

Correlation between Balance and Ankle Range of Motion in Community Dwelling Women Having Fear of Fall Aged 60 to 80 Years

Jain¹, Hetal; Rathod², Sonal, A.

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Jain, Hetal

¹Lecturer, Ashok & Rita Patel Institute of Physiotherapy CHARUSAT Changa, India.

Email: hetaljain85@yahoo.com

Rathod, Sonal, A.

²Ashok & Rita Patel Institute of Physiotherapy CHARUSAT Changa, India.

sonalrathod8192@gmail.com

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Abstract

Objective: To study the relationship between balance impairments and changes in ankle range of motion (ROM) in older women who have fear of fall. *Method:* Correlation study was carried out with 100 female subjects aged 60 to 80 years. Fear of fall was measured using short falls efficacy scale (FES), balance using Tinetti Performance Oriented Mobility Assessment (POMA) (balance and gait) test and functional reach test (FRT). Goniometry was used to determine active and passive ROM of ankle joint. *Result:* High significant correlation value was observed for balance measure (FRT & POMA gait subtest) with ankle range of motion (ROM). Significant correlation value was recorded for sagittal plane motion rather than frontal plane motion for FRT (r: 0.55). Correlation value for frontal plane motion was however observed to be significant for POMA gait subtest (r: 0.49). *Conclusion:* Balance impairments can be predicted using ankle ROM impairments in community dwelling women.

Introduction

Aging is a result of slow and progressive decline in multiple body systems. Impairment in any component of postural control system can lead to instability and falls in older people. 25-35% of elderly people from community fall each year and these rates are rising with age (*Soo-Kyung et al, 2013*). It is one of the major health problems in aging adults. Falls and fall-related injuries are a major cause of morbidity and mortality in the elderly. Fall related mortality rate increases spectacularly with advancing age, especially in populations older than age 70 years (*Laurence & Karen, 2006*).

Fear of fall is one of the major negative consequences of balance impairment. One survey has reported that between 30% and 73% of older persons who have fallen admit fear of falling (*King & Tinetti, 1995, Vellas et al, 1997*). Fear of falling can limit physical and social activities; automatically, lowering quality of life (*Soo-Kyung et al, 2013*). Most falls in elderly people are associated with multiple risk factors, including both extrinsic (environmental hazards, housing characteristics, poor footwear) and intrinsic factors (weakness of muscles, reducing balance control, gait disorder, limited vision, cognitive impairment, advance age, medical illness, dizziness) (*Shehab & El-Kader, 2004, Laurence & Karen, 2006*).

The maintenance of balance is also one of the major factors that lead to fall in elderly people. Maintaining balance is the

ability to maintain an upright position during quiet standing, and it is necessary for successful performance of daily life tasks (*Lord et al, 1996*). Balance maintenance is a complex phenomenon that is influenced by multiple neural and musculoskeletal factors. Balance is maintained through a complex process which involves sensory detection of body motions, integration of sensorimotor information within the central nervous system, and execution of appropriate musculoskeletal responses (*Soo-Kyung et al, 2013*). The postural control ability is decline according to aging. Adequate postural control depends on the integration of vestibular, visual, and somatosensory information of the body motion. As the age advance, generalized reduction of the vision and vestibular function take place. Impairment in any component of postural control system can lead to instability and falls in older people (*Soo-Kyung et al, 2013*). *Lord et al. (1996)* reported that deterioration of postural stability related to aging is associated with reduced sensation in the lower limbs as measured by joint position, tactile, and vibration sensitivities. It not only affects sensorimotor functions, but also affects the muscle strength and joint movement which decline with increasing age (*Grimston et al, 1993*).

Bennell and Goldie (1994) demonstrated that range of motion (ROM) of the ankle is an important risk factor of reducing postural stability. Thereby, decreased ankle range may alter the movement patterns and these altered

movement patterns may compromise balance, and ultimately limit the functional activities (Mecagni & O'Sullivan, 2000). Vandervoort et al. (1992) reported that an average decrement of ankle joint ROM was greater in females than males with aging.

Tinetti Performance Oriented Mobility Assessment (POMA) measures subject's gait and balance. It has two subtests. Scores on this assessment categorize individuals as having a "low risk for falling," "greater chance of falling," or "high risk for falling."

The Functional Reach Test is a single item test developed as a quick screen for balance problems in older adults (Duncan et al, 1990). The FRT evaluates the maximal distance that a person can reach forward while maintaining a fixed base of support (Mecagni & O'Sullivan, 2000). A score of 15 cm or less indicates a significant increased risk for falls. A score between 15-25 cm inches indicates a moderate risk for falls (Duncan et al, 1990). The Short FES-I is a good and feasible measure to assess fear of falling in older persons. It is either self-administered or administered through interview, which asks respondents to rate their level of concerns in performing common activities. Short fall efficacy scale is comprised of 7 components with 1 indicating "not at all concerned" and 4 indicating "very concerned".

The purpose of this study was to examine the relationship between balance and ankle ROM in community-dwelling,

elderly women. These results may serve in clarifying specific components to incorporate into future intervention studies for reducing falls in elderly people.

Materials & Methods

Subjects: Subjects were recruited from the dwelling community through personal contact. It consisted of 100 women with mean age 65.43 years (range= 60-80year). About 81% women were highly concerned of fall and 19% women were moderately concerned about fall.

Instrumentation: The function reach test (FRT) and Tinetti performance-oriented Mobility assessment (POMA) were used to measure balance. Measurement of ankle ROM was done by 360° goniometer. **Reliability:** A pilot study was done to find out intrarater reliability for FRT, POMA and goniometric measurements on 2 consecutive days in 15 subjects. The following ICC value POMA (r: 0.98), FRT (r: 0.98), FES (r: 0.98), goniometry (Dorsiflexion-r: 0.98, Planterflexion-r: 0.86) indicative high intrarater reliability.

Procedure: Subjects were recruited from the community through personal contact. Prior to testing the purpose and procedure of the study were explained to the subjects. After analyzing the inclusion and exclusion criteria, each subject was asked to sign an informed consent form. After taking informed consent short fall efficacy scale measurement was administered. Next functional reach test was performed for three trials, and average of second and third trials were taken as a final reading.

After that POMA balance and gait score were administered by reading instructions from a script. Bilateral ankle range of motion was performed in two positions (1) knee in flexion (2) knee in extension as per *Norkin and White(1995)* with the subjects barefoot to exclude the influence of footwear.

Data collection tools:

- Tinetti Performance Oriented Mobility Assessment (POMA)
- Functional Reach Test (FRT) (Measuring tape)
- Goniometry (360° goniometer)
- Short Falls efficacy scale

Data analysis: Descriptive statistics for each ankle ROM was done using excel 2007. The Spearman's correlation coefficient was used to

calculate correlations. Three levels were taken in consideration.

1. Unilateral sagittal plane motion (DF, PF) and frontal motion (EV, INV) with FRT
2. Unilateral sagittal plane motion (DF, PF) and frontal motion (EV, INV) & POMA balance test
3. Unilateral sagittal plane motion (DF, PF) and frontal motion (EV, INV) & POMA gait test

Results & Discussion

The means and standard deviation for each motion are summarized in table 1.

Table1: Means and Standard deviation for each motion

Ankle range	With Knee flexion				With Knee extension			
	Active		Passive		Active		Passive	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dorsiflexion	17.16	3.59	21.10	1.96	12.13	3.33	20.05	1.89
Planterflexion	26.59	5.82	37.86	5.23	32.35	4.72	39.96	3.82
Eversion	5.50	0.92	7.32	0.89	4.83	0.83	7.16	0.85
Inversion	8.51	1.03	11.30	1.21	7.77	1.25	11.32	1.26

Since there were no differences between the right and left side ankle range of motion, therefore only left side ranges were taken into consideration for data analysis.

Short fall efficacy scale: The mean short FES score was 16.17(SD 3.028). Nineteen subjects had score from 9 to 13, which

indicate moderate concern for fall. Eighty one subjects had scored more than 14, which is considered to be indicative of high concern for fall.

Functional Reach: The mean FRT score for our sample was 25.2 cm (SD 5.58). Three subjects had an FRT score below

15.2 cm (6 inches), which is considered to be indicative of a greater fall risk.

Tinetti Performance Oriented Mobility Assessment: The mean scores of POMA were 14.15 (SD 3.16). Ninety four subjects had total scores below 19, indicating that they were at “high risk of falls”, six had scores between 19-24 indicating that they were at “moderate risk of falls” and no one had scores above 24 indicating “low risk of falls”.

Correlation between balance measurements and goniometry are summarized in figs 1 to 3.

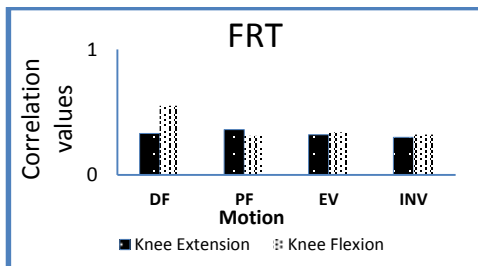


Fig. 1: Correlation between ROM and FRT in Knee Extended & knee flexion (DF-dorsiflexion; PF-Plantarflexion; EV-Eversion; INV-Inversion)

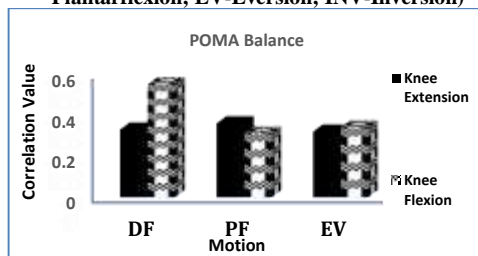


Fig. 2: Correlation between ROM and POMA balance

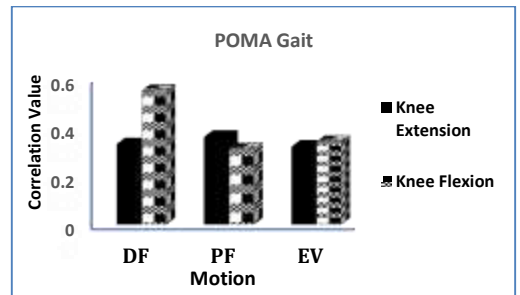


Fig 3: Correlation between ROM and POMA Gait with knee extended and knee flexed [(DF: Dorsiflexion, PF: Plantarflexion, EV: eversion, INV: inversion)]

Discussion

As there are no normative data for ROM measurements for women in this age group, we cannot make comparisons. This may show the fact that our measurements were active and not active assisted which represents maximal possible range. Where active motion is dependent on subjects force generating capacity, lifestyle and footwear difference between populations studied may also have contribute to differences (*Mecagni & O'Sullivan, 2000*).

In the present study, the ROM of subjects was assessed in both knee flexed and extended positions in order to remove the influence of gastrocnemius muscle length. It has been proved in the study by *Mecagni & O'Sullivan, (2000)* that restricted ankle ROM in knee extended position is due to non contractile tissue such as capsule, ligament and bone rather than gastrocnemius muscle.

This study shows a greater correlation of ankle ROM with functional reach test (FRT) and POMA gait subtest

than the POMA balance subtest which indicate that ankle ROM may be more associated with balance during ambulation and forward reaching task of everyday life.

POMA gait subtest has moderate correlation with inversion (knee extension, $r:0.49$ & knee flexion, $r:0.45$) and mild correlation with dorsiflexion (knee extension, $r:0.39$ & knee flexion, $r: 0.47$), Planterflexion (knee extension, $r: 0.35$) & knee flexion, $r: 0.46$), Eversion (knee extension, $r: 0.33$ & knee flexion, $r: 0.46$). This indicate that all ankle motions contribute to maintain balance during gait.

There is a greater degree of correlation between FRT and Dorsiflexion ($r: 0.55$), which is indicative of ankle strategy. Higher correlation between POMA gait subtest and inversion ($r: 0.44$) is suggestive of importance of frontal motion in gait. A study by *Hylton et al (2005)* stated that ankle flexibility and strength of toe planter flexors were associated with leaning tests and functional measure.

In this study a negative correlation between FES and FRT ($r:-0.18$) has been observed. A high score of FES indicate the high risk of fall while in FRT high values indicate more flexibility of ankle. Thus a negative correlation between them in our study supports that fact.

Conclusion: It was found that a relationship exists between ankle ROM and performance on balance tests in community-dwelling elderly women who have fear of fall. Decline in ankle ROM may result in decline in function and

balance control. This is an important finding which can be helpful to improve balance, postural stability and function by training balance strategies which can lower the fall incidence in the elderly population. A frontal plane ROM (inversion, eversion) is considerably important in balance during dynamic activities like walking. And sagittal plane ROM (Dorsiflexion, Planterflexion) which may be more important for balance with voluntary control. There is negative correlation of FES with FRT and POMA. Thus our result suggests that ROM can be used as screening tool to determine balance impairments and fall risk in older elders.

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Conflict of Interest: None Declared

