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# Effectiveness of Sensory Motor Training Program in Community Dwelling Elderly Individuals with History of Fall

**Shrikant Bhimrao Darade*** **and Shyam Devidas Ganvir**

*Department of Physiotherapy, Nanded Physiotherapy College and Research Center, Nanded, Maharashtra, India*

***Corresponding author:** Shrikant Bhimrao Darade, Department of Physiotherapy, Nanded Physiotherapy College and Research Center, Nanded, Maharashtra, India, Tel: +91 08308887747; E-mail: daradeshri31@gmail.com

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## Abstract

**Background:** Falls are major source of death and injury in elderly population. Physiological age related changes in somatosensory, vestibular and visual systems are well documented in older adults. These changes coupled with age related changes in muscle and bones to contribute to an increased risk of falls.

The prevalence of fear of falling in community-living elderly ranges between 12% and 65%, and is higher in women than men, commonly occurs after falls, but also occurs without a previous history of fall.

**Aim and objectives:** To study and determine the effectiveness of sensory motor training program in community dwelling elderly individuals with history of fall.

**Methodology:** Sixty community dwelling elderly individuals were selected from geriatric home care, and study group were form by using purposive sampling. The group under gone sensory motor training program and evaluated on the basis of Berg Balance Scale (BBS), Modified Fall Efficacy Scale (MFES) and Quality of Life (QoL). Intervention used to improve balance consisting of a 45 min. to 1-hour session three times a week.

**Results:** Total 58.33% of patients show, one fall in previous year while 41.67% of patients show two falls in previous year. The mean of BBS at baseline was 39.95 ± 6.32, the mean of BBS at 3 months was 46.21 ± 4.66 and the mean of BBS at 6 months was 43.63 ± 5.10, which is statistically significant ($p<0.0001$). The mean of MFES at baseline was 4.92 ± 0.39, the mean of MFES at 3 months was 5.71 ± 0.53 and the mean of MFES at 6 months was 5.34 ± 0.51, which is statistically significant ($P>0.0001$). And finally, for the mean of QoL at baseline was 3.61 ± 0.46, the mean of QoL at 3 month was 4.36 ± 0.42 and the mean of QoL at 6 month was 4.06 ± 0.40, which is statistically significant ($p>0.0001$).

**Conclusion:** Effect of sensory motor training program shown improvement in balance, reduction in fear of fall, improves quality of life and also helps to prevent fall in community dwelling elderly individuals with history of fall.

**Keywords:** Balance; Fall; Sensory motor training; Quality of life

## Introduction

### Identification of elders who are at a risk for falling is a vital medical concern

**Fall:** Fall is "an unaccepted loss of balance that leads to failure of postural stability" or "it is a sudden and unexpected change in position which usually results in landing on the floor" [1,2].

**Aging:** Aging is the fundamental process that affects all systems and tissues. The rate and magnitude of change in each system may differ from person to person, but total body decline is an inevitable part of life for everyone. Ironically, we spend about 75% of our entire life span undergoing the process of decline [2].

**Falls:** Falls are a common and complex geriatric syndrome that cause considerable mortality, morbidity, reduced functioning, and premature clinic visits and consequently nursing home admissions. Falls in the elderly are a public health and community problem. These include disability, deformity, fear of recurrent falls, curtailment of social activities, costs of medical care associated with injuries and loss of ability to work and potential income. Yet little attention is paid to the problems of falls and are less likely to be screened for the geriatric population (over 60 years). Fall prevention is an assessment category specific to the elderly [3].

Presently in India, 60 years old community elderly persons is fast growing and India, being the second most populous country in the world has 76.6 million people at or over the age of 60 which constitutes above 7.7% of total population [2]. Falls have negative effects on physical, psychological, and socioeconomic status. The incidence of falls in community-dwelling elderly individuals is increasing with advancing age [4]. According to Downton et al. found that the incidence of fall in elderly aged more than 65 years was 28%–35% and 32%–42% in those who aged beyond 75 years. Elderly with a history of falls are more prone of falling again 3. Approximately 30% of falls require medical attention, and approximately 10% result in a fracture [5].

Falls are major source of death and injury in elderly population. Physiological age related changes in somatosensory, vestibular and visual systems are well documented in older adults. These changes coupled with age related changes in muscle and bones to contribute to an increased risk of falls. Falls have varying precipitating causes and risk factors, which make their diagnosis, treatment, and prevention a clinical challenge [6]. Most falls involve multiple factors, but causes of falls are often categorized into intrinsic (personal) and extrinsic (environmental) factors (Figure 1) [7-9].

During the 1950s and 1960s, Dr. Vladimir Janda (1928-2002), a physiatrist and neurologist from the Czech Republic, noted that it was impossible to separate the sensory system and the motor system in the control of human movement, thus he used the term, "Sensorimotor System" and so functions as one unit and changes within one section of the system are reflected by adaptations elsewhere in the system (Janda, 1987).

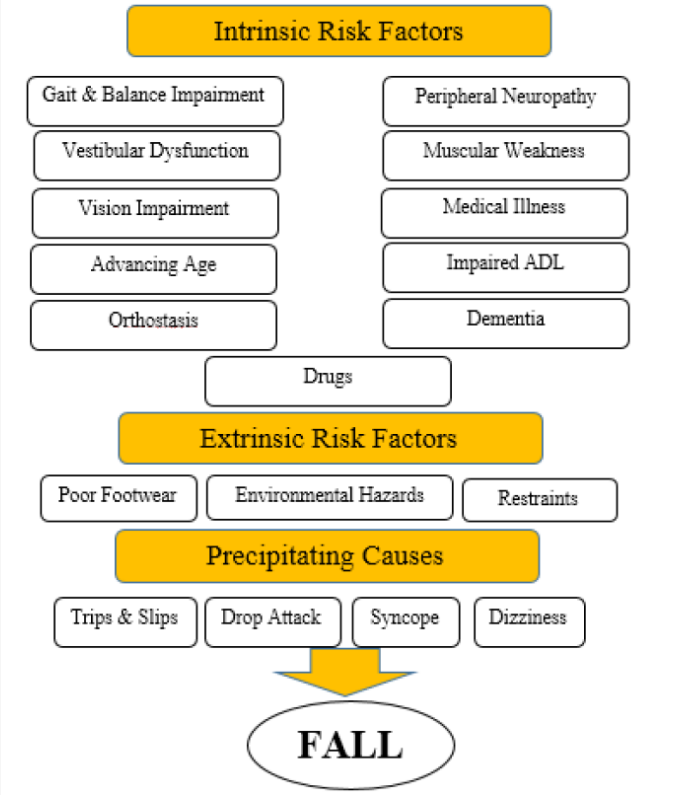


**Figure 1:** The multifactorial and interacting causes of falls.

So muscle imbalances lead to movement impairments and ultimately change the motor programming within the CNS. He also noted that chronic musculoskeletal pain is mediated centrally within the CNS. The only way to correct these impairments was to first normalize the peripheral proprioceptive structures (through joint mobilization or soft tissue mobilization), then correct muscle balance, and finally facilitate a correct motor program. He placed emphasis on restoring function of the nervous system through motor re-learning, rather than emphasizing treatment of isolated structural components [10].

The goal of sensorimotor training is to increase proprioceptive input of these three areas, in order to stimulate subcortical pathways and facilitate automatic coordinated movement patterns [11-13].

There is evidence that exercise can prevent falls [5,14] According to Rezende and Miranda found that sensorimotor training reduces the execution time of tasks, as well as improving functional performance in activities of daily living along with help to reduce recurrent falls among community-dwelling older people compared with multifactorial interventions [5,15]. Also Elwishy (2012) founded that; the sensorimotor training was effective in improving static and dynamic balance in multiple sclerosis patients [16].

The purpose of present study was to determine the potential of sensory motor training program exercise as a stand-alone intervention to improve balance and quality of life and prevent falls among community dwelling elderly individuals.

## Methods

### Design

This study was experimental study of 60 subjects aged 60 to 75 older allocated into study group. The institutional ethical committee approval has been obtained.

### Patient selection

Subjects were recruited from geriatric home care. Where explanation of the study including risk and benefits of study were explained to the participants and written inform consent was taken. The mean for age was 68.9 ± 3. The assessment was undertaken by using a standardized protocol and potential risk factors for falls were addressed.

This included assessments for neurological disorders, locomotor diseases, cardiac diseases and vascular diseases and evaluation of medication that might contribute to falls. Patients were included if they have fall history in previous 1 year (1 or 2 falls) and fear of fall measured with the help of Modified Fall Efficacy Scale, in which the score should be fair i.e. 5.

The study excluded subjects who are not able to follow commands, with severe neurological, cardiac and orthopedic conditions. Subjects were added in study group by using purposive sampling technique.

The study was conducted for 2 year from the date of ethical clearance from ethical committee of institution. The assessment was conducted at Baseline, 3 months and 6 months. Assessment included MFES (Modified Fall Efficacy Scale), BBS (Berg Balance Scale) and QoL (Quality of Life) (Figure 2).

### Interventions

Sensory Motor training program (SMT) [5,11-21], were administered to subjects for three times a week for three months and follow-up taken at 6 months. Before treatment 5 minutes warm up exercise was done. After that SMT program administered, which is repeated 3-5 times during a session (45 minutes' session).

Intermittent rest periods given between each set of exercises. At end of training program cool down exercise were performed. While performing each exercise subjects was monitored to avoid risk of fall. It consists of main three components static, dynamic and functional.

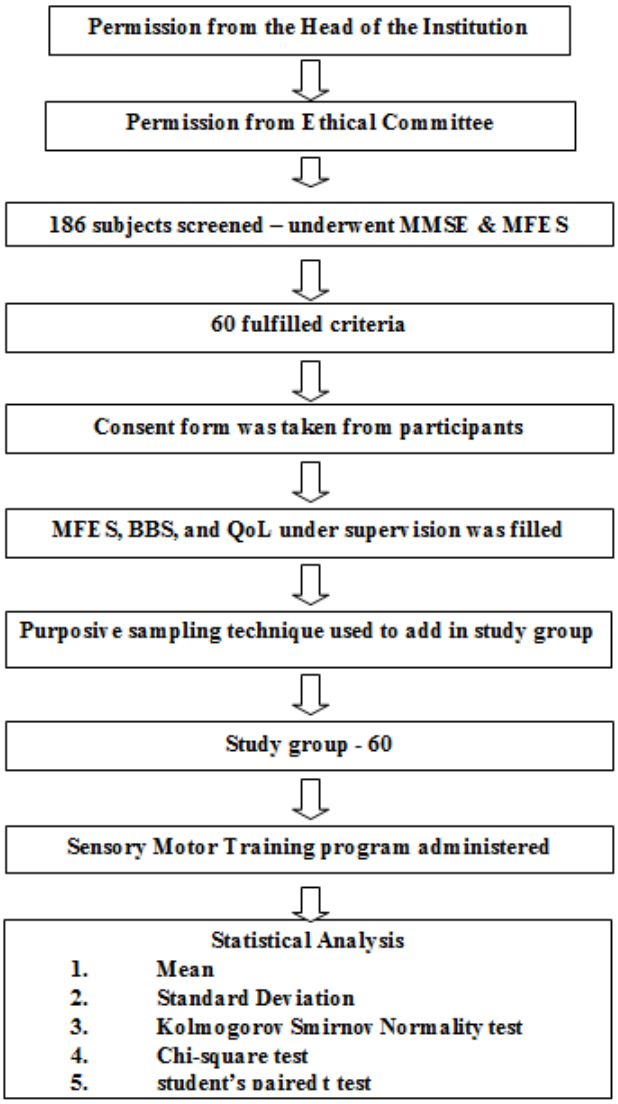


**Figure 2:** Study flow chart

### A. Warm up

1. 5 minutes walking

2. Light stretching: Hamstring stretch, gluteus maximus and hip flexor stretch, gastrocnemius and soleus stretch, paraspinal stretch (5 repetitions and 10 seconds hold).

### B. Static

**Standing upright position:** Asked participant to stand with feet together on firm (Hard) surface for 30 seconds and then perform the same on soft (Foam) surface (Figure 3).

**Single leg stance with closed eyes:** Asked the participant to stand with right leg with closed eyes on firm surface for 10 seconds and then perform the same with left leg. And perform the same on soft surface (Figure 4).

**Half-step position for 10 sec:** Asked the participant to stand in half step position for 10 seconds with right leg and then perform the same with left leg (Figure 5).

**One-leg balance for 10 sec:** Asked the Participant to stand on right leg with open eyes on firm surface for 10 seconds and then perform the same with left leg. And perform the same on soft surface (Figure 6).

### C. Dynamic

**Forward stepping lunge:** Asked the participant to stand upright in good posture and slowly leans forward from the heels. When the weight has perceptually shifted forward, and the heels begin to lift, one leg steps forward as in a lunge. As heel strikes, the patient should attempt to quickly stabilize the body, so no further forward movement occurs (Figure 7).

### D. Functional

**Wobble board double leg stand:** Asked the participant to stand on wobble board with feet together, eyes open. Then to reach and catch ball, the ball should be held at different positions and then perform the same with eyes closed without reach out (Figure 8).

### E. Cool down

1. 5 minutes walking

2. Light stretching: Hamstring stretch, gluteus maximus and hip flexor stretch, gastrocnemius and soleus stretch, paraspinal stretch (5 repetitions and 10 seconds hold).

(A+B+C+D+E=Total treatment session, 45 minutes)

## Sensory motor training program figures

### Static component

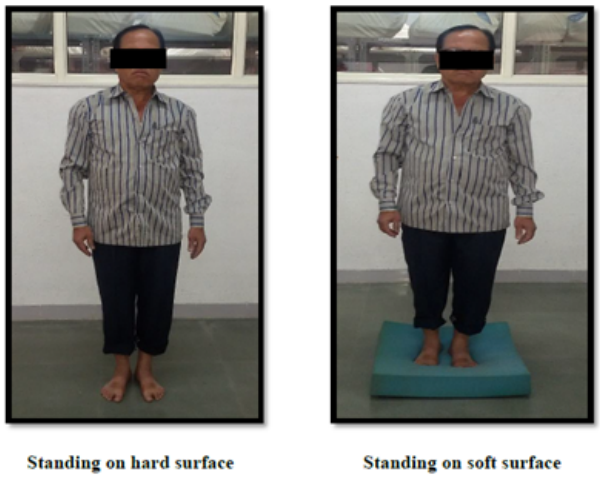


**Figure 3:** Standing upright position.


**Figure 4:** Single leg stance with closed eye.


**Figure 5:** Half step position.


**Figure 6:** Single leg stance position with open eye.

## Dynamic component


**Figure 7:** Forward stepping lunge.

Asked the participant to stand upright in good posture and slowly leans forward from the heels. When the weight has perceptually shifted forward, and the heels begin to lift, one leg steps forward as in a lunge.

As heel strikes, the patient should attempt to quickly stabilize the body, so no further forward movement occurs (Figure 7).

### Functional component

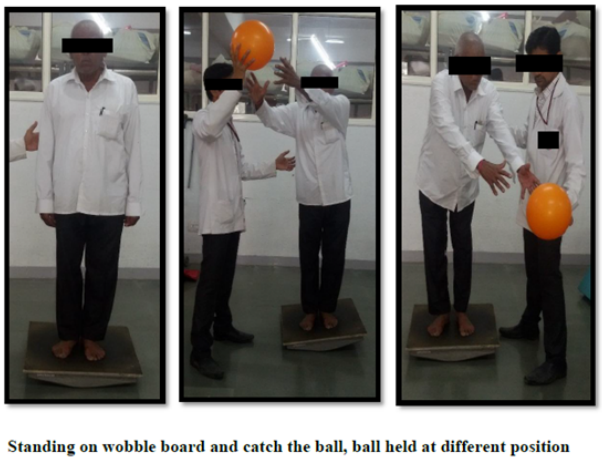


**Figure 8:** Wobble board and catch the ball, ball held at different positions.

Asked the participant to stand on wobble board with feet together, eyes open. Then to reach and catch ball, the ball should be held at different positions and then perform the same with eyes closed without reach out (Figure 8).

### Data analysis

Statistical analysis was performed by using SPSS for the windows evaluation version 21.0 and GraphPad 6.0 version. And $p<0.05$ is considered as level of significance ($p<0.05$). Data were presented as mean and standard deviation (SD). Differences within group were assessed by using student's t-test. The degree of association between MFES, BBS and QoL at baseline, 3 months and 6 months was measured.

## Results

There was significant difference in demographic data and between baseline, 3 months and 6 months ($p<0.05$), as shown in Table 1.

### Effect of sensory motor training

As shown in Table 2 and Figure 9; regarding changes in fall, Table 2 and Figure 10; regarding changes in balance Table 3 and Figure 11; regarding changes in Quality of life measures when comparing at baseline, 3 months and 6 months' scores, which is statistically significant in study group.

| Variable | N | Mean | Std. Deviation | Min | Max | z-value | p-value | Test Distribution |
|---|---|---|---|---|---|---|---|---|
| Age | 60 | 68.9 | 3 | 65 | 75 | 1.02 | 0.22, NS | Normal |
| BMI | 60 | 25.01 | 3.35 | 17.36 | 33.73 | 0.67 | 0.75, NS | Normal |
| MMSE | 60 | 25.95 | 1.44 | 24 | 28 | 1.12 | 0.16, NS | Normal |
| Fall in previous year | 60 | 1.41 | 0.49 | 1 | 2 | 2.96 | 0.0001, S | Normal |
| S-Significant; NS-Not significant | | | | | | | | |

**Table 1:** Demographic data.

| Variables | No. of Fall | Percentage |
|---|---|---|
| **Age Group** | | |
| 65-69 | 44 | 47% |
| 70-75 | 50 | 53% |
| **Gender** | | |
| Male | 44 | 47% |
| Female | 50 | 53% |

**Table 2:** Age group and gender wise fall distribution.


**Figure 9:** Age group wise distribution.

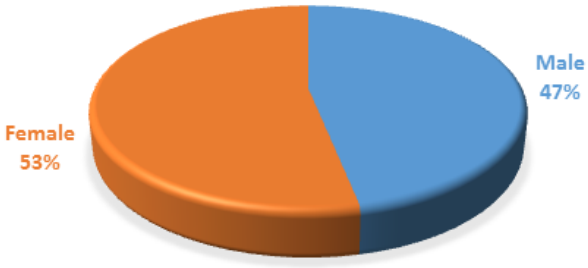


**Figure 10:** Gender wise fall distribution.

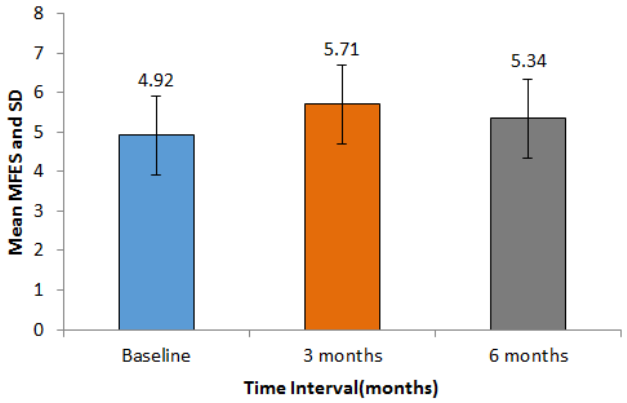


**Figure 11:** Comparison of MFES at baseline, 3 months and 6 months follow-up.

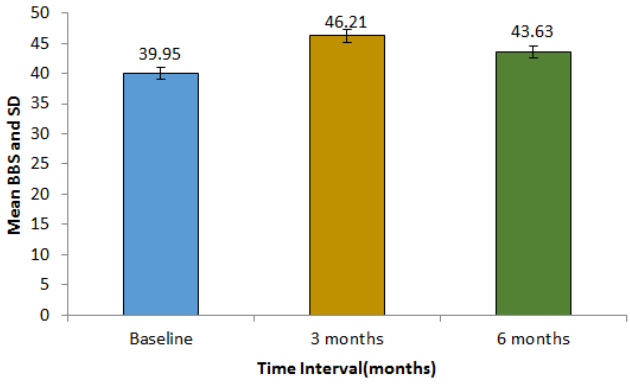


**Figure 12:** Comparison of BBS at baseline, 3 months and 6 months follow-up.

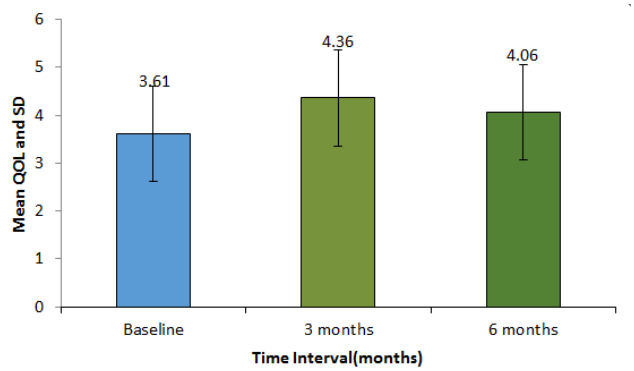


**Figure 13:** Comparison of QoL at baseline, 3 months and 6 months follow-up.

| Time Interval | Mean | N | Std. Deviation | Std. Error Mean | t | P-value |
|---|---|---|---|---|---|---|
| **Modified fall efficacy scale (MFES)** | | | | | | |
| Baseline | 4.92 | 60 | 0.39 | 0.05 | 19.04 | 0.0001, S |
| 3 months | 5.71 | 60 | 0.53 | 0.06 | 10.79 | 0.0001, S |
| 6 months | 5.34 | 60 | 0.51 | 0.06 | 17.29 | 0.0001, S |
| **Berg balance score (BBS)** | | | | | | |
| Baseline | 39.95 | 60 | 6.32 | 0.81 | 14.83 | 0.0001, S |
| 3 months | 46.21 | 60 | 4.66 | 0.6 | 10.7 | 0.0001, S |
| 6 months | 43.63 | 60 | 5.1 | 0.65 | 16.33 | 0.0001, S |
| **Quality of life** | | | | | | |
| Baseline | 3.61 | 60 | 0.46 | 0.06 | 16.8 | 0.0001, S |
| 3 months | 4.36 | 60 | 0.42 | 0.05 | 10.9 | 0.0001, S |
| 6 months | 4.06 | 60 | 0.4 | 0.05 | 16.16 | 0.0001, S |
| S-Significant | | | | | | |

**Table 3:** Modified fall efficacy scale, Berg balance score and Quality of life.

## Discussion

From a prevention or health promotion perspective, this is an important group to target, as many older people do not seek health professional advice until serious injury has resulted from a fall. Assessment and intervention at a stage when balance dysfunction is mild to moderate may prevent this group from progressing to having a serious fall. In addition to potential benefits in preventing falls,

improved balance reduces fear of fall and improving quality of life which are likely to have a positive impact on community dwelling elderly individuals function and independence. Importantly, three of the significant outcomes of this targeted sensory motor training exercise program are an increased level of physical activity, which can lead to a range of other health benefits in elders [22].

Falls are one of the major problems in elderly and considered one of the "Geriatric Gaints". In this study, we have taken history of fall in previous year (mean for fall 1.4 ± 0.5). This shows poor physical and cognitive status of community dwelling elderly individuals. Similarly, according to [23], concluded that recurrent falls are an important cause of morbidity and mortality in elderly individuals and which are a marker of poor physical and cognitive status. As the population ages, such problems are expected to grow and pose an even greater challenge to the health care systems. A majority of falls are predictable and therefore potentially preventable. Similarly, Alok Kumar [24] said that, several risk factors for falls in elderly have been identified from previous studies, including muscle weakness, impaired balancing abilities impaired walking ability, impaired daily movements and impaired postural control in the presence of external disturbances.

In this study, according to fall history, we found that as age increases, frequency of falls also increases (Table 2 and Figure 10). Similarly [25], he concluded that as the age increases the rate of fall also increases and which leads to falls related injuries.

In this study, the frequency of fall is more in females as compared to male (Table 2 and Figure 11). Similarly, according to Stevens et al. [26] they found that quantified gender differences in non-fatal, unintentional fall related injuries among adults, who aged 65 years' older individuals. The extent of these differences was striking. Women sustained fall related injury rates 40–60% higher than men of comparable age. Hospitalization rates for women fall injuries were about 81% higher than men's, suggesting that women sustained more severe injuries. Hence women live longer than men and typically marry men older than themselves. Therefore, virtually all countries have higher numbers of older women than men.

While comparing BBS score between baseline and 3 months, baseline and 6 months follow up and 3 months and 6 months follow up, the p value is 0.0001, which was statistically significant (Table 3 and Figure 12). Similarly, Ahmed [18] found improvement in balance in older adults with osteoarthritis (OA) of knee, he concluded that sensorimotor training is traditional strengthening and stretching exercises could provide more motor control and help neuromuscular restoration of balance and subsequently improve the functional level of OA patients. Also, the close association between balance and functional level should be kept in mind during rehabilitation of knee OA.

According to Douris et al. [27] who found that BBS score is improved by Land exercises (balance). Lower body activity is effective in increasing balance outcomes as determined by using the BBS.

According to Iglesias et al. [28] there were significant improvements in postural sway when subjects stood on both soft and hard insoles compared with standing barefoot, with more pronounced improvements when a hard insole was used. Providing increased sensory inputs with hard insoles may be an inexpensive and effective way to reduce fall risk in older adults.

Balance training i.e. Sensory motor training enhances the ability to sense the joint position in space it improves mental and neural functioning and balance. It also trains central nervous system and sensory receptors to be more receptive to muscular length/tension relationships, weight shifts and range of motion [18,29].

Here the sensory motor training improves balance and reduces fall risk. The same result found by the Shumway-Cook, et al. [30] that exercises can improve balance and mobility function and reduce the likelihood of falls among community dwelling elders with history of fall. Johansson et al. [31] concluded that healthy women aged 70 years are able to improve their balance, both when standing and walking with exercises.

While comparing the MFES score between baseline and 3 months, baseline and 6 months follow up and 3 months and 6 months follow up, the p value is 0.0001, which was statistically significant (Table 3 and Figure 13). Similarly, according to Adsuar et al. [32] concluded that the balance training program was feasible and effective in reducing fear of falling and improving dynamic balance and isometric strength in institutionalized older people with fear of falling.

This study shows that, the sensory motor training program affects proprioception more than classic traditional exercise program as sensory motor training program improves sensory input to central nervous systems thus improving sensory motor function of sacroiliac joint, knee joint and ankle joint. Kinesthesia and balance training were reported to improve proprioception and functional performance of elderly patients and helps to reduce fall risk [11-13,15,30].

According to Miranda et al. [15] they found significant improvement in reduction in task execution which is related to functional performance in activity of daily living along with they also found reduction in fear of fall by using sensorimotor training.

While comparing the QoL score between baseline and 3 months, baseline and 6 months follow up and 3 months and 6 months follow up, the p value is 0.0001, which was statistically significant (Table 6 and Figure 13). This simply designed sensory motor training program exercise affects quality of life (QoL) in physical, social, personal development, recreational activities and mental health dimensions and helps to improve these domains. The results in this study showed the benefits of SMT program in decreased fall rates, and increased QoL. This study was in line to that of Lin et al. [33], who reported that QoL scores in an exercise group of elderlies with recent falls was greater than in those in an education group or a home safety assessment and modification group. He found improvement in creativity and personal development, physical and psychological domains.

Similarly, according to Kuptniratsaikul et al. [5] they found that a simply-designed balancing exercise program, performed at least 3 days per week, can increase balancing abilities, decrease fall rates and improves quality of life in the elderly with history of previous falls.

The probable explanation to this can be improvement in reaction time, strengthening, endurance, risk-taking ability, increase level of confidence with balance exercise. Thus, these may help in improving the Functional mobility, balance and reduces fear of fall ultimately. Similar result found by Laurence. Rubenstein et al. [34] that exercises can improve endurance, strength, gait and function in chronically impaired, fall prone elderly person along with quality of life. In addition, increased physical activity associated with reduced fall rates when adjusted for level of activity.

The community dwelling elderly individuals may become more independent with the help of simple Sensory Motor Training program which improves balance, reduces fear of fall, and improves quality of

life and preventing the fall. So ultimately this reduces financial burden on family and caregiver.

## Conclusion

It was concluded that, Effect of sensory motor training program shown improvement in balance, reduction in fear of fall, improves quality of life and also helps to prevent fall in community dwelling elderly individuals with history of fall.

This sensory motor training program has shown long lasting effect, up to 6 month of follow up in community dwelling elderly individuals.

## Future Scope of Study

As it is known that age related loss of balance may cause life threatening injuries and loss of independence, preventive measures like sensory motor training or strengthening exercises or other balance training exercises etc. can be a part of balance exercise program in rehabilitation. Future studies could be directed at identifying appropriate pathological groups and patient profiles that would most benefit from a cost-effective exercise program in community level.

## Limitation

Language problem in scale measurement. Difficult to understand exercise program for participants. Recurrence of fall during study was not recorded. Control group was not there.

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