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Correlation Between Functional Ability and Great Toe Flexor Strength in Young Adults: A Pilot Study

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ABSTRACT

Background: Functional ability refers to the capacity to perform daily tasks efficiently, which relies on maintaining balance and stability. Balance is essential for keeping the body's center of gravity aligned over a stable base and is supported by the coordination of the vestibular, visual, proprioceptive, and musculoskeletal systems. Factors such as proprioception, muscle strength, and lower extremity range of motion significantly impact functional ability. Toe flexor muscles play a vital role in providing the necessary force for anterior-posterior stability, especially when leaning forward, and contribute to the proprioceptive feedback loop that is essential for maintaining balance.

Objective: To find correlation between functional ability and great toe flexor strength in young adults.

Methodology: 12 male and female young adults with normal BMI were selected for the study. functional ability was measured using Functional Reach Test, great toe flexor strength was assessed using Pinch Guage Dynamometer. Karl Pearson's Correlation Coefficient was used for statistical analysis, with a p value < 0.05 considered as significant.

Result: Statistically significant strong correlation was found between Functional Reach Test score and great toe flexor strength ($r = 0.887$, $p=0.035$) suggesting that higher the great toe flexion strength higher the functional ability score.

Conclusion: This study conluded that an increase in great toe flexor strength is associated With Improved Functional Ability In Young Adults.

Keywords: Toe flexor strength, Functional reach, Functional ability

INTRODUCTION

Postural balance in the upright position is an inherent human ability that is facilitated by neuromusculoskeletal responses.[1] These responses control the center of gravity over a small base of support and are generally established by the age of six. The ability to maintain balance in this position is a complex process that relies on the integration of multiple systems within the body. While large muscle groups, such as those around the trunk, hips, knees, and ankles, are known to play a critical role in

stabilizing balance, the role of the toe flexor muscles in these systems remains less well understood. Despite being smaller in size, the toe flexors may significantly contribute to maintaining postural balance throughout the body and over a person's lifespan, yet their precise influence on these integrated physiological systems has not been thoroughly explored.

The toe muscles generate the necessary force for maintaining anterior-posterior stability, especially when leaning forward, and contribute to proprioception, which is crucial for balance.[2] Sensory receptors in these muscles send information to the central nervous system, enabling the adjustments needed to stabilize the body and prevent falls. While often overlooked, the muscles of the ankle, calf, and toes play a vital role in everyday movements such as walking, running, and balancing. Understanding their function helps highlight their significant contribution to our body's biomechanics. Insufficient muscle strength in the toes of the foot makes it impossible for a person to perform fast postural movements like forward reaching and restricts their functional ability to reach as far as possible.

Any impairment in balance can hinder the acquisition of motor skills, resulting in diminished performance and a greater risk of falls.[3] Understanding the variables that negatively impact balance is essential for preventing injuries.

In standing balance, the base of support is typically the plantar surface of the foot. During movement, the foot acts as both a propulsive lever and a shock absorber, enduring various forces such as compressive, tensile, shearing, and rotational forces.

Any dysfunction in foot biomechanics, due to disease or injury, can disrupt lower extremity biomechanics, placing additional stress on other joints. The great toe plays a significant role in foot function. While standing, it exerts more pressure than the five metatarsal heads and the heel, with its pressure being twice that of the other four toes combined. During walking, as the great toe passively dorsiflexes, the longitudinal arch rises, the rear foot supinates, the leg externally rotates, and the plantar aponeurosis tightens. This "windlass mechanism" creates tension in the plantar fascia, forming a rigid lever for effective push-off. If this mechanism is disrupted, the timing and efficiency of push-off are compromised. As a result, great toe disorders inevitably lead to changes in both static and dynamic balance.

The control of the center of mass is managed over the planted foot, a complex structure with multiple degrees of freedom and remarkable adaptability.[1] The ten toe flexor muscles play a crucial role in foot motion, both when the foot is suspended in space and when in contact with the ground. These muscles are categorized into two groups: extrinsic muscles, which have their bellies located in the posterior lower leg (e.g., flexor digitorum longus and flexor hallucis longus), and intrinsic muscles, which have their bellies situated within the plantar aspect of the foot (e.g., flexor digitorum brevis, flexor hallucis brevis, flexor digitorum brevis, flexor digiti minimi brevis, lumbricals, interossei, and quadratus plantae). When standing upright, the toe flexors generate timely and sufficient plantarflexor torque, which is essential in preventing the center of mass from shifting forward beyond the base of support.

If a correlation is established between functional ability and great toe flexor strength it would enable the development of systemic remedies to avoid falls through the targeted strengthening of the toe flexor muscle groups. Previous research supports this association[3], demonstrating a significant relationship between great toe pressure and body sway parameters, indicating that strengthening these muscles may have a direct impact on enhancing functional capabilities and reducing the risk of impairments.

MATERIAL AND METHODS:

The study is designed as a cross-sectional investigation involving a sample size of 12 participants. A convenient sampling technique is utilized to select male and female young adults with a normal body mass index (BMI). The study population comprises individuals aged between 18 and 30 who meet the inclusion criteria, which require consent and a willingness to participate. Exclusion criteria involve individuals with a BMI outside the normal range, any injuries to the upper or lower extremities, and those unwilling to participate in the study. The materials used for the study include a pinch gauge dynamometer, measuring tape, pen, and paper.

STATISTICAL ANALYSIS:

Statistical analysis of the data was performed using SPSS 23.0. The Categorical variables were presented as frequency and percentage. Continuous variables presented as mean and standard deviation. Correlation was found using Karl-Pearson's coefficient of correlation. A p value <0.05 was considered statistically significant.

RESULTS:

Statistically significant strong correlation was found between functional reach test score and great toe flexor strength (r = 0.887, p=0.035) suggesting that higher the great toe flexion strength higher the functional ability.

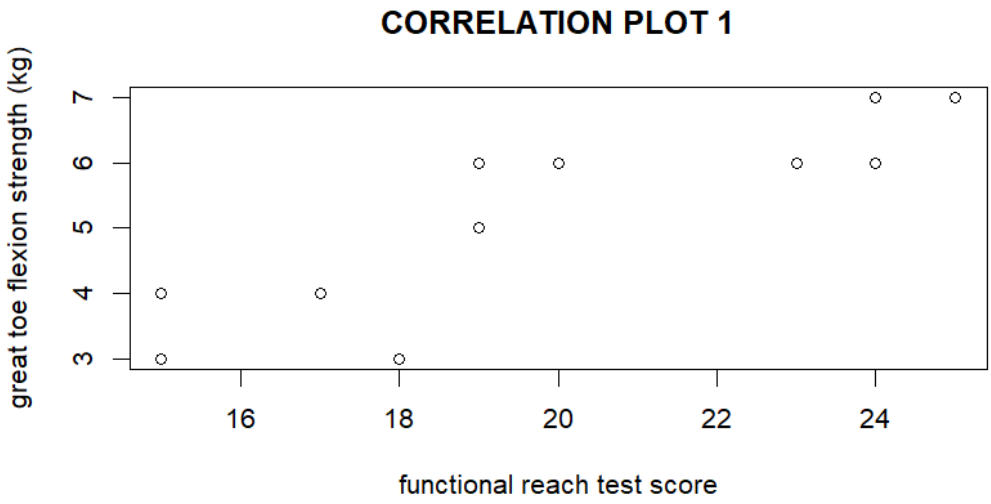

Fig 1 : Scatter diagram for functional reach test score and great toe flexor strength.

DISCUSSION

This study was done to assess the correlation between functional ability and great toe flexor strength in young adults. Functional reach test was performed for the assessment of functional ability and toe flexor strength was assessed by pinch guage dynamometer. Result of the present study showed significant correlation exists between functional ability and great toe flexor strength in young adults.

The result of correlation between functional ability and great toe flexor strength showed statistically significant Endo et al.[4] found significant correlations between the strength of the toe plantar flexors and the anterior limit of the functional base of support. The study normalized toe flexor strength, obtained

using a force plate during one-legged toe standing, to body measurements. Also demonstrated that stronger toe flexor muscles enable a greater forward shift of ground reaction force under the foot.

Chou et al.[5] also examined the role of the great toe in balancing performance. Their approach included disabling toe function by using a special toe-tying harness in a 30° dorsal bend. The authors found that directional control scores (%) were markedly lower during rhythmic weight shifting between the two toe conditions in the forward/backward direction, whereas this was not the case in the left/right direction.

Kurihara et.al[6] conducted a study to investigate the relationship between toe muscular strength and change of direction ability in athletes. The results showed that toe-pushing force, with the metatarsophalangeal joint in the dorsiflexed position, was significantly correlated with pro-agility and 3-cone test performance, while toe flexor strength, in the plantar flexed position, was not. This suggests that dorsiflexed toe-pushing strength is more influential for agility and directional changes in athletes.

The study aimed to investigate the impact of hallux valgus (HV) on functional ability, toe flexor strength, and plantar pressure in young females.[7] Results showed that participants with HV had significantly lower toe flexor strength and reduced plantar pressure in the second through fifth toes during walking compared to those without HV. HV angle was negatively correlated with toe flexor strength and plantar pressure during walking, while positively correlated with plantar pressure in the first metatarsal during functional reach. Toe flexor strength was positively correlated with maximum step length, indicating that HV may affect foot function even in young adults.

When standing individuals initiate a forward reach, they create forward angular and linear momentum of the body. To prevent their center of gravity from moving beyond the functional base of support, they must stabilize posture by coordinating muscle activation and joint movements, which helps control the generated momentum and maintain balance during the reach. Individuals with impaired toe flexor strength may be advised that their functional base of support for activities such as forward reach is diminished. When appropriate, incorporating a toe flexor strengthening program could be recommended as part of their rehabilitation.

CONCLUSION

The present study concludes that there significant correlation between functional ability and great toe flexor strength in young adults. Suggesting that an increase in great toe flexor strength is associated with improved functional ability in young adults.

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