



# The Immediate Effect Of Ankle Mobilization For Improving Balance, Gait Speed And Risk Of Falls In Community Dwelling Elderly People-Quasi Experimental Study

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## Abstract

**Introduction:** Globally, the population is ageing and the World Health Organisation (WHO) predicts that, by 2050, the population aged 60 years or more will be double and those aged 80 years or more will number 400 million persons. Ankle mobilization and calf stretching has proved to increase the range and has positive effect on balance, gait speed and risk of fall.

**Aim:.** To see the immediate effect of ankle joint mobilization on balance, gait speed and risk of falls in community dwelling elderly persons.

**Study design:** Quasi experimental study.

**Study setting:** Senior Citizen Club, Old Age Home

**Study population:** Patient Aged 60 and more, Both genders.

**Sample size :** 40

**Outcome Measures:** Body Sway Meter , 10-Meter Walk Test , Time Up and Go Scale, Universal Goniometer , Length Test.

**Procedure:** For the purpose of selecting the subject in the study they were evaluated with the Body Sway Meter, 10 meter walk test and Time up and Go Test. Ankle ROM was measured with universal goniometer. Mobilization, Distraction, anterior gliding, posterior gliding of talocrural joint was performed for 30 sec. for each mobilization. Mobilization is performed at Grade3 while the subjects where in supine position. For the

tightness of gastrocnemius and soleus muscles active stretching was given to the subjects – 3 sets with 30 sec. hold.

Result: The result were analysed by using Paired t test, Statistical analysis was performed using the all Data were expressed as mean  $\pm$  standard deviation (SD). The results were analyzed by using 'P' value is  $<0.05$  was considered significant for all cases.

Conclusion: There is significant immediate effect of ankle joint mobilization on balance, gait speed, risk of falls in elderly population.

Keywords ; Balance,Gait,Elderly,Mobilization

## Introduction

Globally, the population is ageing and the World Health Organisation (WHO) predicts that, by 2050, the population aged 60 years or more will be double and those aged 80 years or more will number 400 million persons. This extension of the lifespan is looked upon as a triumph of medical advances, stemming from access to better treatments as well as a focus on preventive therapies<sup>1</sup>.

Ageing causes various structural and functional changes in body which can lead to balance disorders and increases the risk of falls. Structural and functional changes in the foot has been seen which includes deformities, increased soft tissue stiffness, decreased range of motion, and decreased strength, increased risk of falls, reduced joint mobility, reduced gait speed, and less efficient and stable walking, ultimately worsening the quality of life of older individuals<sup>2</sup>.

Joint physiology changes with age, including a decrease in cartilage water content, synovial fluid volume, and proteoglycans. Crosslinking occurs in the collagen fibres of cartilage, resulting in increased stiffness. These changes could explain why elderly adults have a restricted range of motion in their lower extremity joints<sup>3</sup>. A study by Chiara Mecagni, Janet et.al (2000) indicated a direct relationship between Dynamic balance and a low range of motion in joints. Reduced range of motion results from the tissues around the joints, particularly in the lower extremities, which affect the dynamics of this muscle in walking and increases the risk of falling<sup>4</sup>

As stated by vaillat J. et.al, a decline in balance in elderly is linked to an increase in elderly falls as they get older<sup>[5]</sup>. Aging is associated with declining balance. More specifically as task difficulty rises through attenuation of sensory feedback the balance disorders increases. Balance is the result of this multimodal

function involving vision, the vestibular system, brain and proprioception. Balance refers to the ability to retain the body's centre of mass (COM) within the confines of the base of support.

The ankle joint controls the contact between the feet and the ground, and every movement in the ankle is important to maintaining balance during walking. Because of their incapacity to recover from a loss of balance, elderly people frequently experience fatal or disabling falls<sup>[6]</sup>. As stated by Seong-Gil Kim, ankle joint ROM is crucially important because balance is most frequently controlled in the ankle joint, and the movement of the joint is large. Additionally, the capacity to maintain static balance can be affected by proprioception, which detects joint position and stiffness of non-contractile tissues surrounding joints that are associated to joint stability<sup>7</sup>

Every year, almost one-third of the elderly population of a community falls, and the rates of falling increase with age. Long-term immobility and associated consequences are brought on by falls in the older population. As a result, balance issues in elderly people are an indication of functional deficit. As a result of dynamic postural control, appropriate rehabilitation following the early detection of balance disorders could prevent falls and increase an individual's quality of life<sup>8</sup>. According to Hornbrook et al, fall prevention depends on a clear understanding of the risk factors associated with falls. Falls result from many factors, including both extrinsic or environmental factors and intrinsic factors<sup>4</sup>. As said by VanSwearingen the more frequently a fall or injury connected with a fall occurs, the higher the risk of mortality and morbidity for the older adult<sup>9</sup>. There is a significant association between ankle range of motion, balance and increased fall risk<sup>10</sup>.

Nowadays, it has been clearly established that ankle joints and plantar sole play a determining role in balance and gait<sup>[6]</sup>. As stated by Wontae Gong every movement in the ankle is related to maintaining balancing during walking, and the ankle joint also controls the interaction between feet and the ground. Therefore, ankle movement is an essential component of walking and maintenance of equilibrium<sup>11</sup>. According to salzman(2010), the most common causes of falls in older persons are gait speed and balance issues. Early detection and treatment of gait and balance abnormalities can help to prevent dysfunction and loss of independence<sup>12</sup>.

Gait is one of the most basic movements of the human body. It is the result of a series of rhythmic alternating movements of different segments of the body. The maintenance of walking ability is important for older adults

as it provides independence and is necessary to carry out several activities of daily life. Normal aging brings about significant changes in the elderly gait pattern. Age-related gait modifications associated with reduced muscle strength and limited lower-limb joint range of motion as a result of physiological changes. The step length becomes shorter and the walking speed is reduced. These findings show that elderly experience exacerbated declines in the biomechanical parameters of gait associated with their functional worsening. Difficulties in walking can be the precursors of falls, which is the most common cause of serious injuries in older age<sup>13</sup>.

The use of manual therapy has been suggested as a possible treatment to increase joint mobility and restore their arthrokinematics. According to Kaltenborn, joint mobilization can increase the physiologic and accessory movements by increasing the extensibility of the non - contractile capsular and ligamentous tissues and improve the transmission of afferent information by stimulating the joint mechanoreceptors<sup>[14]</sup>. Manual therapy has been proposed as a possible treatment to improve the mobility and restore arthrokinematics of joints. The approach consists of the application of forces in the form of rhythmic oscillations in articulated segments of the body. In the case of the ankle joint, the limitation of dorsiflexion movement is commonly related to anterior displacement of the talus and reduced capacity for posterior sliding, so the technique is based mainly on talus mobilizations in the anteroposterior direction. Mobilizations can be categorized according to the degree of intensity and aspects such as the oscillatory frequency and duration of treatment<sup>15</sup>.

Muscle tightness is a common motor system component that impacts gait speed and balance. It occurs when a muscle's ability to contract and relax decreases, resulting in narrower ranges of motion for the acting joint than normal and decreased muscle length, limiting movement in the direction of extension<sup>16</sup>. Muscle tightness in the legs, in particular, is frequently observed in the calf consisting of muscles that pass more than two joints, as a result, it negatively affects gait and balance and is also accompanied by proprioceptive sensory problems

16

Functional problems brought on by muscle tension, which increases the risk of injury to muscles and tendons and restricts joint motion. Due to calf tightness, the ankle's reduced range of motion for dorsiflexion makes it difficult to maintain the centre of mass in the weight-bearing position. This compensatory movement in the ankle causes leg deformation. <sup>16</sup>.

Stretching can alter muscle stiffness, muscle length, and joint range of motion, therefore it's logical to believe that it can impact proprioception and consequently balance. Stretching is frequently used to lengthen muscles, increase range of motion (ROM) around joints, and, in the elderly, enhance balancing performance. To keep equilibrium, the musculoskeletal system must function normally. Aging causes the stiffness around the joints to increase, which reduces flexibility. Flexibility is based on the viscoelasticity of the muscles, ligaments, and other connective tissues. Muscle flexibility must be sufficient to maintain proper balance. In the aged, increased joint stiffness may be detrimental to balance<sup>17</sup>. With the knee extended, gastrocnemius stretching exercises are commonly used to increase ankle DF PROM. Because of increased tolerance to stretching, changes in sensation, and changes in the anatomy of the gastrocnemius muscle-tendon unit, especially in the displacement of the gastrocnemius myotendinous junction (MTJ), gastrocnemius stretching workouts result in greater ankle DF PROM with the knee extended<sup>18</sup>.

Restriction in ankle range of motion and stiffness of gastrocnemius –soleus muscles has been found in older adults. Ankle mobilization and calf stretching has proved to increase the range and has positive effect on balance, gait speed and risk of fall, so the present study focuses on immediate effect of talocrural joint mobilization and calf muscles stretching on balance, gait speed and risk of fall in community dwelling elderly adults.

### **Need of the study**

The loss of functional qualities at the cellular, tissue, and organ level is referred to as ageing. This loss of functional characteristics results in a loss of homeostasis and a reduced ability to adjust to internal and external stress, increasing disease vulnerability and mortality<sup>20</sup>. As stated by Grimmer M, Riener R in today's culture, the number of persons aged 60 and up is rapidly increasing. Every year, over one-third of the older individuals in a community die, and the rates of death are increasing with age<sup>21</sup>. In the health of senior people, balance and gait speed are essential factors<sup>19</sup>. Gait speed and balance issues are widespread in the elderly, and they are a leading cause of falls in this group. They are associated with increased morbidity and mortality, as well as reduced level of function<sup>7</sup>. Falls have been linked to problems with balance and gait. The annual prevalence of falls among persons aged 65 and older is estimated to be 28%. According to Osoba MY, Rao AK(2019) falls are the most prevalent cause of accidental death and nonfatal unintentional injury among the elderly, and they are associated with high morbidity and mortality<sup>19</sup>. Chevutschi et.al(2015) had done a study on ankle mobilization to increase

balance in elderly population similarly Gong et.al (2011) had done a study on ankle joint mobilization for improving equilibrium in elderly women's, Studies has also been made on effect of stretching to increase ROM thus improves functional balance, but no studies has been made on immediate effect of ankle joint mobilization on balance, gait speed, and risk of fall in elderly. In rural areas people are not aware of calf stiffness and range of motion of ankle joint thus they have poor balance, and increased risk of fall. So the present study may be useful for improving the activity of daily living in the form of gait speed, balance, as well as to decrease risk of falls by giving stretching & ankle joint mobilization

## Aim & Objectives

**Aim:** To see the immediate effect of ankle joint mobilization on balance, gait speed and risk of falls in community dwelling elderly persons

### Objectives:

- To find out immediate effect of ankle joint mobilization and Gastrocnemius-Soleus stretching on balance in elderly people measured using body sway meter.
- To find out immediate effect of ankle joint mobilization and Gastrocnemius-Soleus stretching on gait speed in elderly measured using 10 meter walk test.
- To find out immediate effect of ankle joint mobilization and Gastrocnemius-Soleus stretching for decreasing fall risk in older population using time up and go test.

## Methodology:-

Ethical clearance: Ethical committee approval was obtained before the commencement of the study.

Study design: Quasi experimental study.

Study setting: Senior Citizen Club, Old Age Home

Study population: Patient Aged 60 and more

Both genders.

Study duration: 1 ½ years.

Sample size:

**Variables:****Dependent:**

1. Balance
2. Gait speed
3. Risk of fall

**Independent:**

1. Mobilization

**Inclusion Criteria:**

1. Community dwelling elderly individuals with more than 60 years of age.
2. Decreased ankle ROM.
3. Tight gastro-soleus muscles – [ Using Length test values: For Soleus muscle -  $<20^\circ$  gastrocnemius muscle is  $<10$  degree<sup>23</sup>]
4. Elderly with mini mental score  $\geq 25$ .
5. Subjects walking for atleast 10 meters with/without assistance.

**Exclusion Criteria:**

- Elderly individuals having the following;
1. Cognitive impairment.
  2. Current history of dislocation of lower limb.
  3. Fractures of lower limb, within 6 months prior to inclusion.
  4. Neurological disorders.
  5. Malignancy.
  6. Bone diseases.
  7. Excessive pain
  8. Hypermobility of ankle joint.
  9. Recent injury to ankle joint.

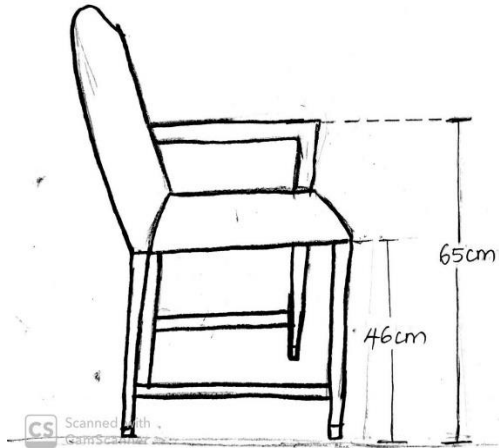


## Procedure

**Recruitment of samples:** Samples were recruited according to inclusion and exclusion criteria.

### Material used:

1. **Armrest Chair** : For Self stretching of Soleus muscles.

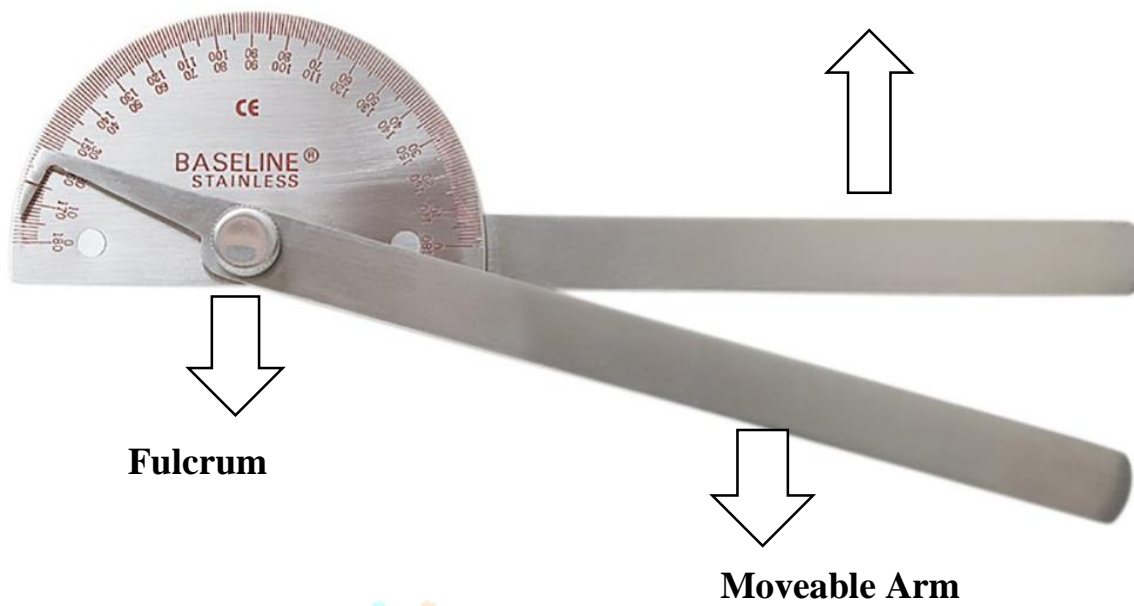


2. **Stretching belt:** Used for stretching of Gastrocnemius and soleus muscles.



3. **universal goniometer:** For checking range of motion of ankle joint.



**Stationary Arm**

4. **Metal couch:** Used for assessment and treatment of patients.



5. **stabilizing belt:** Used to stabilize lower leg while giving maitland joint mobilization.



6. **Turkish Towel:** Used while treating mobilization to avoid ankle injury.



7. **Body Sway Meter:** Used to check functional balance.



**8. Stop watch:** Used for recording time for TUG Test and Gait speed.



**9. Inclined board:** Used for checking tightness of gastrocnemius muscle.



**Inclined at 10 degree**

## Evaluation:

- Instructions were given to the participants about study and its benefits and risk in their own language.
- Consent was taken from participants.
- The participants were selected on basis of inclusion and exclusion criteria.
- For the purpose of selecting the subject in the study they were valuated with the Body Sway Meter, 10 meter walk test and Time up and Go Test. Ankle ROM was measured with universal goniometer.
- Maithland Mobilization, Distraction, anterior gliding, posterior gliding of talocrural joint was performed 30 sec. for each mobilization. Mobilization was performed at Grade3 while the subjects where in supine position.<sup>24</sup>



Starting position for mobilization

- **For Distraction:** The resting position was 10 plantarflexion.

Treatment Plane- The treatment plane was in the mortise, in an anteriorposterior direction with respect to the leg.

Stabilization- The tibia was strapped or held against the table<sup>24</sup>





### Giving Distraction

- **Talocrural Dorsal (Posterior) Glide:** Patient Position Supine, with the leg supported on the table and the heel over the edge.
- Therapist Position and Hand Placement Stand to the side of the patient. Stabilize was given to leg with cranial hand or a belt to secure the leg to the table and the palmar aspect of the web space of other hand over the talus just distal to the mortise. Wrap fingers and thumb around the foot to maintain the ankle in resting position. Grade I distraction force was applied in a caudal direction.

Mobilizing Force Glide the talus posteriorly with respect to the tibia by pushing against the talus<sup>24</sup>

Reference: Kisner C, Colby LA, Borstad J. Therapeutic exercise: foundations and techniques. Fa Davis; 2017 Oct 18.



Giving Posterior Glide

### Talocrural Ventral (Anterior) Glide:

Patient Position Prone, with the foot over the edge of the table.

Therapist Position and Hand Placement Working from the end of the table, placing lateral hand across the dorsum of the foot to apply a grade I distraction, the web space of other hand just distal to the mortise on the posterior aspect of the talus and calcaneus.

Mobilizing Force Push against the calcaneus in an anterior direction (with respect to the tibia); this glides the talus anteriorly<sup>24</sup>.

Reference: Kisner C, Colby LA, Borstad J. Therapeutic exercise: foundations and techniques. Fa Davis; 2017 Oct 18.



Giving Anterior Glide

- The data was collected and analysed.
- For the tightness of gastrocnemius and soleus muscles active stretching was given to the subjects.
- **Gastrocnemius muscle self- stretching:** While the subject was in long sitting position with a towel or stretching belt positioned around the forefoot, he/she was instructed to actively dorsiflex the talocrural joint and then apply graded overpressure into dorsiflexion direction using the towel

Reference: El-Kader SM. Impact of ankle joint mobility on balance performance in elderly type 2 diabetic subjects. *MOJ Gerontol Ger.* 2018;3(2):00082.





Gastrocnemius muscle self- stretching

- **Soleus muscle self-stretching:** While the subject was in sitting position at the edge of the bed with a towel or stretching belt positioned around the forefoot, he/she was instructed to actively dorsiflex the talocrural joint and then applies graded overpressure into dorsiflexion direction using the towel .

Reference: El-Kader SM. Impact of ankle joint mobility on balance performance in elderly type 2 diabetic subjects. *MOJ Gerontol Ger.* 2018;3(2):00082.



Soleus muscle self- stretching

- The data was collected and analysed.

#### Outcome Measures:

1. **Body Sway Meter** – To check the functional balance in elderly adults.
2. **10-Meter Walk Test** – To assess the Gait Speed in elderly adults.
3. **Time Up and Go Scale** – To assess risk of fall in elderly adults.
4. **Universal Goniometer** – To check Range of Motion of ankle joint.
5. **Length Test** – To assess tightness of Gastrocnemius and Soleus Muscles.

## Body Sway Meter:

- The sway meter is a useful field test, as it is compact, lightweight, has short administering and data processing time. Thus, assessment can be conducted in variety of community settings and health care facilities.
- Several research groups have found the sway meter to be feasible for use in different populations of young and older people.
- It is a self-made instrument which is made up of with firm belt and 40 cm rod which is attached to it. Firm belt tie over the level of PSIS (posterior superior iliac spine) and that 40 cm rod with the pen attached to it.
- Normally postural sway are seen anterior, posterior, right, and left. According to Lord and Sherrington's study<sup>22</sup>.

Reference: Ramachandran S, Yegnaswamy R. Measurement of postural sway with a sway meter-an analysis. J Phys ther. 2011;2:46-53.

**10-Meter Walk Test:** Individual walks without assistance 10 meters (32.8 feet) and the time is measured for the intermediate 6 meters (19.7 feet) to allow for acceleration and deceleration

- Start timing when the toes of the leading foot crosses the 2-meter mark o stop timing when the toes of the leading foot crosses the 8-meter mark o assistive devices can be used but should be kept consistent and documented from test to test
- If physical assistance is required to walk, this should not be performed can be performed at preferred walking speed or fastest speed possible
- Documentation should include the speed tested (preferred vs. fast) collect three trials and calculate the average of the three trials.

Reference: Bohannon, R. W. "Comfortable and maximum walking speed of adults aged 20-79 years: reference values and determinants." Age Ageing 1997 26(1): 15-19



**Length Test:**

**For Soleus muscles:** Sit forward in a chair with knees bent and feet pulled back toward chair enough to raise the heels slightly from the floor. Press down on thigh to help force heel to the floor.

Normal ROM for soleus is 20 degree<sup>23</sup>.

Reference: Kendall FP, McCreary EK, Provance PG, Rodgers M, Romani WA. Muscles: testing and function with posture and pain. Baltimore, MD: Williams & Wilkins; 1993.

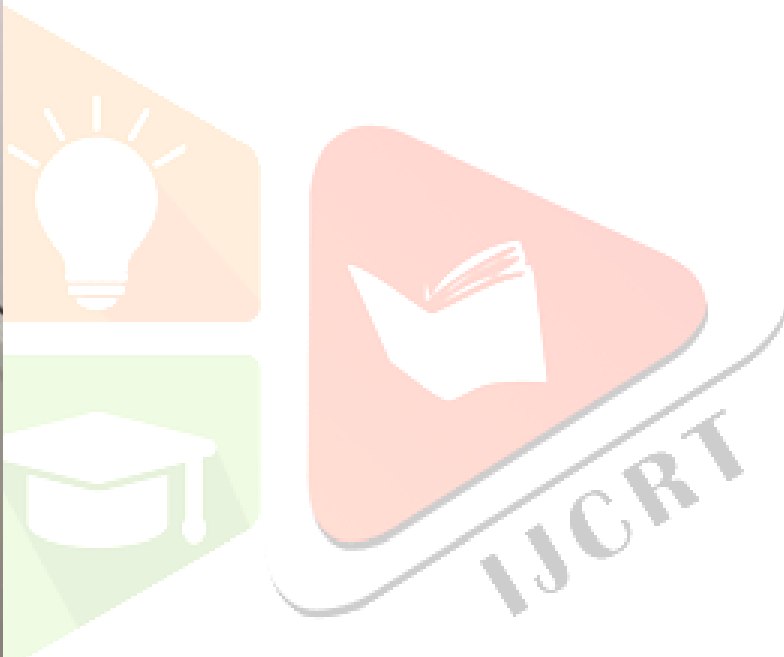


**For Gastrocnemius muscles:** Stand erect on board inclined at a 10° angle, with feet in approximately 8° to 10° of outtoeing<sup>23</sup>.



Normal ROM for gastrocnemius muscle is 10 degree<sup>23</sup>.

Reference: Kendall FP, McCreary EK, Provance PG, Rodgers M, Romani WA. Muscles: testing and function with posture and pain. Baltimore, MD: Williams & Wilkins; 1993.



**6. Mini-Mental State Examination (MMSE):** It is a set of 30 questions that to check for cognitive impairment . The MMSE test consists of a series of tasks such as:

- memorising a short list of objects and then repeating the list back
- writing a short sentence that is grammatically correct, such as "The dog sat on the floor"
- correctly identifying the current day of the week, followed by the date, the month, the season and the year.

The maximum score for the MMSE is 30. A score of 25 or higher is classed as normal. Impairment may be classified as follows:

- mild — MMSE score of between 21 and 24
- moderate — MMSE score of between 10 and 20
- severe — MMSE score of less than 10

Reference: Folstein MF, Folstein SE, McHugh PR "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975 Nov; 12(3):189-98.

## STATISTICAL ANALYSIS

The result was analysed using Graph pad version 3.06,32 bits for window. Descriptive statistics including mean  $\pm$  standard deviation (SD) .The result were analysed by using Paired t test, Statistical analysis was performed using the all Data were expressed as mean  $\pm$  standard deviation (SD). The results were analyzed by using 'P' value is  $<0.05$  was considered significant for all cases.

### Result

The result was analysed using Graph pad version 3.06,32 bits for window. Descriptive statistics including mean  $\pm$  standard deviation (SD) .The result were analysed by using Paired t test , pearsons correlation test , Statistical analysis was performed using the all Data were expressed as mean  $\pm$  standard deviation (SD). The results were analyzed by using 'P' value is  $< 0.05$  was considered significant for all cases.

Table no. 1. Baseline Characteristics (mean $\pm$ SD)

Age	69 $\pm$ 4.7
Height	150.81 $\pm$ 25.04
Weight	51.26 $\pm$ 5.02
BMI	26.4 $\pm$ 2.46



Table no. 2 Age wise distribution.:

Age groups	60-65	66-70	>71
	Mean	Mean	Mean
Male	3	14	04
Female	5	8	06

Table no. 3 Comparison of Pre – post ankle Dorsiflexion ROM:

	Pre(Mean± SD)	Post (Mean± SD)	P value
Dorsiflexion –Right side	13.07 ± 2.51	14.17 ± 2.79	0.0052
Dorsiflexion –Left side	12.95 ± 2.70	14.2 ± 2.75	0.0001

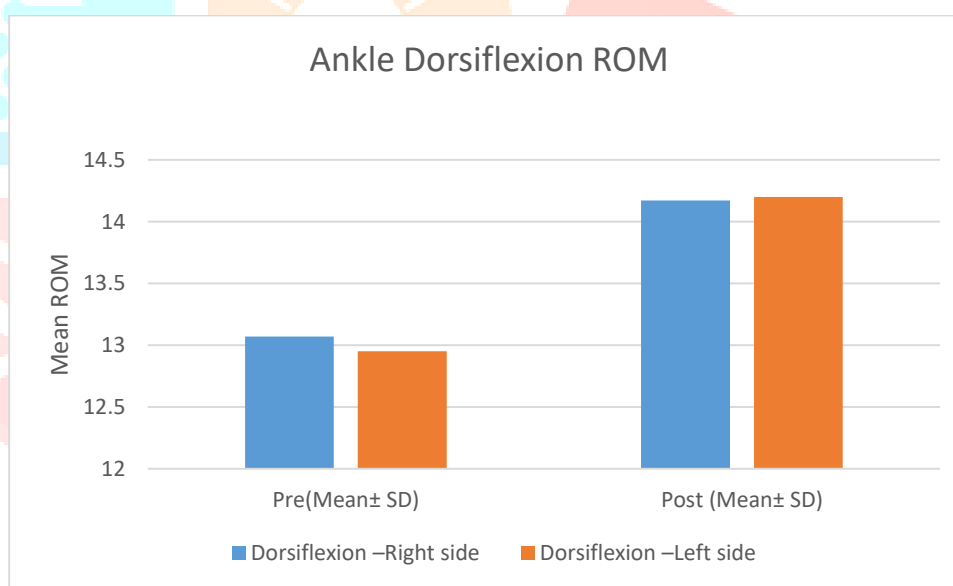


Fig 1. Comparison of Pre – post ankle Dorsiflexion ROM

The graph indicates that there is statistically significant difference observed in ankle dorsiflexion ( $p < 0.05$ ). Left side ankle dorsiflexion is consider extremely significant ( $p=0.0001$  and  $r =0.6712$ ) compared to right side. Their was increase in range by 1.1-1.5 after the post treatment session.

Table no. 4 Comparison of Pre – post ankle plantarflexion ROM :

	Pre(Mean± SD)	Post (Mean± SD)	P value
Plantarflexion –Right side	19.35 ± 9.07	20.97 ± 9.54	0.2455
Plantarflexion –Left side	19.75 ± 9.91	20.95 ± 10.16	0.594

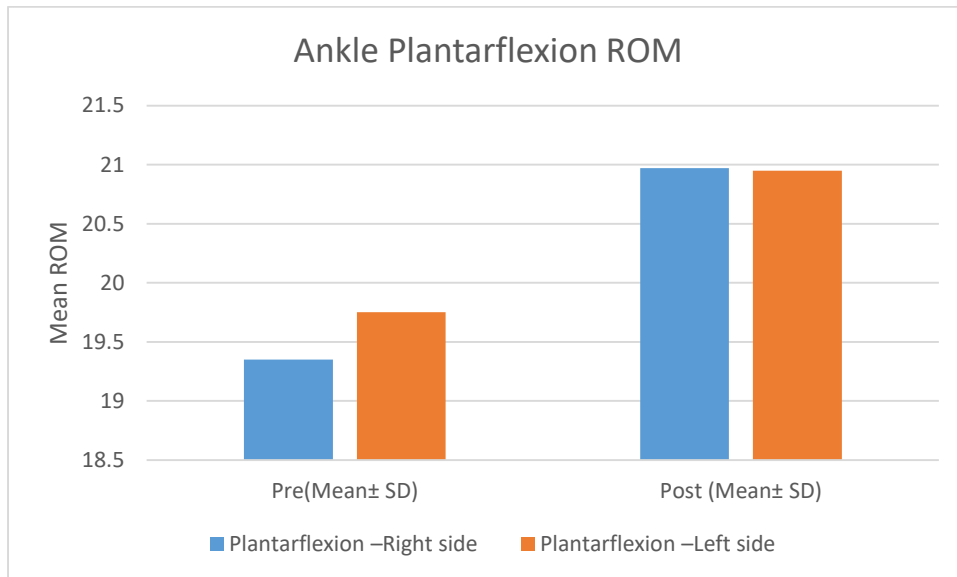


Fig 2. Comparison of Pre – post ankle Plantarflexion ROM

The graph indicates that there is statistically significant difference observed in ankle plantarflexion ( $p < 0.05$ ). There was an increase in range by 1.1-1.5 after the post treatment session.

Table no. 5 Comparison of pre – post Length test – Gastrocnemius:

	Pre(Mean± SD)	Post (Mean± SD)	P value
Right Gastrocnemius	3.77 ± 1.18	2.57 ± 0.74	0.0001
Left Gastrocnemius	2.28 ± 1.10	1.74 ± 1.15	0.004

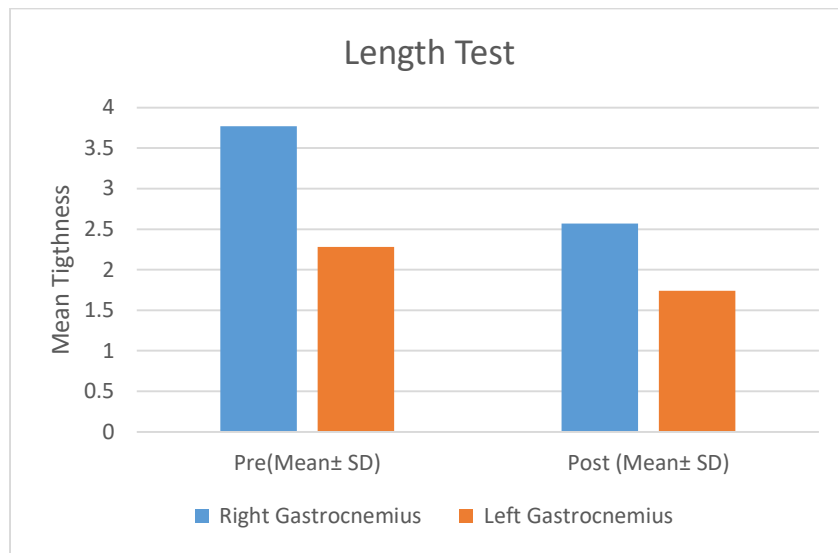


Fig 3.Comparison of Pre – post ankle Plantarflexion ROM

The graph indicates that there is statistically significant difference observed in Gastrocnemius length test after the intervention ( $p < 0.05$ ). There was decrease in stiffness by 0.5-1.5 after the post treatment session.

Table no. 6 Comparison of pre – post Length test – Soleus:

	Pre(Mean± SD)	Post (Mean± SD)	P value
Right Soleus	3.25 ± 1.49	2.52 ± 0.78	0.0016
Left Soleus	3.2 ± 1.2	2.49 ± 0.75	0.002



Fig 4.Comparison of Pre – post Length test – Soleus

The graph indicates that there is statistically significant difference observed in soleus length test after the intervention ( $p < 0.05$ ). There was decrease in stiffness by 0.7-1 after the post treatment session.

Table no. 7 Comparison of Pre-Post Gait speed –Self selected:

Gait Speed-Self Selected	Pre(Mean± SD)	Post (Mean± SD)	P value
	4.225 ± 1.59	4.8 ± 1.63	0.05

Table no. 8 Comparison of Pre-Post Gait speed – Fast selected:

Gait Speed-Fast Selected	Pre(Mean± SD)	Post (Mean± SD)	P value
	5.35 ± 1.44	5.67 ± 1.63	0.41

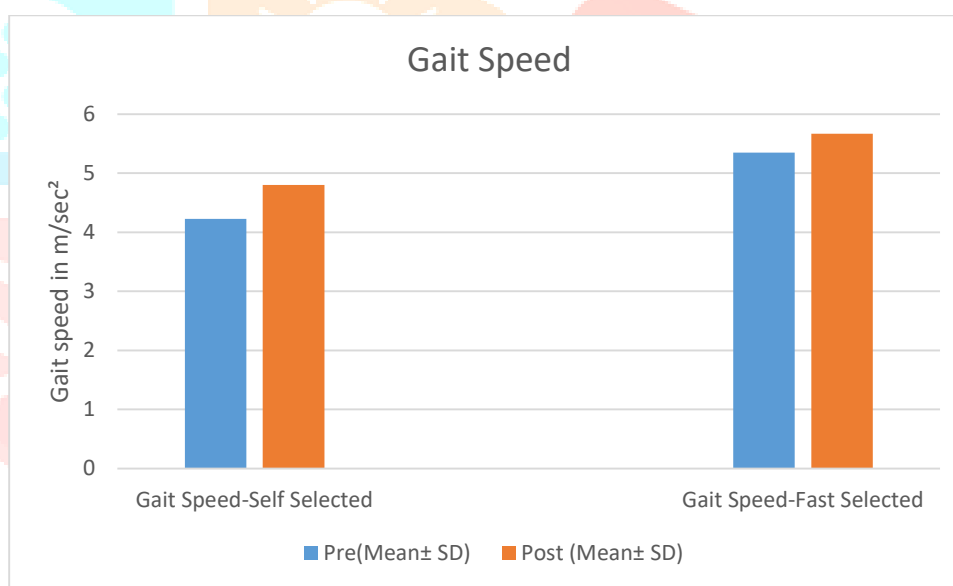


Fig 5.Comparison of Pre – post Gait Speed

The graph shows pre and post values of gait speed which shows increase in self selected and fast selected gait speed with p value 0.05.

Table no. 9 Comparison of Pre –Post functional balance:

Postural Sway with Eyes open	Pre(Mean± SD)	Post (Mean± SD)	P value
Anterior	7.021 ± 1.90	6.52 ± 0.68	0.001
Posterior	1.85 ± 0.63	1.55 ± 0.55	0.068
Right	1.82 ± 0.93	1.78 ± 0.52	0.07
Left	2.29 ± 0.59	1.56 ± 0.47	0.001

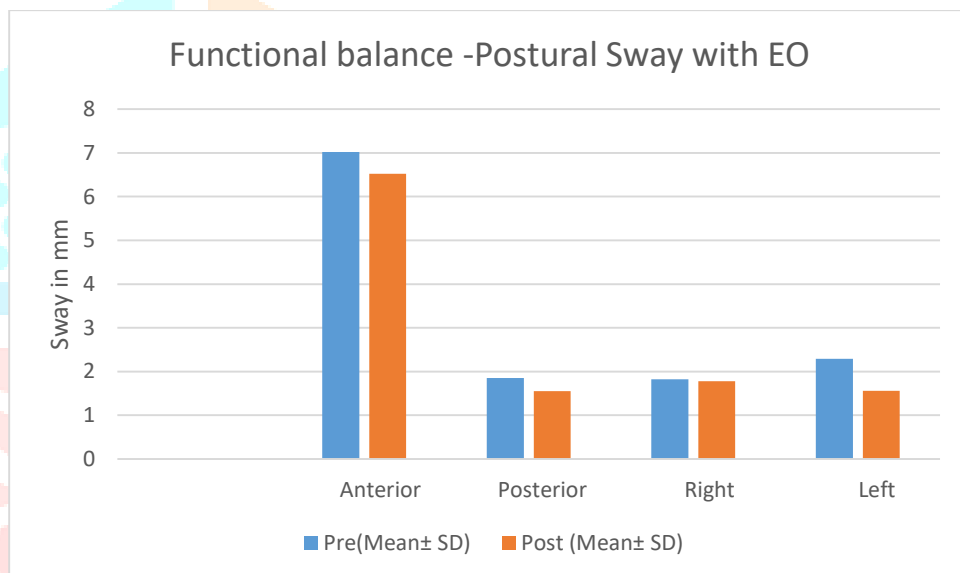


Fig 6. Comparison of Pre – post Functional balance with EO

The graph shows pre, post functional balance with eyes open using sway meter. There was greater improvement in posterior and right side sway with eyes open after the intervention which indicates improvement in Balance.

Table no. 10 Comparison of Pre –Post Functional Balance :

Postural Sway with Eyes Close	Pre(Mean± SD)	Post (Mean± SD)	P value
Anterior	1.97 ± 1.90	1.4 ± 0.68	0.0131
Posterior	1.85 ± 1.02	1.58 ± 0.72	0.001
Right	1.844 ± 0.90	1.7 ± 0.65	0.26
Left	2.27 ± 0.75	1.76 ± 0.64	0.003

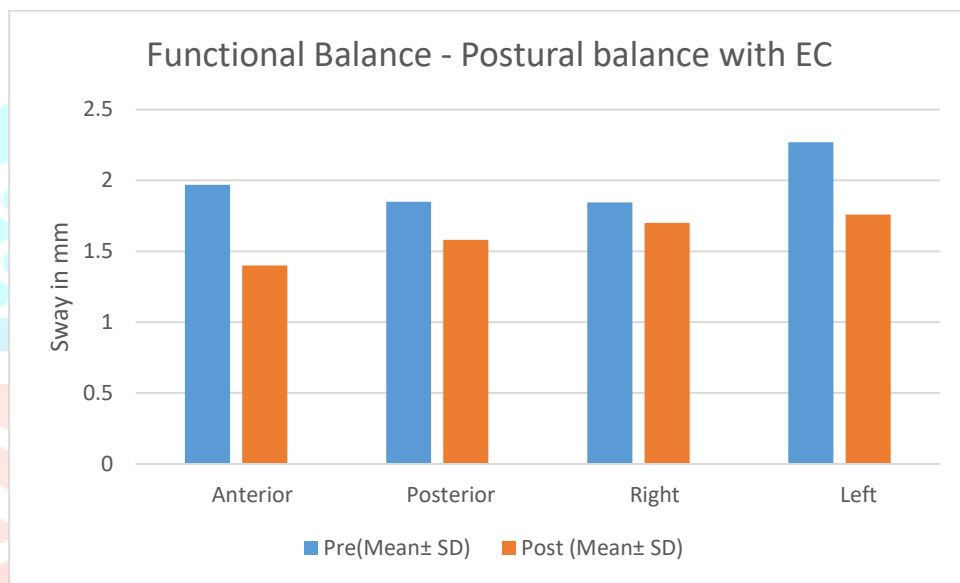


Fig 7. Comparison of Pre – post Functional balance with EC

The graph shows pre, post functional balance with eyes close using sway meter. There was greater improvement in Anterior and posterior sway with eyes close after the intervention which indicates improvement in Balance. Posterior sway is considered extremely significant with p value 0.001 and  $r = 0.85$ .

Table no. 11 Comparison of Pre-Post Risk of Fall :

TUG Test	Pre(Mean± SD)	Post (Mean± SD)	P value
	14.72 ± 1.00	14.13 ± 0.85	0.002

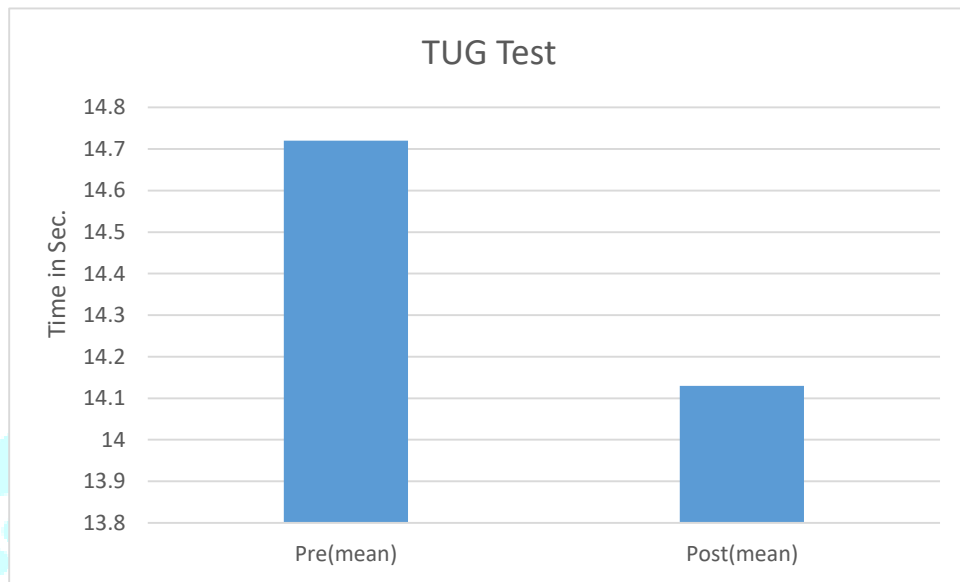


Fig 8.Comparison of Pre – post Risk of Fall

The graph shows pre and post mean value of TUG test. It is consider extremely significant with p value 0.002 and  $r = 0.544$ .

## Discussion

The study was intended to find out the immediate effect of ankle mobilization for improving balance, gait speed and risk of falls in community dwelling elderly people The protocol included application of maitland mobilization technique to talocrural joint and gastrocnemius-soleus stretching. The study found that there was increase in ankle plantarflexion and dorsiflexion range and decrease in gastro-soleus tightness which had an effect on balance, gait speed and ultimately risk of fall. Sway meter, 10 meters walk test and TUG test was used as a outcome measure for balance,gait speed and risk of fall respectively.



In a study conducted in 2000 by Chiara Mecagni et al., the association between balance and ankle range of motion in older women living in communities was investigated. The findings may help to identify specific elements to include in future intervention trials aimed at preventing falls in elderly persons. Their study found that decreased performance on balancing measures was linked to restricted ankle motion, which may be caused by non-contractile tissues such as bone, ligaments, or capsule<sup>4</sup>.

David Hernandez Guillen et al. (2021) carried out a similar study to examine the relationship between postural control and ankle function in the sagittal plane in community-dwelling older persons. Their findings suggest that weight- and non-weight-bearing ankle ROM measures were similarly associated with balance measures. According to their study, the ankle strategy, in which the body moves at the ankle as a flexible inverted pendulum, is appropriate to maintain balance for small amounts of sway when standing on a firm surface<sup>15</sup>.

According to a study by Pavlos Morfisi et al. from 2021, ageing and changes in gait characteristics are related to falling in the elderly. In their study, they observed alterations in the walking pattern of the elderly; they indicate decreased plantar flexion peak ankle in late stance compared to young participants. This condition is likely to contribute to an older person's shorter step length, thus increasing the risk of fall. This is due to age-related changes in gait that are brought on by diminished muscle strength and restricted range of motion in the lower limb joints as a result of physiological and neuromuscular changes.<sup>13</sup>

There have been many studies done on improving balance and reducing the risk of fall in the elderly.

Mobilization and stretching is one of the techniques to increase ankle range of motion and reduce gastrocnemius & soleus tightness, thus improving balance, gait speed, and reducing the risk of fall. In the present study, talocrural joint mobilization is used as a treatment to increase functional balance and reduce the risk of fall, as done in Rafael Duarte Silva et al. (2017) study. In their study, they measure the acute (1 session) and chronic effects (6 sessions) and the follow-up (2 weeks) of anteroposterior articular mobilization of the talus, grade III of Maitland, on the dorsiflexion range of motion (ROM), pain, and functional capacity of individuals with subacute and chronic traumatic injuries of the ankle. Universal Goniometer, Visual Analog Scale, Functional Assessment Questionnaire were used as outcome measures in this study. According to their study, a possible

reason for increase in dorsiflexion ROM could be due to correction of an anterior positional fault of the talus after joint mobilizations. Anteroposterior mobilization of the talus using a gentle force resulted in greater improvement in dorsiflexion ROM and return to normal gait pattern<sup>2</sup>.

Alain Chevuttschi et.al (2014) did the study to evaluate the immediate effects of therapeutic mobilization of the talocrural and subtalar joints on ankle mobility and postural control in elderly subjects. According to their findings, mobilisation can improve stability in elderly individuals by reducing the sway area during the static experiment as well as by increasing the ankle joint's range of motion.

The author stated that mobilization reactivated the proprioceptive system, especially the mechanoreceptors of the ankle. The stimulation of these mechanoreceptors may increase the afferent input from the talocrural and subtalar joints and surrounding tissues, thus reducing the sway area and improving the balance in elderly<sup>6</sup>.

Colby kisner et.al 6<sup>th</sup> edition says that stretching of gastrocnemius- soleus muscles is also effective in improving balance and thus reduced risk of fall. Stretching can restore or increase the extensibility of the muscle-tendon unit and, therefore, regain or achieve the flexibility and ROM required for necessary or desired functional activities. The underlying mechanisms for stretch-induced gains in ROM include biomechanical and neural changes in the contractile and noncontractile elements of the muscle-tendon unit. These changes are thought to be the result of increased muscle extensibility and length or decreased muscle stiffness<sup>24</sup>

The neurophysiological properties of the muscle-tendon unit also may influence a muscle's response to stretch and the effectiveness of stretching interventions to elongate muscle. In particular, two sensory organs of muscle-tendon units, the muscle spindle and the Golgi tendon organ, are mechanoreceptors that convey information to the central nervous system about what is occurring in a muscle-tendon unit and that affect a muscle's response to stretch<sup>24</sup>

In a study published in 2016, Ravi Shankar Reddy et al. focused on determining the effectiveness of stretching exercises for all major leg muscle groups that can affect balance in the elderly.. In their study they took 60 elderly individuals and performed stretching of all major muscles in lower limb for 10 weeks. According to their study the prolonged static- stretching protocol may have reduced the stiffness of the joint, fascia, and musculo-tendinous unit thus helps to increase the balance. The effects of prolonged and intense static-

stretching on the joint receptors might lead to inhibitory effects on motoneurons, and their greatest effects can remain for 5-10 minutes. These finding supported the results of our study that the static- stretching protocol affected muscle activation only immediately after the experimental protocol<sup>17</sup>.

Similar study was done by Jeon Hyeong Lee et.al (2019) to investigate the effects of calf tightness on gait, plantar pressure, and balance in adults. They observed that calf tightness had an impact on gait and balance. They found that when walking, jogging, jumping, or ascending stairs, calf stiffness can make it difficult for the heel to push the ground effectively. Problems in performing an ankle strategy may also occur when small body disturbance occurs<sup>16</sup>.

Min Hyeok Kang et.al (2018) has done a cross sectional study to demonstrate correlations of ankle DF PROM and gastrocnemius tightness and amount of posterior talar glide. In their research they observed that stretching exercises contribute to increase in gastrocnemius muscle length as well as weaker adjacent soft tissues, including ligaments, fascia, and capsule. Amount of posterior talar glide may be one of the other factors influencing ankle DF. Thus amount of talar glide, and tight calf muscles has an effect on reduced dorsiflexion range and thus affect balance<sup>25</sup>. Thus the present study includes both talar glide and calf muscles stiffness.

## Conclusion

Immediate effect of ankle joint mobilization is proved to be effective in improving the range of motion of ankle plantarflexion and dorsiflexion thus helps to improve balance, gait speed and reduced risk of fall in elderly population.

Along with mobilization, stretching of gastrocnemius-soleus muscle is also effective in reducing the stiffness and thus improving range of motion of ankle joint.

From the above, the alternate hypothesis has been proven that there is significant immediate effect of ankle joint mobilization on balance, gait speed, risk of falls in elderly population.

## Limitation

1. Ankle plantarflexion and dorsiflexion range was taken other ranges of ankle was not taken into consideration.
2. No follow up of patient was taken.

## Future Scope

1. Future follow up of elderly adults can be included in future study.
2. This study has only concentrated on the immediate effects of joint mobilizations. Similar research needs to be done to assess the immediate and long-term effects of mobilization on balance, gait speed and risk of fall in community dwelling adults.
3. All ranges like inversion, eversion, pronation, and supination can be added in future study.

## Clinical Implication

As the ankle mobilization and calf stretching has proved to increase the ankle range of motion and has positive effect on balance, gait speed and risk of fall in elderly adults, so this intervention can be implemented in the clinical settings.

The patients who are unable to come to clinical settings on daily basis, Maitland mobilization and stretching intervention can be applied to them for immediate effect, thus improving the functional balance in community dwelling elderly adults.

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