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Original Article

Physiotherapy Section

Functional Reach Test between Dominant and Non Dominant Leg: A Cross-sectional Study

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ABSTRACT

Introduction: Elderly individuals with balance disorders are vulnerable to falls. To prevent such events, it is imperative to evaluate and recognise the underlying causes of balance-associated issues. The functional reach test measures limits of stability and balance and does not require any special apparatus. The body weight bearing is greater on the dominant side. However, there is no scientific literature on the side preference (right or left) for performing a functional reach test.

Aim: To determine the difference in functional reach test scores between the non dominant and the dominant leg.

Materials and Methods: A cross-sectional study was conducted at the Department of Physical Therapy and Health Rehabilitation, College of Applied Medical Sciences, Majmaah University, Al-majmaah, Saudi Arabia, from May 2023 to September 2023. A total of 64 healthy individuals were included. Basic demographics such as age, height, weight, Body Mass Index (BMI), and foot dominance data, were gathered. The dominant foot was established by asking participants which leg they use while kicking a ball. For the outcome measure of the difference in functional reach test scores between the non dominant and dominant leg, participants were subjected to a functional reach test, which assesses an individual's postural stability. Independent samples t-test and Analysis of Covariance (ANCOVA) were applied for statistical evaluation. A p-value <0.05 was regarded as statistically significant.

Results: A total of 64 healthy subjects participated. The mean functional reach test scores for the right side were 13.22±2.64, while the left side was 12.81±2.68. A trend was noted for a higher functional reach test score for the right side in the dominant compared to that of the non dominant side (p-value=0.076). There was also no significant difference in the adjusted mean functional reach test scores of the right side (p-value=0.134) and left side (p-value=0.266) between the two groups after controlling for gender and BMI categories.

Conclusion: The findings did not demonstrate statistically significant differences in functional reach test scores between the non dominant and dominant legs. These results imply that physical therapists could utilise functional reach test scores from both legs as a reference when evaluating unilateral balance function.

Keywords: Functional laterality, Lower extremity, Physical therapists, Postural balance

INTRODUCTION

The elderly population and individuals with balance disorders are vulnerable to falls. To prevent such events, it is imperative to timely evaluate and recognise the underlying causes of balance-associated issues [1]. Balance, in a clinical setting, is measured using several assessment tools. The 'functional reach test' is one such widely used tool in clinical practice. The functional reach test was first introduced by Duncan PW et al., (1990) and described functional reach as "the maximal distance one can reach forward beyond arm's length while maintaining a fixed base of support in the standing position" [2].

The functional reach test was developed to enable the easy measurement of the limits of stability, comparable to the centre of pressure excursion [2]. Limits of stability have been defined as the maximum distance that the centre of mass can cover securely without needing to alter the base of support. It is important to note that as limits of stability expand, so does the ability to balance [3].

Weight-bearing is primarily the role of the lower extremities. There are no functions in which one foot has to perform predominantly more than the other foot. Nevertheless, leg dominance might influence the functions of mobility and stability [4]. It is normal for individuals to have a fundamental inclination to tolerate slightly more weight on one lower limb than the other or to exhibit a negligible or significant difference in weight bearing between the non dominant and dominant lower extremities [5]. A dominant limb is described as the limb that demonstrates dynamic control due to an unevenness of muscular power between both lower limbs, along with recruitment patterns [6-9].

To the best of knowledge, there are no clear instructions regarding the side preference for the functional reach test. However, body weight bearing is typically more on the dominant side. Therefore, the present study aimed to determine the difference in functional reach test scores between the non dominant and dominant legs.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Physical Therapy and Health Rehabilitation, College of Applied Medical Sciences, Majmaah University, Al-majmaah, Saudi Arabia, from May 2023 to September 2023. The study was approved by the Institutional Ethics Committee, and ethical approval was granted by the Deanship of Scientific Research, Majmaah University, Saudi Arabia (Reference # MUREC-May 23/COM-2023/18-5). Written informed consent was obtained from the participants before conducting the study. It was ensured that the anonymity and confidentiality of the participants were maintained. A total of 64 subjects were included in the study according to the inclusion and exclusion criteria.

Inclusion criteria: Adults with no history of musculoskeletal or neurological disorders affecting balance, normal vision and vestibular function, the ability to stand independently, and clear identification of their dominant leg were included.

Exclusion criteria: Subjects with a history of falls in the last six months or with recent or ongoing limb injuries, fractures, surgeries,

or pain that prohibited them from maintaining an upright posture for a minimum of 30 minutes or from performing movements requiring 90° shoulder flexion were excluded.

Study Procedure

The dominant foot was established by asking participants which leg they use while kicking a ball [10]. To assess the outcome measure of the difference in functional reach test scores between the non dominant and dominant sides of the body, participants were subjected to the functional reach test. The functional reach test assesses an individual's postural stability by evaluating the greatest forward distance a person can reach while maintaining a fixed upright position. For the functional reach test, the subjects were asked to assume a standing posture with one foot across two nearby force plates, feet parallel to one another, and positioned at shoulder width. The subjects were instructed to extend their arm at the shoulder to 90°, with the elbow fully stretched, thereby reaching as far forward as possible. The distance was measured using a measuring tape. Three measurements were obtained for both the right and left sides. The sequence of assessments for the right and left sides was randomly assigned. The measurement with the largest functional reach test score for each side was incorporated into the final analysis [11].

STATISTICAL ANALYSIS

The Statistical Package for Social Sciences (SPSS) for Windows, version 24.0 (IBM Corp., Armonk, N.Y., USA), was used for data analyses. Data normality was established through the Shapiro-Wilk test. Quantitative data were presented as mean±Standard Deviations (SDs), and qualitative data were shown as frequencies and percentages. Descriptive analyses were performed. To determine between-group differences for functional reach test scores, an independent samples t-test was applied. Adjusted mean functional reach test scores (adjusted for gender and BMI categories) were obtained through ANCOVA and means with their respective 95% Confidence Intervals (CIs) were reported. A p-value<0.05 was regarded as statistically significant.

RESULTS

Characteristics of study participants: A total of 64 healthy subjects participated in present research study. Overall, the mean age of the participants was 24.78±7.05 years, and the age range was between 18 and 47 years. Female participation was predominant, with 34 participants (53.1%). The mean height (cm), weight (kg), and BMI (kg/m^2) were 163.52±9.36, 74.99±23.62, and 28.08±7.69, respectively. A total of 23 (35.9%) were classified as overweight. The left foot was found to be more dominant among 35 participants (54.7%) compared to the right foot, which was dominant in 29 participants (45.3%).

Mean functional reach test scores for the right side were 13.22±2.64, while for the left side, they were 12.81±2.68 [Table/Fig-1].

Variables	n (%)
Age (years) (mean±SD)	24.78±7.05
Gender	
Female	34 (53.1%)
Male	30 (46.9%)
Height (cm) (mean±SD)	163.52±9.36
Weight (kg) (mean±SD)	74.99±23.62
BMI (Kg/m^2)	28.08±7.69
BMI categories	
Normal	20 (31.3%)
Underweight	2 (3.1%)
Overweight	23 (35.9%)
Obese	19 (29.7%)
Foot dominance	
Right	29 (45.3%)
Left	35 (54.7%)
Functional reach test scores (mean±SD)	
Right	13.22±2.64
Left	12.81±2.68

[Table/Fig-1]: Demographic characteristics of study participants (N=64).

Difference in functional reach test scores between non dominant and dominant side: The functional reach test score for the right side of the non dominant and dominant side was 12.69±2.56 and 13.86±2.63, respectively. For the left side, the scores for the non dominant and dominant leg were 13.14±2.60 and 12.54±2.76, with the differences being non-significant (p-values=0.076, 0.381). However, a trend was noted for higher functional reach test scores on the right side for the dominant leg compared to that of the non dominant side [Table/Fig-2].

Variables	n (%)	Functional reach test scores (mean±SD)	p-value
Right foot			
Non dominant side	35 (54.7%)	12.69±2.56	0.076
Dominant side	29 (45.3%)	13.86±2.63	
Left foot			
Non dominant side	29 (45.3%)	13.14±2.60	0.381
Dominant side	35 (54.7%)	12.54±2.76	

[Table/Fig-2]: Difference in functional reach test scores between non dominant and dominant side (N=64).
*Independent samples t-test, **significant p-value-<0.05

Comparison between non dominant and dominant side for adjusted mean functional reach test scores for gender and BMI: Intergroup analysis was performed using ANCOVA to ascertain the significant difference in functional reach test scores between the non dominant and dominant sides, with gender and BMI categories as covariates. There was no significant difference in the adjusted mean functional reach test scores for the right and left sides between the non dominant and dominant groups after controlling for the effects of gender and BMI categories (p-values=0.134 and 0.266) [Table/Fig-3].

Variables	Non dominant side (n=35)	Dominant side (n=29)	p-value
Right foot	12.74 (11.83-13.65)	13.80 (12.79-14.81)	0.134
Variables	**Non dominant side (n=29)**	**Dominant side (n=35)**	**p-value**
Left foot	13.26 (12.22-14.30)	12.45 (11.50-13.39)	0.266

[Table/Fig-3]: Comparison between non dominant and dominant side for adjusted mean functional reach test scores (95% CI) for gender and BMI.
*Analysis of Covariance (ANCOVA) test, **significant p-value <0.05)

Balance is a fundamental element of numerous daily life activities. It is simply described as the ability to keep the body upright over a base of support without significant movements [12]. To maintain balance, a complex and coordinated interaction among the musculoskeletal, auditory, visual, motor, and somatosensory systems is indispensable [13]. A handful of tests are available to examine balance and related issues [14]. The 'functional reach test' is a commonly utilised clinical instrument to evaluate balance [11].

DISCUSSION

Balance is a fundamental element of numerous daily life activities. It is simply described as the ability to keep the body upright over a base of support without significant movements [12]. To maintain balance, a complex and coordinated interaction among the musculoskeletal, auditory, visual, motor, and somatosensory systems is indispensable [13]. A handful of tests are available to examine balance and related

issues [14]. The 'functional reach test' is a commonly utilised clinical instrument to evaluate balance [11].

In clinical practice, physical therapists usually compare and contrast test results obtained from both legs to decide on a treatment strategy [15]. In particular, the results of the non injured leg are widely regarded as a reference when interpreting the test findings of the other leg [16]. This has led to the emergence of a research question among several subject experts regarding whether the function of balance varies between the non dominant and dominant legs. A handful of research studies have examined the role leg dominance plays in the function of balance and stability; however, the results have been inconclusive [16,17].

A study by Muehlbauer T et al., evaluated static balance and muscle activity during one-leg standing on the dominant and non dominant legs under diverse sensory conditions with progressive difficulty in the task. However, the authors did not find significant differences in balance and electromyographic parameters between the dominant and non dominant legs, irrespective of the sensory environment [16]. On the other hand, Knight AC et al., reported greater mean displacement of the center of pressure in the medial/lateral direction in the non dominant leg for both the eyes open and closed environments when assessing balance among adolescent track and field athletes [17].

A study on volleyball athletes by Sinsurin K et al., demonstrated significant differences in the biomechanics of the non dominant and dominant legs while performing multi-directional jump landings [18]. In contrast, a study on soccer players documented no significant variation in vertical jump during the landing phase between the non dominant and dominant legs [19]. Given the above scientific literature, it is reasonable to assume that balance and stability function might vary between the non dominant and dominant legs. This is also because functional movements and weight bearing are stronger on the dominant side [5,15]. This hypothesis is immensely important from a clinical standpoint for physical therapists.

In the present research study, statistically significant differences were not observed in functional reach test scores between the non dominant and dominant legs. Present findings are in line with a recent research study by Stoddard CA et al., which also reported no significant differences between the non dominant and dominant legs in balance testing [20]. Conversely, a number of research studies have confirmed that there is variation in balance performance concerning leg dominance [21-23].

A recent systematic review and meta-analysis of 46 research studies by Schorderet C et al., reported no role of leg dominance in balance function when in a unilateral posture [24]. It has been suggested that functional performance and muscle strength are inclined towards the dominant leg [15,25]. Nevertheless, it is worth mentioning that balance is a skillset that is orchestrated by a number of elements coordinating together, such as biomechanics (muscle power and stamina), coordination of motor function, and somatosensory function [26,27]. Furthermore, their coordination and interaction depend on the type of function or task being performed [26].

To the best of present knowledge, present study is the first study ever undertaken to evaluate the role of leg dominance on balance and stability using the functional reach test. The findings of present research suggest that, in a clinical setting, physical therapists can use functional reach test scores of both legs as a reference when evaluating unilateral balance function. Furthermore, the injured leg can be compared with the non-injured leg to determine the course of treatment and rehabilitation. However, this should be interpreted carefully in such situations, as a non injured leg can also be influenced by altered weight transfer [28] or rewiring of the brain post-injury [29]. Further, detailed research studies are required in this regard.

Limitation(s)

The current research study had a few limitations that merit discussion; therefore, interpretations of the findings should be made cautiously, considering these limitations. The first limitation of the study is the small sample size, which may affect the generalisability of the present study findings to the larger population in Saudi Arabia. Secondly, the study sample consisted of healthy subjects, for whom the application of the functional reach test is relatively straightforward. It is therefore assumed that differences in functional reach test scores might emerge when evaluating elderly individuals or those suffering from musculoskeletal, auditory, visual, or vestibular issues. Additionally, due to the exploratory nature of this study and time constraints, a sample size calculation was not performed. Another limitation of the study was that leg dominance was self-reported. Author did not evaluate leg dominance through an objective assessment. Nevertheless, we believe this would not have affected the results, as leg dominance was consistent with the functional reach test scores.

CONCLUSION(S)

To conclude, the findings of the present research did not demonstrate statistically significant differences in functional reach test scores between the non dominant and dominant legs. These results imply that physical therapists could utilise functional reach test scores of both legs as a reference when evaluating unilateral balance function. Furthermore, the injured leg can be compared with the non-injured leg to determine the course of treatment and rehabilitation. While we did observe a trend of leg dominance for balance and stability, further detailed research studies are required to extend or support these findings.

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