Research Report

PERFORMANCE OF COMMUNITY-LIVING FILIPINO ADULTS AGED 21-87 YEARS ON THE FUNCTIONAL REACH TEST

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ABSTRACT

Objectives: The Functional Reach test (FR) is used to detect balance impairment and change in balance performance over time. This test measures the maximal distance one can reach forward beyond arm's length while maintaining balance over a fixed base of support. This study aims to determine FR values of a selected group of Filipino adults and elderly on the functional reach test; to compare Filipino FR values with American standard values & to determine the correlation between forward and sideward reaching, and those of FRT and factors such as age, gender and anthropometric characteristics. ***Methodology***: This research is a cross-sectional, observational study on forward and sideward functional reach where 162 males and females aged 21 and 87 were selected from specific areas in Metro Manila. All participants were asked to lean forward and sideward as far as possible without losing balance or taking a step. ***Results***: There was a difference between local and American standard values. A strong positive correlation between forward and sideward reaching was found at 0.827. Height, age, arm's length, trunk length, and shoulder length were found to affect FR. ***Conclusion***: The standard American values may not be used as reference values for Filipino patients. Forward and sideward reach has a strong positive correlation, therefore a person with good antero-posterior stability would possess efficient lateral stability. Anthropometric values influence FR scores.

Keywords: *Balance, Adults, Elderly, Functional Reach Test (non-MeSH)*

INTRODUCTION

Balance or postural stability is the condition in which all the forces acting on the body are equalized such that the center of mass (COM) is within the boundaries of the base of support[1]. The ability to balance and maintain a stable posture is integral in the execution of most movements. As postural control mechanisms deteriorate with age and disease, balance becomes increasingly tenuous resulting in an enhanced susceptibility to falls[2,3,4]. Balance training activities can be used to improve trunk stability, biomechanical alignment, symmetrical weight distribution and improve awareness of COM and limits of stability (LOS). Balance exercises also improve the utilization of sensory systems (somatosensory, visual, vestibular inputs) and central nervous system sensory integration mechanisms and as well as the compensatory strategies for effective fall prevention[5]. This produces improved ability to control the center of gravity (COG) over a fixed base of support [1,3]. The farther the person is able to displace his COG, the better is his dynamic balance status. Standardized tests and measures of balance that emphasize functional performance are available. One of these is the Functional Reach (FR) Test.

The FR test is an assessment tool for balance first developed by Duncan, et al in 1990[6]. According to this study, the FR test is the maximal distance one can reach forward beyond arm's length while maintaining balance over a fixed base of support.

They postulated that FR is a measure of postural control that can easily be implemented in clinical practice and may have importance for studies examining balance because it is inexpensive, precise, stable, age-sensitive, and clinically accessible. Furthermore, the authors reported test-retest reliability of 0.92 and an inter-rater reliability of 0.98. Age-related norms for functional reach have been determined for American population. Scores of less than 7 inches are indicative of a frail individual who is limited in mobility and ADL skills and who demonstrates increased fall risk[7].

Takahashi in 2005[8] found that elderly people frequently experience lateral falls and suffer fractures of the femoral neck as a result. Therefore, he suggested that it is also important to examine balance in this coronal plane. The study is aimed to measure the balance of the lateral side, which is evaluating the ability to reach to both the right and left side. The test-retest reliability of lateral FR was highly reliable (ICC=0.90; CI: 0.89-0.96). It was found that lateral FR was associated with the performance of ADL and geriatric depression. Subjects with greater lateral FR had higher basic and instrumental ADL scores than those with shorter lateral FR. The lateral FR of participants with depression was shorter than in those without.

The objectives of this study were *1)* to determine FR values of a selected group of Filipino adults and elderly on the functional reach test, forward and sideward, 2) to compare Filipino FR values with American standard values, 3) to determine the correlation between forward and sideward reaching, and 4) to determine the influence of age, gender and anthropometric measures on FR values.

METHODOLOGY

Study Design

This was a cross-sectional, observational study involving multiple measures.

Participants

The study made use of the convenience sampling method where 162 participants, between 21 and 87 years old, were selected based on the inclusion criteria. Inclusion criteria were:

- The participant should be a Filipino
- The declaration of the participant feeling a general sense of well-being at the time of study
- The range of motion (ROM) of trunk, shoulder, hip and ankle within normal limits
- The participant does not have a history of falls in the last 6 months
- The participant must have ideal body weight as measured through the body mass index (BMI)
- The participant must be within the norms of the average Filipino height based on the National Nutrition Survey 1998.

There was an equal distribution of male and female participants selected from various parks in Manila, such as Luneta Park, Quezon City Circle, and Greenhills Shopping Center. Each of the volunteers was briefed on how the test would be done and was asked to sign a consent form.

Subjects were excluded by on-site evaluation if they demonstrated painful shoulder during abduction and flexion, if they were (L) handed, or if they had a major orthopedic or neurologic diagnosis (e.g. amputation, fracture of any extremity within the past year).

Procedure

The FR for both forward and sideways reaching were tested in the standing position with feet apart. All participants stood on a wooden platform next to a wall without touching it and without shoes or socks. A yardstick mounted on a wall was positioned at the level of the acromion process. Participants were asked to forward flex the arm to 90^{o} with the elbow extended and hand fisted (figure 1). An initial measurement was done with the 3rd metacarpal positioned along the yardstick. All were instructed to lean forward as far as possible without losing their balance or taking a step. The test was done 3 times for each of the participants. The same procedures were performed with the participant reaching sideways (figure 2). Those who took a step were made to repeat the procedure. Prior to testing, each participant got to practice the FR test.

Figure 1: Forward Functional Reach

Figure 2: Sideward Functional Reach

Anthropometric data such as height, weight, trunk length, shoulder length, arm length and foot length were also gathered. Height was measured in centimeters using the yardstick attached to the Detecto weighing scale. Subjects were asked to stand on the weighing scale and to maintain a relaxed stance with head level while height was being measured. Weight was obtained in kilograms using the Detecto weighing scale. Trunk length, shoulder length, arm length and foot length were all obtained in standing position using a tape measure. Trunk length corresponds to the distance between the 7th cervical and 2nd sacral vertebra. Shoulder length was measured from the acromion process to the floor. Arm length is the distance between the acromion process and the 3rd metacarpal of a fisted hand, with the shoulder in 90 degrees of flexion and elbow in extension. Foot length was measured from the heel to the tip of the big toe, while the anterior foot length corresponds to the distance between the anterior aspect of the medial malleolus to the tip of the big toe. All obtained data were recorded on the participant's information sheet.

The results from the 3 trials were compared and correlated. Simple descriptive statistics were used to determine FR test values for all the participants. Comparison between males and females was achieved by using a paired T-test. A *p* value of .05 or less was considered significant. Factors such as height, weight, age, BMI and other anthropometrics were correlated using Pearson's Correlation. SPSS v.1.0 was used in all statistical tests.

RESULTS

One hundred and seventy nine volunteers were gathered to serve as participants for the functional reach test. Five subjects were excluded on-site, secondary to claims of falls for the past 6 months; 12 more were excluded due to inadequate range of motion. One hundred and sixty two volunteers were then tested based on the inclusion criteria with 81 males and 81 females. Table 1 shows descriptions of Filipino subjects' height, weight, and arm's length according to age group. These were compared with those found by Duncan, et al[6] and set as American standards, as shown in Table 2.

Figures 3, 4, and 5 illustrate the mean height, weight and arm length in relation to age group and gender of subjects. Male subjects had a linear decrease in height and weight with age, whereas female subject selection had no specific pattern as to height and weight in relation with age (Figure 3 and 4). The same holds true for arm's length (Figure 5).

FR values for both forward and sideways reaching were expressed as mean ± SD, as summarized in Table 3.

Figure 6 illustrates the mean forward reach of males and females of different age groups.

Table 1. Descriptive Characteristics of Filipino Subjects by Age Category

	Age 21- 40	Age 41 - 69	Age 70 – 87
Males	26	32	23
Females	20	39	22
Height (cm)	161.10 ± 7.70	157 ± 5.3	159 ± 3.8
Weight (kg)	52.22 ± 5.26	55.08 ± 3.67	56.44 ± 3.11
Arm length (cm)	64.31 ± 19.77	57.79 ± 3.44	59.64 ± 3.83

Table 2. Duncan's (American Standard)[6] Descriptive Characteristics of Subjects by Age Category

	Age 21- 40	Age 41 - 69	Age 70 – 87
Males	16	22	20
Females	28	28	14
Height (cm)	171.20 ±9.40	169.16 ± 8.89	167.13 ± 8.89
Weight (kg)	70.24 ± 16.06	72.91 ± 13.39	71.19 ± 13.11
Arm length (cm)	62.48 ± 3.56	62.23 ± 4.83	62.23 ± 5.84

T-test revealed a significant difference between males and females on all age brackets for both forward and sideward reaching with p values < .001. Comparing the two directions of reach, forward and sideward, a strong positive correlation was found at 0.827.

As shown in Table 4, there seems to be a difference between locally obtained (Filipino) FR values from standard (American) FR values. American values obtained by Duncan et al[6] are generally higher that those obtained from Filipino subjects.

Age, height, weight, trunk length, shoulder length, arm length and body mass index were obtained to ascertain which factors might affect functional reach. Pearson's correlation coefficient was used to determine how strong each factor was correlated with forward and sideways reaching. Parallel to Duncan, et al's findings[6], age and height were correlated with functional reach. Age had a moderate negative correlation to both forward and sideways reaching at –0.54 and –0.53 respectively, meaning older subjects have lower FR values. Height had a perfect positive correlation (+1.00) with forward reaching, and also held a strong correlation with sideways reaching at 0.83.

Other factors such as arm length, trunk length, shoulder length, and foot length revealed moderate to strong correlation with functional reach. Trunk length was moderately correlated with forward and sideward reach values at 0.627 and 0.597 respectively. Shoulder length was strongly correlated to forward reaching at 0.807 and moderately associated with sideward reach at 0.635. Foot length was moderately correlated with forward and sideward reach with values at 0.670 and 0.515 respectively for the right foot, and 0.717 and 0.568 for the left foot. Foot length was likewise moderately correlated with functional and sideward reach at 0.407 and 0.307 correspondingly for the right foot, and 0.368 and 0.278 for the left foot.

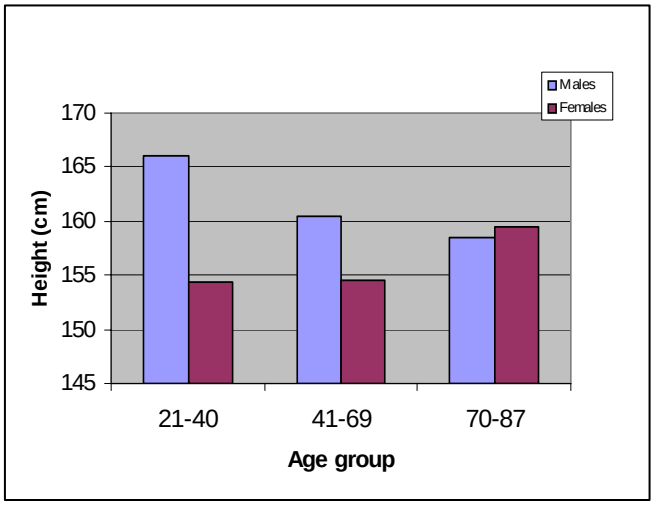

Figure 3. Filipino Height Stratified According to Age and Sex

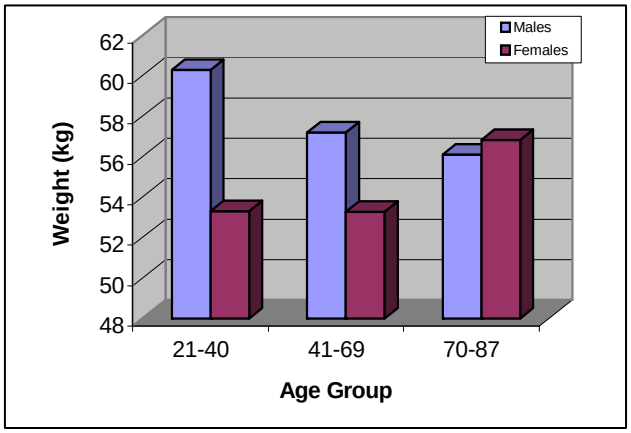

Figure 4. Filipino Weight Stratified According to Age

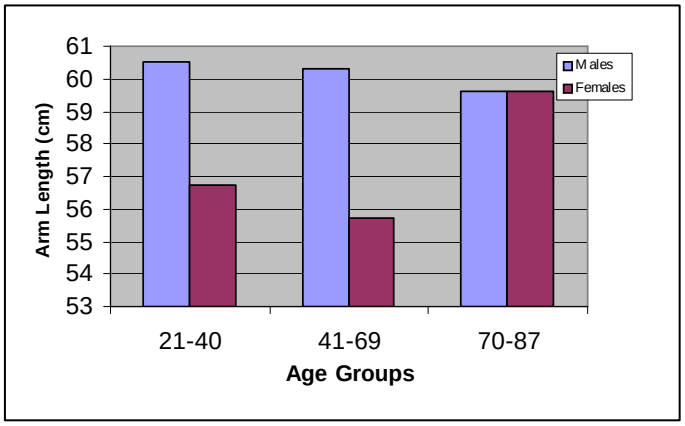

Figure 5. Filipino Arm Length Stratified According to Age

DISCUSSION

The functional reach test is defined as the maximum distance one can reach forward or sideways beyond arm's length, while maintaining a fixed base of support (BOS) in the standing position [4,7,9]. FR is a clinical tool that assesses balance in patients with difficulties in maintaining postural stability. These patients are usually with

Table 3. Filipino Functional Reach Values (Mean ± SD)		
Age groups (Males)	Filipino values	
	Forward reaching	Sideward reaching
21 – 40 y/o	26.03-38.91	18.05-27.51
41 – 69 y/o	22.26-33.94	14.84-23.46
70 – 87 y/o	16.53-23.53	10.83-16.25
Age groups (Females)	Filipino values	
	Forward reaching	Sideward reaching
21 – 40 y/o	21.30-27.12	15.46-22.88
41 – 69 y/o	17.59-24.77	14.75-20.35
70 – 87 y/o	14.12-23.58	12.69-18.03

Table 4. Comparison of Filipino values with American values[10] of the Forward Functional Reach by Age & Sex		
MALES	**Mean Filipino FR (cm)**	**Mean American FR (cm)**
20 – 40 y/o	32.47	42.49
41 – 69 y/o	28.10	38.05
70 – 87 y/o	20.03	33.43
FEMALES	**Mean Filipino FR (cm)**	**Mean American FR (cm)**
20 – 40 y/o	24.21	37.19
41 – 69 y/o	21.18	35.08
70 – 87 y/o	18.85	26.60

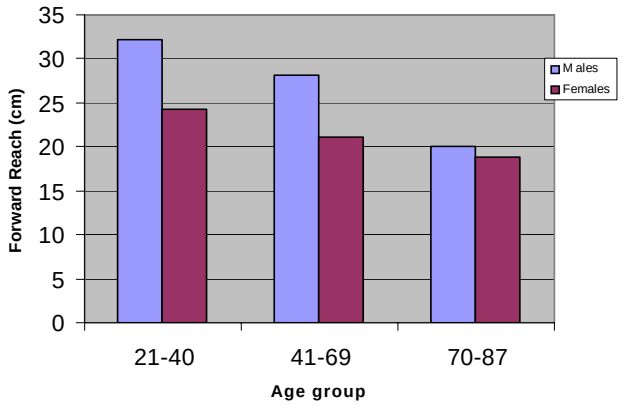

Figure 6. Mean Forward Reach of Filipinos Stratified by Age and Sex

neurological disorders (e.g. Stroke, Parkinson's Disease, and other Cerebellar disorders) and orthopedic problems (ankle sprain, post-operative hip, knee or ankle, and other conditions with proprioceptive loss).

Similar to the results of the study of Duncan et al in 1990[6], the participants in this study were also aged 21-87 years. The same procedures in measuring the forward reach values were followed. However, in the present investigation, sideward reach values were also considered.

Duncan, et al[6] found out that FR is highly reproducible, thus it is a feasible tool to use in the clinics for patients with balance problems. In another study by Giorgetti et al in 1999, it was found out that FR is a reliable clinical measure in an elderly population demonstrating moderate to high inter-rater and intra-rater reliability [10]. On the other hand, Takahashi in 1995[8] found that lateral or sideward FR has good test-retest reliability.

There are many insights to be gathered from this research. The present study showed differences in the reach values between males and females. Reach test values between Filipino males and females show that males have greater FR values than the females. This study also illustrated that Filipino values are different from the standard

American values. This may be due to the height difference between the average American and the average Filipino person. In our data, height had a perfect positive correlation with forward reaching and a strong positive correlation with sideways reaching. Therefore, taller individuals will tend to have higher FR values. The noted differences between Filipinos and Americans in anthropometric measurements and FR values underpins the importance of establishing FR normative values tailored to Filipinos to serve as basis for identifying the existence of balance problems.

Forward reaching has a stronger correlation with trunk length than sideward reaching, showing that there is greater amount of range of motion of the trunk available in forward reaching than in lateral trunk bending. In forward reaching, both the lumbar spine, pelvis and hip joints contribute to further displacement of COG, through the lumbar-pelvic rhythm [2,11]. In addition, the ankle also contributes to the stability and balance of an individual in the sagittal plane through the eccentric contraction of the gastroc-soleus muscle. In lateral reaching, the thoracic and lumbar spine and the ankle are only capable of minimal movements due to the bony and ligamentous restraints offered to these joints. During sideways reaching, the anatomical structures limit the further displacement of the center of gravity, such as the costal cartilage and transverse processes of the lumbar vertebrae approximating each other, taut spinal ligaments, ipsilateral muscle bulk wedging at the trunk, longer lateral malleolus and taut ankle ligaments. These restraints therefore, limit the sideward reach of an individual.

Another major contribution of this study is the comparison between forward and sideways reaching, which was not originally done by Duncan et al's study[6]. Comparing the two directions of reach, forward and sideward, a strong positive correlation was found at 0.827; hence a person with good antero-posterior stability would possess efficient lateral stability. This is explained by central mechanisms on balance control (CNS, cerebellum) and not attributed solely to peripheral/mechanical systems (somatosensory receptors located in the joints, ligaments, muscles and skin).

There was a negative correlation between age and the reach test values. As an individual gets older, there is a decrease in forward reaching and sideward reaching. This may reflect the decrease in balance as one ages. Balance disturbances may be due to slow reaction time, reduction in nerve conduction velocity and decrease in sensory-motor and proprioceptive response. A decline in proprioceptive response, in turn, may be due to a decrease in neurons, decrease in muscle strength and postural abnormalities. All these changes affect the reaching capability of a person. [12]

LIMITATIONS AND RECOMMENDATIONS

The sample size and the recruitment procedures used for this study limit the external generalizability of its findings to the Filipino population in general. It is recommended that future studies of this nature use stratified random sampling representing population from different regions of the country in order to have a more comprehensive picture of Filipino FR values and relevant anthropometric measures.

CONCLUSION

This study illustrated that standard American values may not be used for Filipinos. There is a difference in locally obtained (Filipino) FR values from standard (American) FR values, hence it is not unusual for the average Filipino to fail to reach the standard FR value provided by Duncan et al. Comparing the two directions of reach, a longer forward reach appears to be associated with greater lateral stability. Increasing age is related to decrease in forward and sideward reaching due to a decrease in functional base of support of elderly. Height has a perfect positive correlation with forward functional reach, and a strong correlation with sideward reach. Other anthropometric measurements such as arm's length, trunk length, shoulder length revealed moderate to strong correlation with forward and sideward reach values. Though the findings of this study cannot be generalized to the whole Filipino population, they provide objective data that local rehabilitation practitioners may use when evaluating balance. This poses a challenge to conduct further studies on FR in the Philippine setting, and hopefully normal values can be derived.

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