Original Research Article

Barefooted vs with footwear: functional mobility assessment on community dwelling elders

Dhruv Dave[1], Payal Vashi[2]*

[1]Ashok & Rita Patel College of Physiotherapy, CHARUSAT University, Changa, Ananad, Gujarat, India
[2]Shrimad Rajchandra College of Physiotherapy, Uka Tarsadia University, Bardoli, Surat, Gujarat, India

*Correspondence:
Dr. Payal Vashi,
E-mail: vashi31payal@gmail.com

ABSTRACT

Background: Affected balance, restricted mobility and probability of fall is more common in elder. Most of the geriatric individuals prefer walking independently as one of the prime function, so maintenances of that even with affecting factors of fall it is essential. Footwear is one extrinsic factor which may affects postural stability and increase risk of fall.

Methods: A cross sectional study conducted among community dwelling elders. Participants (n=40) have performed time up and go test (TUG) and ten meter walk test (TMW) in or out of the house with barefoot and two different type of pre-screened footwear. Descriptive statistics were done and ANOVA was performed.

Results: The calculated F ratio (0.7817), (1.3100) is lesser than the table F ratio (3.0737), (3.0737) for the TMW and even For TUG so the TUG score for barefoot and two different type of footwear do not differ significantly.

Conclusions: Functional mobility is not influenced by routine footwear. Barefooted and with footwear dynamic balance and gait speed is not significantly different from each other.

Keywords: Footwear, Dynamic balance, Functional mobility

INTRODUCTION

In geriatric population, evaluation of physical activity has become prerequisite to improve quality of life.[1] Physical activity refers to all activities of daily living which require maintenances of balance.[2] Independent functional mobility is essential to maintain physical activity.[3] Functional mobility skills include static and dynamic balance and gait.[4] Balance is achieved by complex integration and coordination of multiple body system including vestibular, visual, auditory and motor system. Information from sensory system is interpreted in central nervous system, an appropriate response is formulated and postural muscle synergies are activated to perform the appropriate head, eye, trunk and limb movements to maintain posture.[5] Intact balance control is required not only to maintain postural stability, but also important to maintain mobility related activities during daily life, such as standing while performing manual task, rising from chair, walking and turning.[3]

Gait is described as translator progression of the body as whole, produced by coordinated and alternating movement of lower extremities essentially support and carry along head, arms and trunk.[6] Purposes of gait analysis are to understand characteristic of gait, to identify gait deviation, to inform selection of treatment and to evaluate effectiveness of treatment.[7] Elders have potential to affect balance, restrict safe mobility and increase likelihood of fall.[2] Most of the geriatric individuals perceive walking independently as one of the prime function, so maintenances of gait becomes one of

the essential goal of their rehabilitation.[8] Deterioration of gait speed is common in elder and sometime extreme slowness leads to fall.[1]

43% community dwelling elderly person having fear of falling and 44% has reported restriction in daily activity. Fear of fall is also there in geriatric individual who have not experienced any falling episodes.[9] Lipsitz et al followed a group of community dwelling older adult over 70 year of age for one year and concluded that multiple risk factors are responsible for fall. They found intrinsic factors like arthritis of knee; impairment of gait, hypotension, and use of psychotropic drug etc. and extrinsic factors like poor lighting, slippery surface, and obstacles are responsible for fall.[10,11] Footwear has been identified as an environmental risk factor for indoor and outdoor falls.[12] Although propulsion and protection of foot is primary role of footwear which has strongly influenced by fashion.[10] Foot provides only source of direct contact with ground during walking and footwear interfere between foot and ground.[13]Interference of footwear affects postural stability and increase risk of fall.[14] A shoe's sole material and tread design can affect the coefficient of friction on the walking surface, which may influence the risk of slipping. Heel height and width may affect a shoe's tendency to tip sideways on an uneven surface, as well as gait and posture. Sole thickness and shoe collar height may affect proprioception.[10] There is very limited research that has been done on direct effect of footwear on functional performance in geriatric population.[1] Jasmine et al have found that optimizing low heels and firm slip resistant sole footwear are better for elderly who are at risk of fall.[12] Loard and Bashford studied the effect of footwear on balance in 30 women aged 60 to 89 year using sway meter and concluded that performance should be better with flat shoes and barefoot than high heel shoes.[15] Several studies included older women however, no study was done on effect of footwear on functional mobility in community dwelling elderly.[1]

Various approaches have been developed to asses balance and gait, but it needs to be safe, inexpensive and easily applicable into clinical setup.[1] Examination of gait include parameters like step length, stride length, cadence and velocity.[6] Madubuch et al, involve 80 participants between age of 18-26 years and perform simple footprint and gait speed analysis using paper-paint and stopwatch and found that there is no significant effect of footwear (mid-heel and low-heel) on stride length, step length and cadence but significant difference has been noted for velocity.[13] Romberg test, functional reach test and one leg standing test are used to determine static balance.[4] Brigges et al, found no effect of performance with shoes on versus shoes off for Romberg and one leg stance among 71 female subjects with unknown pathology between 60-86 year of age.[1] Berg balance scale is measure of static and dynamic balance.[4] Clinician rate 14 functional activities including sitting, standing and

postural transition.[5] Functional reach test objectively assesses limits of stability by measuring the maximal distance a person can reach beyond the length of arm while maintaining fix base of support in standing. Tinetti balance and gait assessment include 14-item balance and 10-item gait test which predicts elderly individual who are at risk of fall at least once during the following year.[5] So to identify effect of footwear on dynamic balance and gait speed, Time Up and Go test and 10-meter walk test are appropriate measuring tools.

Time up and go test (TUG) is used to evaluate dynamic balance.[16] It is the shortest, simplest clinical balance test and probably the most reliable because it uses agreement in stop watch duration rather than rating scales.[5] TUG describes realistic mobility skills which include transfer in and out of chair, potential fall situation, walking and turning.[17] It is sensitive and specific measure to identify an individual who are at risk of fall.[16] However, TUG have some limitations like identification of type of balance problem is not possible and it only include one functional task.[5] The 10-metre walk test (TMW) has the potential to provide valuable clinical information regarding gait abilities.[18] The test can be used to determine speed, stride and cadence.[4] To measure gait speed self-selected walking speed ten meter walk is appropriate for elders. Advantage of this scale is that it takes less than one minute to perform, widely used because it is very simple and it provide predictive of falls. Gait speed can be expected to be reduced in individual of lesser height and grater age.[8] Standardization of footwear is not mention for Time Up and Go test and Ten Meter Walk test.[1] Podsiadlo and Richardson simply described that subjects wearing their regular footwear for time up and go test.[19] Cress et al, described normal walking shoes for ten meter walk test.[20] The initiation of this research is to find the influence of footwear on dynamic balance and gait speed and to categorize footwear.

METHODS

Cross Sectional Study was done in three different areas of Gujarat on elderly. It was started in Dec 2013 and we proceed further towards analysis in March 2014 in Subjects who satisfied the inclusion criteria were asked for their consent to participate.

Inclusion criteria for this study was community dwelling elders above age of 60 years, could walk independently at least 10 m and turn 180 degrees, without any ambulatory aid, Owns at least one pair of shoes and slipper as per shoes screening criteria. Characterization of footwear was done to maintain uniformity of footwear. Footwear was screened based on heel height. A slipper was defined as soft soled with a heel height of ≥1 cm and <2 cm. Other shoes –soled chappals, Velcro-fastened sandal and laced-up or leather shoes, with heel height of ≥ 2 cm and ≤ 4 cm. The heel height was established by measuring the vertical distance from the floor to the insole at the front

of heel. Other footwear characteristic such as firmness of sole is qualitatively judged and documented. Individual wearing lower-extremity orthosis or prosthesis or suffering from acute injuries of lower limb were excluded from study.
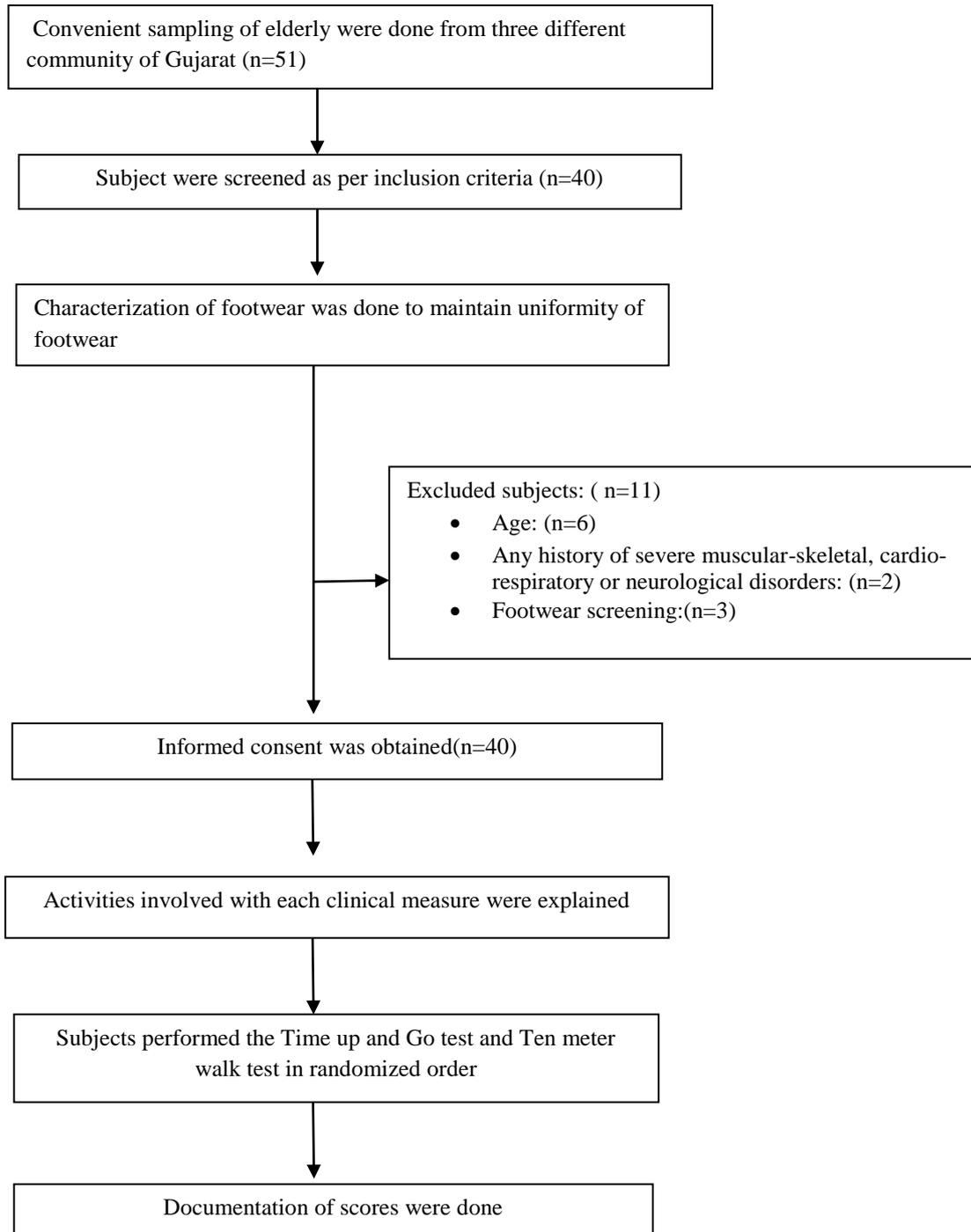
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│ Convenient sampling of elderly were done      │
│ from three different community of Gujarat      │
│ (n=51)                                         │
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┌─────────────────────────────────────────────┐
│ Subject were screened as per inclusion         │
│ criteria (n=40)                                │
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│ Characterization of footwear was done to       │
│ maintain uniformity of footwear                │
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                     │──────────────►┌──────────────────────────────────────────────┐
                     │               │ Excluded subjects: ( n=11)                    │
                     │               │   • Age: (n=6)                                │
                     │               │   • Any history of severe muscular-skeletal,  │
                     │               │     cardio-respiratory or neurological         │
                     │               │     disorders: (n=2)                          │
                     │               │   • Footwear screening:(n=3)                  │
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│ Informed consent was obtained(n=40)            │
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│ Activities involved with each clinical measure │
│ were explained                                 │
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│ Subjects performed the Time up and Go test     │
│ and Ten meter walk test in randomized order    │
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│ Documentation of scores were done              │
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Figure 1: Method of data collection.

Other exclusion criteria were history of severe muscular-skeletal, cardio-respiratory or neurological disorders before or during 1 year which required immobilization or hospitalization for more than 72 hours and individual, instructed to avoid strenuous physical activity.

The order of footwear exchange was same for both test performance. To avoid undue fatigue, subjects rested 3 minutes between footwear conditions and 1 minute between different functional measures. The tests were administered in subject's own outdoor area. Each testing session took approximately 15-20 minute to complete.

For the first footwear condition, the tester has demonstrated the test and repeated the explanations during performance

At that time, the activities involved with each clinical measure were explained and informed consent was obtained. Subjects performed the time up and go test for dynamic balance and ten meter walk test for gait speed, in randomized order. The walking distance for time up and go test was measured with a tape measure and marked with chalk. Each subject began the test in a sitting position with his/her back against the chair back, hands on the chair arms. He/she was instructed to perform test on the word "go," the subject stood up, walked at a self-selected pace to a line 3 m away, turned around, returned to the chair, and sat. The tester timed the TUG to the nearest hundredth of a second using a digital stopwatch. Timing began on the word "go" and ended when the subject returned to the start position. Measurement of gait speed was done by Ten Meter Walk Test. The subject was instructed to walk at normal and comfortable pace. The tester timed the TMW to the nearest hundredth of a second using a digital stopwatch. Timing began when the subject's leading foot crossed the start line and ended when the leading foot crossed the finish line. The subject performed 3 trial for data collection. It is explained in Figure 1. Data was obtained and statical analysis was done using Microsoft Excel 2010.

RESULTS

The subject (n=40) completed both TUG and TMW test without difficulty. Demographic details for subjects were given in table 1. The descriptive statistic for TUG and TMW scores for barefoot and two different type of footwear are documented in Table 2-4. The ANOVA discovered an overall footwear condition (i.e. barefoot, slipper, other footwear[*]) effect for TMW scores (F=0.78; df=1, 19; p>0.05; F_{tab}= 3.07) and TUG scores (F=1.31; df=1, 19; p>0.05; F_{tab}= 3.07) for subjects and indicating that calculated F ratio is lesser than the table F ratio for TMW and TUG score for all three types of footwear condition (i.e. barefoot, slipper, other footwear[*]). So effect of different footwear condition on dynamic balance and gait speed was not significant. Figure 2 and 3 shows TMW and TUG scores for barefoot and two different type of footwear. Subjects performed better on TUG and TMW when barefooted in comparison to other footwear and slipper.

Table 1: Demographic data.

No.	N	Gender	Age (range) (years)	Mean±SD
1	26	Male	60-75	64±4.03 years
2	14	Female	60-75	65±4.84 years

Table 2: Descriptive statistics for timed up & go test (TUG), and 10-meter walk test (TMW).

	Mean	SD	Range	95% CI
TUG (seconds)				
Barefoot	9.30	1.87	6.41-12.98	8.70-9.90
Other footwear	9.77	1.90	6.90-13.62	9.16-10.38
Slipper	9.97	1.90	6.70-12.98	9.36-10.58
TMW (m/sec)				
Barefoot	0.78	0.22	0.5-1.37	0.71-0.86
Other footwear	0.75	0.25	0.47-1.36	0.69-0.85
Slipper	0.71	0.22	0.46-1.35	0.65-0.79

Table 3: Descriptive statistics for timed up & go test (TUG), and 10-meter walk test (TMW) – female.

	Mean	SD	Range	95% CI
TUG (seconds)				
Bare foot	9.55	1.69	6.64-11.98	8.56-10.53
Other footwear	10.21	1.35	8.24-12.21.	9.42-10.99
Slipper	10.18	1.60	8.09-12.56	9.25-11.11
TMW (m/sec)				
Bare foot	0.76	0.23	0.5-1.37	0.62-0.89
Other footwear	0.71	0.22	0.47-1.36	0.58-0.84
Slipper	0.70	0.23	0.46-1.35	0.57-0.83

Table 4: Descriptive statistics for timed up & go test (TUG), and 10-meter walk test (TMW) – male.

	Mean	SD	Range	95% CI
TUG (seconds)				
Bare foot	9.29	2.13	6.41-12.98	8.42-10.15
Other footwear	9.65	2.27	6.90-13.62	8.73-10.57
Slipper	9.97	2.25	6.70-12.98	9.06-10.88
TMW (m/sec)				
Bare foot	0.80	0.043	0.5-1.37	0.71-0.89
Other footwear	0.81	0.052	0.47-1.36	0.69-0.91
Slipper	0.73	0.044	0.46-1.35	0.64-0.82
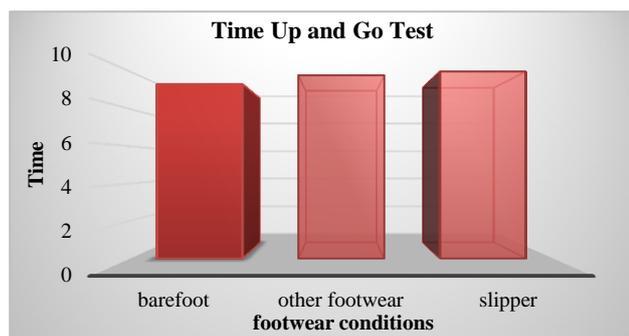
Figure 2: TUG scores for barefoot and two different type of footwear.
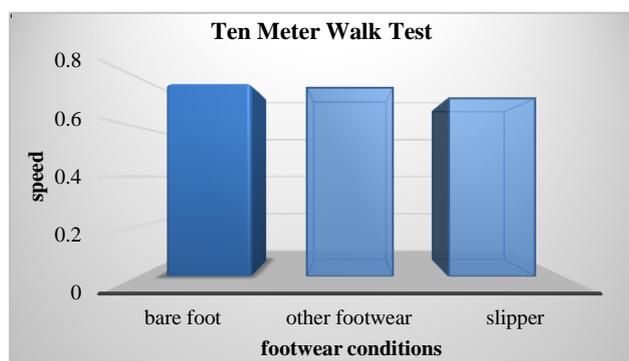
Figure 3: TMW scores for barefoot and two different type of footwear.

DISCUSSION

Many study has proven that footwear may also impair balance and alter gait patterns in the elderly.[21] The characteristics of that footwear were also specified in several studies as the footwear is considered as extrinsic factor of fall in many studies. Kuhirunyaratn et al mentioned experiencing two or more non-injurious falls was associated with a decline in social activities while experiencing at least one injurious fall was associated with a decline in physical activity in geriatric population.[22] The 60th National Sample Survey (January–June 2004) collected data on the old age dependency ratio. At 125, it was found to be higher in rural areas than in urban areas, which had the ratio at 103.[22] Going shoeless might be expected to be more common in

relatively sedentary, housebound adults.[8] So descriptive statical analysis shows that the functional mobility is better while walking barefooted while comparing it with footwear walking (Figure 2 and 3).

The national census 2011 states that 833 million people currently live in rural areas.[22] In India ruler geriatric population are mostly occupied themselves as a farmer or most of them are in a retired zone of life. Considering house bound life style of Indian elderly population the TUG test and TMW test was assessed in home based set up and with their own shoes. Testing subjects in new shoes, however, may influence postural responses to footwear.[1]

Farmer population falls by 9 million in 10 years, It was 127.3 million in 2001 and as per census data of May 1, 2013, Framer population is 118.7 million.[23] Most of them are male. They have to work whole day at farm while wearing shoes. So the men walk fastest in other footwear* ($0.81_{m/s}$), slower while barefooted ($0.8034_{m/s}$), and slowest wearing slipper ($0.73_{m/s}$). This gait speed was measured by ten meter walk test. Mostly in Indian tradition the people of rural areas walk barefoot in their houses as well as in the community and occasionally wear slippers and /or other footwear* so their dynamic balance is good while barefooted in compare to walking with footwear.

As per census Indie 2011 data, number of female workers per 100 males workers is less.[25] This discrepancy may arise because many women are involved in home-based work. They walk barefoot in their houses and most often wore other footwear like chappals and low heels sandals at social occasion and rarely wore slippers. The functional mobility of women is better while barefooted in comparison to walking with other footwear as per (Table 3) descriptive data analysis.

Our study has hypothesised to find the difference of effect on functional mobility by barefoot walking and with different type of footwear walking. Results of this study found that to walk barefooted and with different type of footwear does not significantly affects the measurements, which was obtained by the TUG and TMW in community dwelling elders. TUG was used to measure dynamic balance and TMW was used to measure

gait speed. The ANOVA discovered an overall footwear condition effect for TMW scores (F=0.78; df=1, 19; p>0.05; F_{tab}=3.07) and TUG scores (F=1.31; df=1, 19; p>0.05; F_{tab}= 3.07) for subjects and found that calculated F ratio is lesser than the table F ratio for TMW and TUG score for all three types of footwear condition (i.e. barefoot, slipper, other footwear[*]).

CONCLUSION

This study indicates that there is no significant difference between three different footwear conditions i.e. barefoot, slipper, other footwear[*] on TUG and TMW scores so there is no effect of different types of footwear on dynamic balance and gait speed among community dwelling elders, but subjects performed better on TUG and TMW when barefooted in comparison to other footwear[*] and slipper.

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