

Correlation of Core Muscle Strength and Lower Limb Muscle Strength with Lower Limb Functional Status In Healthy Middle Old Population

Ms. Pallavi Hoge¹, Dr. Mayuri Khatavkar (PT)²

¹Intern, Bachelor of Physiotherapy, ²Assistant Professor, Community Physiotherapy, MGM College of Physiotherapy, Navi Mumbai-410206, Maharashtra, India.

Abstract:

Background: Aging is a gradual, life-long process and highly variable, characterized by a progressive and cumulative generalized impairment of physiological functions which in turn reduces functional performance and disturbs ADL's & may lead to significant impact on core & lower limb muscles, which are important in functioning. Thus, the study aimed at assessing correlation amongst the core & lower limb muscles and functional status. **Methods and procedures:** 84 participants between 70-79 years of age (Male:Female = 1:1) were assessed for core strength, Lower limb strength and functional mobility using pressure biofeedback, five times sit to stand and timed up and go test respectively and data was tabulated & analyzed further in SPSS. **Results:** Spearman's correlation was used in this study which showed significant positive correlation between core strength and lower limb strength with lower limb functional status. ($r(\text{Core})=0.813$, $r(5\text{SST})=0.893$; $p(\text{Core})=0.00$, $p(5\text{SST})=0.00$) **Discussion:** Optimal core stability helps maintain the center of gravity within the altered base of support and this could be a reason for individuals with good core strength having better functional mobility. Also force of muscle contraction is directly proportional to velocity of movement which is seen reduced in lower limb musculature because of aging in this population. **Conclusion:** The present study concluded that strong correlation of core strength and lower limb strength with functional mobility exists among middle old elderly population.

Keywords: Core strength, TUG, 5SST, Functional status, Lower limb strength, Pressure biofeedback.

Introduction:

WHO defines healthy ageing as “the process of developing and maintaining the functional ability that enables well-being in older age.” The available community-based studies have reported the prevalence of falls among elderly persons to be 2.4%–50%.[1] Middle old population in whom aging processes are accelerated shows consequences such as decrease in strength, endurance and flexibility leading to decreased coordination, stability and balance impacting on overall functional status and thus, the quality of life.

Functional status provides a more global and functional perspective of patients' health conditions and hence is increasingly used as an outcome in clinical studies. It may be discussed in terms of functional mobility which is physiological ability of people to move independently and safely in a variety

of environments in order to accomplish functional activities or tasks and to participate in activities of daily living (ADL), at home, work and in the community. It includes movements like standing, bending, walking and climbing, which are the building blocks of ADLs, and hence, these are crucial to an individual's independent living and global health status.[2, 3] Impaired functional mobility has been found to be associated with a greater risk of falls, loss of independence, and institutionalization.[4] It is well documented that aging impairs balance and functional mobility. Thus, functional mobility is a multi-system approach and has various components such as neurological system involving static and dynamic balance, movement-based system involving different musculature such as core strength, lower limb strength and various postures may be affecting ADLs.

Corresponding Author: Dr. Mayuri Khatavkar (PT)

Email ID: mayu.kadam98@gmail.com

Address: Department of Community Physiotherapy, MGM College of Physiotherapy, Navi Mumbai-410206, Maharashtra, India

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The Core is the central, key point of the body; it plays a postural role in holding the body upright and in performing selective trunk movements, during static and dynamic postural adjustments. It functions to stabilize the trunk while the arms and legs move during functional movements. There are evidences that support findings wherein there is increasing atrophy of transversus abdominus observed as age progresses.[5] Core muscles are widely used while performing daily tasks like getting up from a chair, standing, walking, cleaning and lifting objects. Functionally, trunk acts as link to transfer these forces to appendicular skeleton while executing whole body movements such as activities of daily living and instrumental activities of daily living.

As mentioned above, appendicular skeleton also plays a major role in performing functional activities and ADL's. Although studies reveal that muscle thickness in Gluteus Medius, Gluteus Minimums, Psoas Major, Rectus Femoris, Vastus Lateralis, Vastus Intermedius, Biceps Femoris and Gastrocnemius which are prime movers for activities of daily living like walking, stepping squatting. Major contributing factors for the diminishing capacity to perform basic activities of daily living (e.g. rising from a chair, walking unassisted, and climbing stairs) in elderly are age-related decrease in lower limb strength, speed, and power. Poor lower extremity physical function, especially a poor walking ability, has been found to be an important risk factor related to falls in elderly community-dwelling people.[6]

As discussed above, both core and lower limb strength may have a significant impact on functional status. Thus, it is essential to investigate the association between them to reduce health care burden and prevent further complications.

Methodology:

The study undertaken was a cross sectional study in and around Mumbai, Navi Mumbai from March 2022 to May 2022 in which sampling was done by using convenience type. 150 elderlies were screened from community set ups and tertiary health care centre. A sample size of 84 was calculated using G Power software (Male:Female = 1:1), keeping effect size as 0.3. They were falling in the age group 70-79 years

with mean age years (73.476 ± 2.98). After obtaining approval from the Institutional Ethical Committee, samples were recruited with their consent, as per our inclusion criteria and those who had recent lower limb fractures, Severe pain due to acute injuries (VAS 5+) or acute injuries limiting person's ability to walk, Severe back pain with SI joint dysfunction (VAS 5+), Neurological conditions like stroke and Parkinsonism etc. and conditions involving balance issues, Or Uncontrolled Diabetes mellitus were excluded from the study. Procedure and Purpose of the study was explained. They were assessed for Core muscle strength, lower limb muscle strength and lower limb functional status.

Core muscle strength was evaluated using pressure biofeedback unit where Patient is in prone lying. The stabilizer pressure biofeedback unit was placed horizontally under the abdomen with the lower edge just below the anterior superior iliac spine (ASIS) (navel at the center of the unit.) It was inflated up to 70 mmhg before performing Drawing in maneuver. The pressure drops 6 to 100 mmHg. It was observed if the patient could maintain pressure drop for up to 10 secs. Muscle endurance (holding for tonic capacity) of the Transversus abdominis (TrA) was measured by number of 10 secs holds (up to 10).[7]

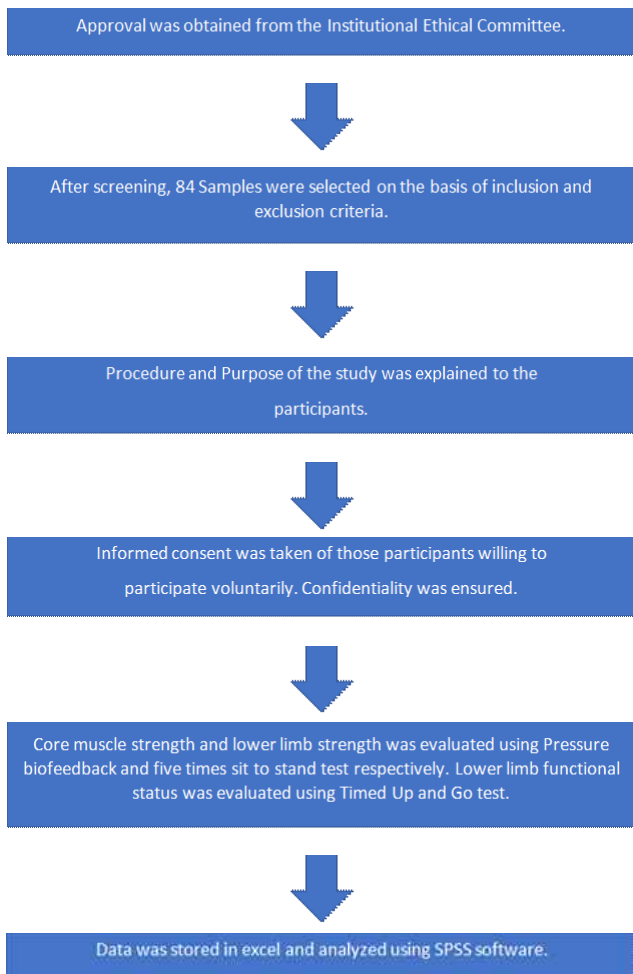
Lower limb functional status was evaluated using Timed Up and Go test where a chair was placed in an open space and three meters (9.8 feet) from the front edge of the seat was measured. A small piece of tape or chalk was used to mark the distance on the floor. Care was taken that the chair was stable and did not move when getting up. The participant sat in the chair with his arms resting comfortably on his lap or at his sides (not on the armrests). They should be seated properly with their hips positioned all the way to the back of the seat. They would then be timed as they rise from the chair, walk three meters, turn around, return to the chair, and sit down. The recorded time on the stopwatch was the TUG score.[8]

Lower limb strength was evaluated using Five times sit to stand where the patient sat with their back against the back of the chair. Each stand was counted aloud so that the patient remains oriented.

The test was stopped when the patient achieved the standing position on the 5th repetition. Patient was instructed to stand up straight as quickly as you can 5 times, without stopping in between. Keeping arms folded across chest. Time taken to complete Five sit to stands was noted.[9]

The data was tabulated, stored and evaluated in Excel wherein the Demographics were analyzed in. Data was further analyzed using SPSS software. A descriptive statistic for variables like Core strength, five times sit to stand and TUG scores was done for mean, median and interquartile range. Normality was assessed for these variables by using Kolmogorov's Smirnov test. As the data was not normally distributed, non-parametric spearman's correlation was found between Core strength and TUG as well as Five times sit to stand and TUG.

STROBE guidelines:



Results:

Our Demographics showed that the mean age of participants in our study was 73.476±2.98 years; (42 males and 42 females) and 11 of them having controlled hypertension as shown in demographics Table I below.

Table I: Demographics

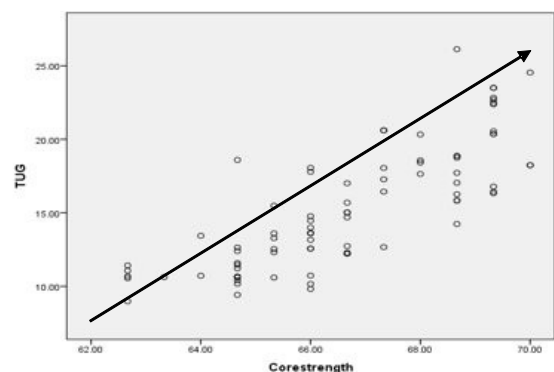
Age	Mean±SD = 73.476±2.98
Gender	No. Of Male=42 No. Of Female=42
Residence	Mumbai: 22 Navi Mumbai: 25 Others: 37
Co morbidities	HTN (controlled)= 11 DM (controlled)= 0

Correlation between core strength and lower limb functional status signifies a significant (p=0.00) and a strong positive correlation between core strength and Lower limb functional status as the r value is 0.81 as mentioned in the Table II. A graphical representation of this positive relationship can be seen in Graph 1.

Table II: Correlation between Core strength and TUG

	Median (IQR)	r-value	p-value
Core strength	66.66(65-68) mmHg	0.81	0.000
TUG	14.73(12.23-18.24) seconds		

Graph 1: Correlation between core strength and lower limb functional status

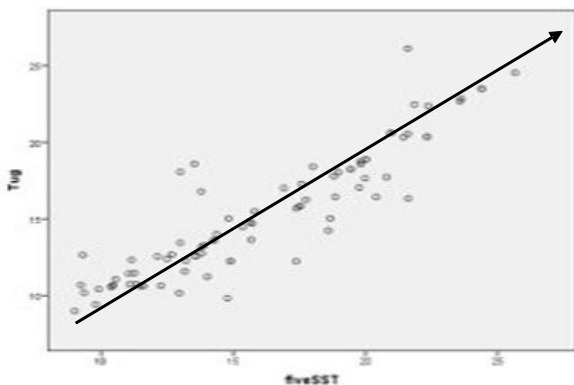


Correlation between lower limb strength and functional status signifies a significant ($p=0.00$) and a strong positive correlation between Lower limb strength and Lower limb functional status as the r value is 0.893 as mentioned in Table III. A graphical representation of this positive relationship can be seen in Graph 2.

Table III: Correlation between 5SST and TUG

	Median(IQR)	r-value	p-value
5 SST	15.50(12.75-19.82) seconds	0.893	0.000
TUG	14.73(12.23-18.24) seconds		

Graph 2: Correlation between lower limb strength and lower limb functional status



Discussion:

The purpose of this study was to investigate the correlation between lumbar core strength and lower limb strength with lower limb functional status in middle old people. The objective was to assess lower limb functional status, core strength and lower limb strength in middle old population and to find correlation between core strength as well as lower limb strength with lower limb functional status.

150 older adults were screened to obtain 84 participants (42 males and 42 females) of the age group 70-79 with the mean age of 73.47 ± 2.98 , who were fulfilling our inclusion criteria. Among them, 11 participants had controlled hypertension. They were obtained from various rural as well as urban regions. They were assessed for Functional status by using Timed up and go (TUG), Core strength by using Pressure biofeedback unit and Lower limb strength by using five times sit to stand test. A significant positive correlation was found between functional status and the core muscle strength as well as lower

limb strength in Middle old population. (Graph 1,2)

Advancing age is associated with changes in various physiological systems. Of particular interest is the musculoskeletal system because it directly contributes to mobility and functional independence. Skeletal muscle mass and strength decline with age. These changes are mostly due to a reduction in the number of muscle fibers and cellular and molecular changes that reduce the force-generation process. Skeletal muscle cross-sectional area (CSA) decreases with age.[10] This phenomenon, which is referred to as sarcopenia, can be the result of a reduction in fiber size, fiber number, or a combination of the two. Most researchers who have investigated sarcopenia have used either imaging techniques or muscle biopsies that have been performed in a cross-sectional manner.[11] The results of microscopic evaluation of cross-sections from whole human vastus lateralis muscles suggest that, although a small reduction in fiber size may occur, a reduction in the total number of fibers within a muscle is the primary source of sarcopenia.[12] Researchers have also demonstrated that, in addition to the decrease in skeletal muscle CSA, the muscles of older people (65–83 years of age) contain less contractile tissue and more noncontractile tissue when compared with the skeletal muscle of younger people (26–44 years of age).[13] A greater percentage of noncontractile tissue (fat and connective tissue) results in a decreased force production capability. The change in tissue composition in older people suggests that their muscle mass may be reduced to a greater extent than can be determined by measurements of muscle CSA alone. Of the musculature, few muscles pose great importance in carrying out daily tasks. Core plays an important role in postural stabilization. Lower limb has a crucial role in performing dynamic activities and ADL's.

Core strength and lower limb functional status:

Out of various core muscles, the superficial abdominal muscles, for example, rectus abdominis and the external and internal oblique muscles, are often seen involved in stability as well as bending and rotation movements of the trunk. The deep abdominal muscles, such as the transversus abdominis muscle, have an important role to play in stabilizing the lumbar spine.[14]

As age progresses, there were seen various degenerative changes such as atrophy in overall abdominal muscles. Out of which there was seen a slow but gradual impact on transversus abdominis.[15] According to Barbosa et al (2002), the functional capacity of older individual's declines with the onset of aging. this affects both static and dynamic balance, proprioception, strategies, etc. This may result in an increased risk of falls.[16] This is linked with quality of core strength attained at given instance.

It was stated by Brittenham et al. That Trunk has 60% of the mass of one's body and thus trunk acts as a linking chain wherein all movements of the extremities either originate or are coupled through the trunk.[17] The deep muscles are particularly important for spinal stabilization which is supported by a study performed by Nishad et al.[18] According to the kinetic chain theory, core stability is the ability to control the position and motion of the trunk and pelvis relative to the extremities to allow for optimal force production dissipation and transfer to the extremities during movement.[19]

Additionally, central neurophysiologic mechanisms, which influence an individual's ability to exert a maximal effort known as central drive, may be manifested greater with maximal power production than with force production alone.[20] This is supported by Hodges et al., who found that prior to any movement of the limbs, the co-contraction of the deeper layer of transversus abdominis and multifidus muscle groups occur. This neuromuscular pre-activation is crucial in stabilizing the spine prior to any movement.[21] This further suggests that core muscles are active before the prime movers of the limbs' during any activity in the limbs. multiple activities including sit-to-stand, walking a short distance, changing direction during walking which alters the base of support. As seen previously, optimal core stability helps maintain the center of gravity within the altered base of support and this could be a reason for individuals with good core strength having better functional status. This also supports our observations which shows positive correlation between core strength and lower limb functional status in graph. Thus, it is important to work on core so as to prevent falls, injuries.

Lower limb strength and lower limb functional status: As per studies, role of lower limb is prerequisite in performing any ADLs as Lower limb strength is required to perform functional mobility. Lower limbs act as a carrier of the body that transfers or shifts body from one position to another. A kinematic study done by Schenkman M. et al (1990) suggested that hip flexors and extensors, Ankle dorsiflexors and plantar flexors and knee extensors are seen essential in lower limb movement. These would also result in maintenance of postural stability and balance and thus, further in functional mobility.[22] Lower limb muscle strength is associated with functional performance and may get affected during aging process as mentioned above. M. Callahan Et al (2011) has studied about the force-velocity relationship which describes the fact that the force-generating capacity of the muscle also depends on the contraction velocity. Which means that the force-generating capacity of the muscle also depends on the contraction velocity and on whether it is an eccentric or concentric contraction. Damien M. Callahan and Jane A. Kent-Braun found that the muscles of aged individuals' contract with less force, have slower relaxation rates, and demonstrate downward slope of force velocity relationship.[23] Low muscle mass could be defined as age-related lean tissue mass loss that usually resulted in reduced physical function, muscular strength, and mobility and so as affecting overall functional status[24] and thus, it can be associated with an increase in the risk of falling or physical disability in community-dwelling middle-aged and older adults in several studies.

From above discussion it can be postulated that there is indeed a significant impact of core strength and Lower Limb strength on lower limb Functional Status. Thus, it is needed to focus on above mentioned parameters so to improve this further. This would help in prevention of injuries, trauma and attaining appropriate QOL.

Conclusion:

The present study concluded that strong correlation of core strength and lower limb strength with functional mobility exists among middle old elderly population.

Conflict of Interest: None

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