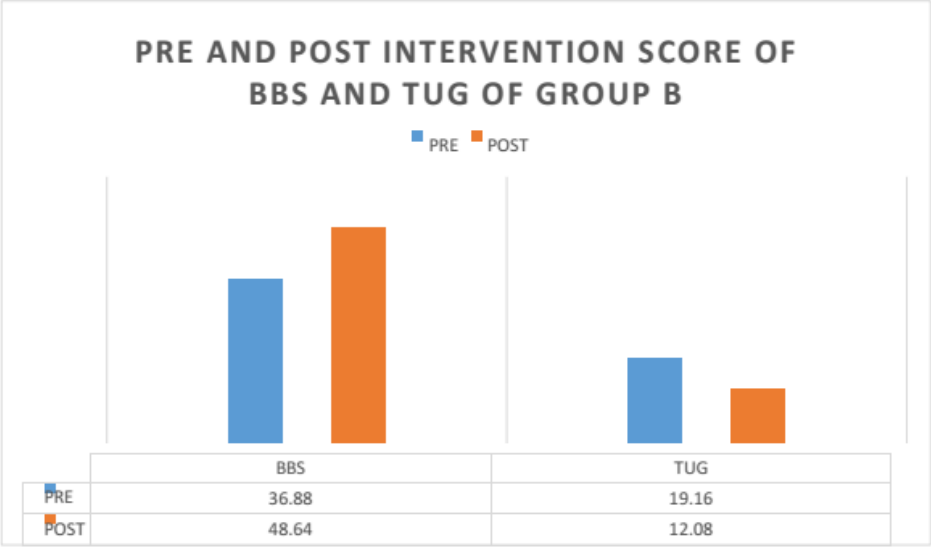

Fig-5: Pre and Post Intervention Scores Of BBS and TUG of Group B

Above graph shows pre and post intervention scores of BBS and TUG of Group B

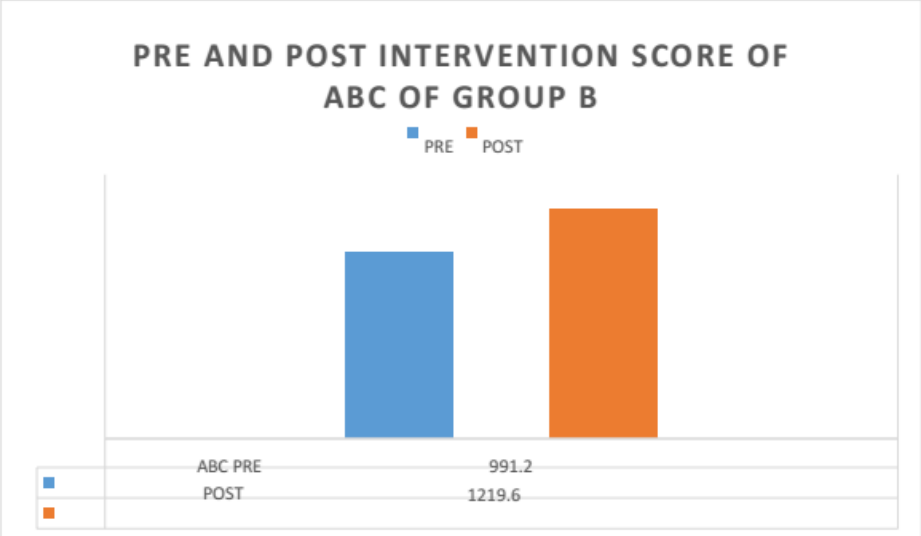

Fig-6: Pre and Post Intervention Scores of ABC of Group B

Above graph shows pre and post intervention scores of ABC of Group B.

Table-5: Post Intervention Scores of BBS, TUG & ABC of Group A & Group B

	Group A (Mean ±SD)	Group B (Mean ±SD)	P value
BBS	44.72±4.04	48.64 ±1.77	.000 (S*)
TUG	14.12±2.04	12.08 ±1.86	.001(S*)
ABC	1114.80±43.40	1219.60±68.52	.000 (S*)

S*- Significant

Above table shows post intervention scores of BBS, TUG, & ABC of group A & GROUP B respectively. The post intervention values for BBS, TUG and ABC are significant with p-values 0.000, 0.001 and 0.000 respectively.

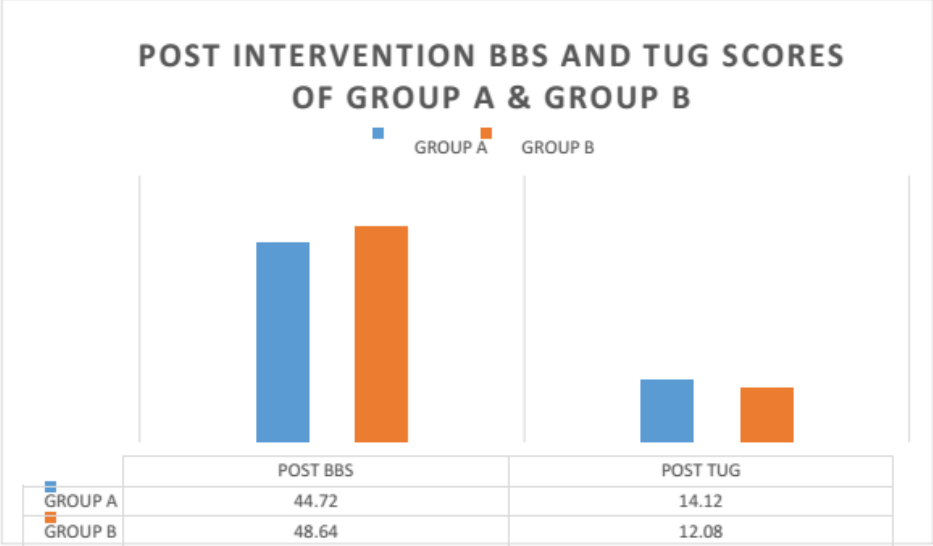

Fig- 7: - Post Intervention Scores of BBS and TUG of Group A & Group B

Above graph shows post intervention scores of BBS and TUG of Group A & Group B.

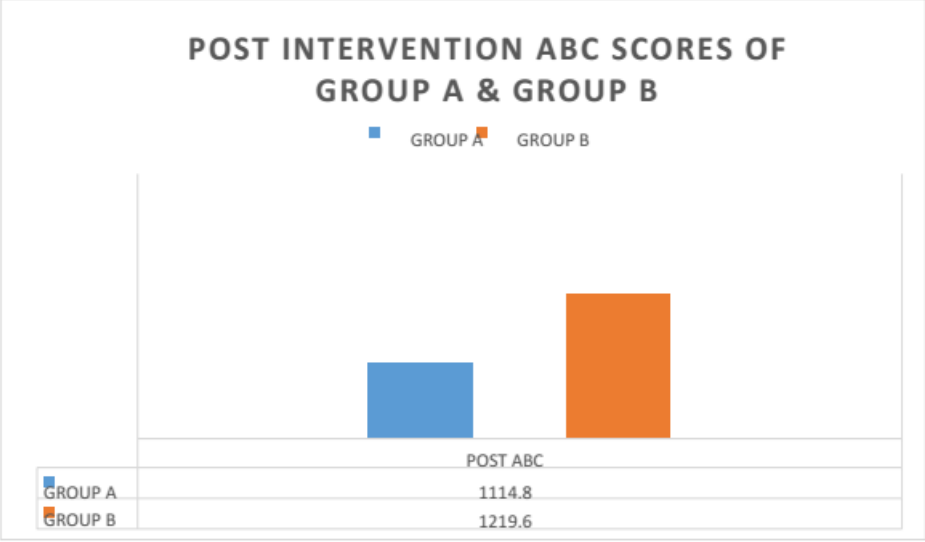

Fig-8: Post Intervention Scores of ABC of Group A & Group B

Above graph shows post intervention scores of ABC of Group A & Group B.

DISCUSSION

The Purpose of this study was to find out effectiveness of Wii Fit balance board training on balance and confidence in elderly fallers. The finding of this study supports the hypothesis that balance & strength training combined with Wii fit balance board is having additional benefit than that of conventional PT (strengthening and balance training) alone so null hypothesis was rejected and alternative hypothesis was accepted.

The finding of this study is supported by study done by Emily Bainbridge *et al*. on "The Effects of the Nintendo Wii Fit on Community-Dwelling Older Adults with Perceived Balance Deficits": A Pilot Study in which they concluded that the Wii Fit may be an effective tool for physical therapists to consider when choosing interventions for older adults with balance deficits [38].

Another study by Bateni on "Changes in balance of older adults based on use of physical therapy vs the Wii Fit gaming system": a preliminary study, in which he concluded that Wii Fit training appears to improve balance. However, physical therapy training on its own or in addition to Wii Fit training appears to improve balance to a greater extent than Wii Fit training alone [39].

The better score in experimental group (WBB+PT) may be due to the gaming intervention that was designed to address 3 therapeutic goals: postural control, functional mobility, and visual-perceptual processing. Functional mobility was addressed indirectly by combining visual-perceptual processing, postural control, and endurance training in a standing position [40].

Wii fit balance board platform provides visual and auditory feedback about task and weight shift of person while playing games and performing exercises over it. As suggested by Nichols [41] DS over Balance retraining after stroke using force platform biofeedback, Balance can further be broken down into three aspects: steadiness, symmetry, and dynamic stability. Steadiness refers to the ability to maintain a given posture with minimal extraneous movement (sway). The term symmetry is used to describe equal weight distribution between the weight-bearing components (e.g., the feet in a standing position, the buttocks in a sitting position), and dynamic stability is the ability to move within a given posture without loss of balance. The force platform biofeedback is designed to provide visual or auditory biofeedback to patients regarding the locus of their center of force (COF) or center of pressure (COP), as well as training protocols to enhance stance symmetry, steadiness, and dynamic stability [42]. These rules may be applicable for Wii Fit balance board also.

The Wii fit balance training stimulated motor behaviors that had visual-perceptual requirements rather than training visual spatial perception in isolation. This training approach is consistent with the notion that it is necessary to engage the individual in the motor behavior to acquire the spatial processing ability. The training provided in this case combined massed practice of balance with vision and attention directed at the game rather than maintaining balance, which we believe stimulated the proprioceptive vestibular system. With the visual-perceptual processing, attention was focused on the game and performance in the gaming environment rather than attending to posture [38, 39, 40].

The findings of this study do not correlate with results of the study done by Toulotte *et al*." Wii fit training vs. adapted physical activities: Which one is the most appropriate to improve the balance of independent senior subjects? Researcher concluded that older adults training with the Wii Fit were able to improve only in the static conditions of the Tinetti test not the dynamic [43].

The possibility of using the Wii Fit Balance Board to improve balance in older adults is appealing for many reasons. The experimental group B have better outcome as compared to conventional group A, may be due to at First, participants tend to enjoy what they are doing. Subjects enjoyed therapy with the Wii Balance Board and thought it to be more challenging and fun compared to regular therapy [38, 43, 44].

Therefore, the feasibility of implementing this training program at home is high. This allows potential for long term adherence to a training program outside of the study, and may lead to longer retention of any improvement from the training sessions. This may be the reason why experimental group had significant better score at the end of intervention.

Limitation of study

In term of study limitations, the sample size used in this study was small; no follow up was taken after 10 weeks. The changes in COP and symmetry of weight bearing, changes in gait & any change in reaction time were not assessed. Both the groups performed training under supervision but extra caution by physiotherapist while Wii fit training may have produced some Hawthorne-effect over experimental group can't be rule out.

Future scope of study

Future clinical trial can be carried out on a larger sample size with long term follow up. Wii Fit Balance Board measurement of COP and weight symmetry can be used as outcome measures. Further studies are needed to investigate the Wii Fit Balance Board training when compared with conventional physiotherapy in other balance disorder pathology.

Clinical implication

The results of this study have important clinical implication for developing effective intervention for elderly fallers by incorporating Wii fit balance board training that can improve the balance functions for activities of daily living. They can be easily incorporated in any rehabilitation technique.

CONCLUSION

The result obtained from this study demonstrated that Wii Fit Balance Board with conventional physiotherapy showed significant results as compared to control group and displayed efficient improvement in elderly fallers after 10 weeks of treatment. Wii Fit training may be a novel and fun way for older adults to improve some clinical measures of balance in a low-cost manner.

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