

ARTICLE

Association of BMI And Quadriceps Muscle Strength with Physical Function in Community-Dwelling Older Adults with Knee Osteoarthritis: A Cross-Sectional Study

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ABSTRACT:

BACKGROUND: A significant cause of disability nowadays among the community-dwelling elderly population is knee osteoarthritis. Knee osteoarthritis is a frequent cause of pain and disability. In OA knee patients and ageing, the reduction in strength is greater than a decrease in muscle size. This means that the reduction in muscle quality may also contribute to impaired muscle function of the older adults and those with knee OA. **METHOD:** In this study, 60 subjects were enrolled, assessed for Body Mass Index, Quadriceps Muscle Strength with modified sphygmomanometer device, and 30-second Chair Stand Test for evaluation of physical function. **RESULTS:** There is a weaker negative relationship between BMI and Physical function in normal-weight patients. There is a tendency for reduced physical function when BMI is increased. There is a weaker positive relationship between quadriceps muscle strength and Physical function in total patients. If the quadriceps muscle strength increased, there would be an enhancement in physical function.

KEYWORDS:

Osteoarthritis, Quadriceps Muscle Strength, Physical Function, Modified Sphygmomanometer, 30s Chair Stand Test

Introduction:

The ageing word derived from the Latin word "Aetas." It is defined as 'the lifelong process of growing older at the cellular, organ, or whole-body level throughout the life span.'¹

The WHO (WORLD HEALTH ORGANIZATION) classified old age as young-old (60-74) years, old-old (75-84) years and oldest-old (more than 85 years).

In the 20th century, the elderly population represented the fastest-growing segment of the total world population³⁻⁴. A decline in physical function and significant increases in the risk for disability and dependence are typical of advanced adult age.

In humans, a number of age-related changes in various biological systems contribute to this decline including, but not limited to, decreases in muscle and bone mass, increases in body fat, loss of brain volume and cognitive capacity, loss of cardiovascular and pulmonary reserves, impaired vision and hearing function, sleeping disorders, anxiety and depression, and changes in dietary habits leading to mal undernutrition²⁻³.

Some of these changes are directly associated with lower levels of habitual physical activity. Further, pain-associated with musculoskeletal disorders frequently reported by older men and women and is associated with a reduction in their habitual level of physical activity⁷.

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Osteoarthritis (OA) is the most common joint problem in India, having 22% to 39% of incidence⁸.

In the beginning of the 20th century, the disease had been granted its name, i.e., “osteoarthritis,” which was derived from the Greek word “osteo” means “of the bone,” “arthro” means “joint” and “it is” meaning inflammation.

Moderate to severe limitations in participation activities and a decreased quality of life are the consequences of impairments in body functions and physical functioning caused by OA.¹⁰⁸

In studies done by Kinsala et al. in 2009, it was observed that there is rapid increasing OA in the elderly population in Asian countries.⁹

Obesity is a risk factor for both the development and progression of knee osteoarthritis (OA). Van Dijk et al. year suggested that BMI and older age were risk factors for worsening functioning in knee OA. Also, Visser et al. found that knee OA was associated with weight.

Knee osteoarthritis is a significant cause of disability among the community-dwelling elderly population. Knee osteoarthritis is a frequent cause of pain and disability. For many years, Osteoarthritis has been regarded as a “wear and tear” or “degenerative” condition.

Medical treatments designed to control pain and swelling can be associated with side effects.

Sarcopenia is defined as a generalized loss of skeletal muscle mass with ageing, leading to muscle weakness.⁷

In Osteoarthritis patients and ageing, reduced strength is having more impact than decrement in the muscle's size.

This suggests that the internal characteristics of a muscle, i.e., the muscle quality, if it is reduced, can lead to impairment in the muscle function of the older adults with knee osteoarthritis.

The quadriceps muscle absorbs loads and provides dynamic stability. The quadriceps

muscle weakness will result in pain at the knee joint and can contribute to OA knee.

Insufficient quadriceps strength and physical function have been linked cross-sectionally with OA knee.¹⁰

So, improvement in the quadriceps muscle strength will result in better knee joint pain complaints associated with Osteoarthritis. There will also be an improvement in the physical function of the elderly population with OA knee.

Obesity and quadriceps muscle strength are the predominant factors that affect the knee joint in the elderly population.¹¹

Overall body composition (Body Mass Index) and obesity considered as risk factors for OA of the knee joint. Many patients with Osteoarthritis of the knee are obese. The body mass index will also impact the physical functioning in community-dwelling older adults with OA knee.

As the prevalence of OA increases with age and ageing is associated with decreasing physiological function, the combination has significant health implications.

So, this study aims to explore the association of body composition, i.e., Body Mass Index and quadriceps muscle strength, which affects the physical function in community-dwelling older adults.

MATERIALS AND METHODOLOGY:

This is a Cross-sectional Study in which Sampling technique used is Purposive Sampling in Ahmednagar District.

The Sample size is 60 with Confidence level= 80%, Confidence limit= 5%, and Hypothesized Frequency= 24%. Using this formula, sample size is calculated.

$$N = \frac{(1.96)^2 \times (SD)^2}{(E)^2}$$

OUTCOME MEASURES:

1) BODY MASS INDEX (Quetelet's Index):

Calculated by = Weight (kg)/ Height (m²)

2) QUADRICEPS MUSCLE STRENGTH:

The Modified Sphygmomanometer instrument measures it. In the high sitting position, hip and knee flexed to 90°, resistance proximal to the ankle on the leg's anterior surface. For the quadriceps muscle, manual stabilization was provided at the distal and anterior on the thigh. Before the assessments, the subjects were asked to perform a submaximal isometric contraction with a modified sphygmomanometer, which was pre-inflated to 20 mmHg, then placed to resist the movements generated by the muscle group. During trial efforts, the subjects were verbally encouraged to exert their maximal isometric contractions over 5 sec. After familiarization, three trials of maximal isometric contractions were performed by the patient with the sphygmomanometer. The peak values were recorded on the data collection sheet. Rest intervals of 15 s between trials were allowed. The test-retest reliability of the modified sphygmomanometer showed high to very high ICC values ($0.77 \leq \text{ICC} \leq 0.98$; $P \leq 0.001$).¹²⁻¹³

3) 30-SECOND CHAIR STAND TEST

In 30 second duration, the maximum number of chair stand repetitions are taken into consideration. The participant stands up completely, so hips and knees are extended, from the sitting position, then completely back down, for 30 seconds. When instruction is given to subjects, start the stopwatch. The total number of chair stands completed in 30 seconds needs to be counted—the 30 sec. CST has excellent test-retest reliability. ICC values ranged from 0.97 (95% CI 0.94-0.98) to 0.98 (95% CI 0.97-0.99).¹⁴

Inclusion criteria – 1) Community-dwelling older adults. 2) Both Male and Female. 3) Age of 60 years and above. 4) Diagnosed Osteoarthritis

of the knee joint. The Kellegran-Lawrence Classification used for diagnosis of Osteoarthritis

Exclusion Criteria – 1) History of recent B/L or U/L knee replacement. 2) Had any medical conditions that can lead to impaired physical function. 3) Required an assistive device or other support to walk.

PROCEDURE

The study was done at the Out-Patient Department and in the community by organizing various camps and visiting old age homes. The Institutional Ethical Committee approved the study protocol.

The patients were enrolled in the study are having symptoms of Osteoarthritis of the knee joint. All participants signed informed consent. After explaining this study details and its benefits and risk in their language or a language, the patient can understand.

After approval of the Ethical Committee, the recruitment initiated. Subjects were selected based on Inclusion and Exclusion criteria by purposive sampling technique.

The demographic data were obtained from the assessment form; then, patients were assessed for Body Mass Index with height and weight, quadriceps muscle strength by Modified Sphygmomanometer device and Physical function performance by 30-second chair stand test. The subjects information was then noted on the data collection sheet, and by using statistical analysis tests, the results were drawn.

RESULTS:

The result was analyzed using the GraphPad InStat Version 3.06.

$P < 0.05$ considered as the level of significance ($p < 0.05$).

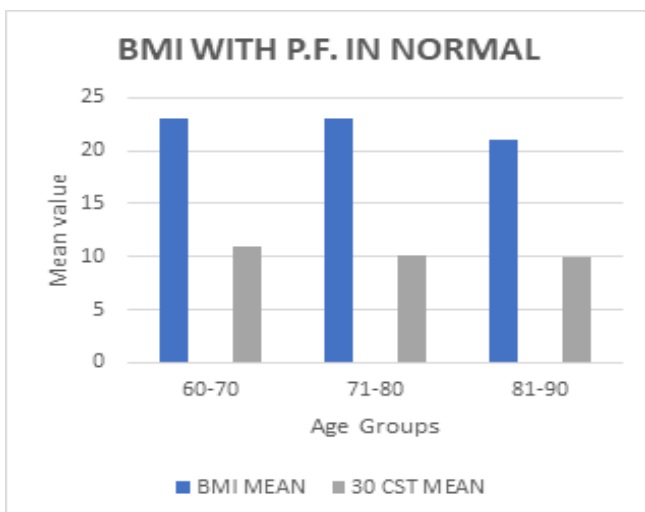
Spearman Rank Correlation test is used in the study.

Descriptive Statistics: used to characterize the study sample

Sr. No.	Characteristics of Subjects (N= 60)		Mean±SD
1.	Age		67.1±7.00
2.	Gender	Male (N=44)	68.29±7.11
		Female (N=16)	63.81±5.64
3.	BMI		26.11±3.48
4.	Quadriceps Muscle Strength		53.32±6.22
5.	30 seconds Chair Stand Test		8.95±2.69

Age Group (yrs)	No. of Subjects (N)	BMI (kg/m ²)		30 CST		No. of Subjects in Fall Risk Zone
		MEAN	SD	MEAN	SD	
60-70	15	23.08	1.62	11	3.22	3
71-80	7	23.12	1.19	10.14	2.54	2
81-90	2	21.1	1.98	10	0	0

Graph shows the Mean Values of BMI and 30 Sec. CST Scores in normal weight Subjects

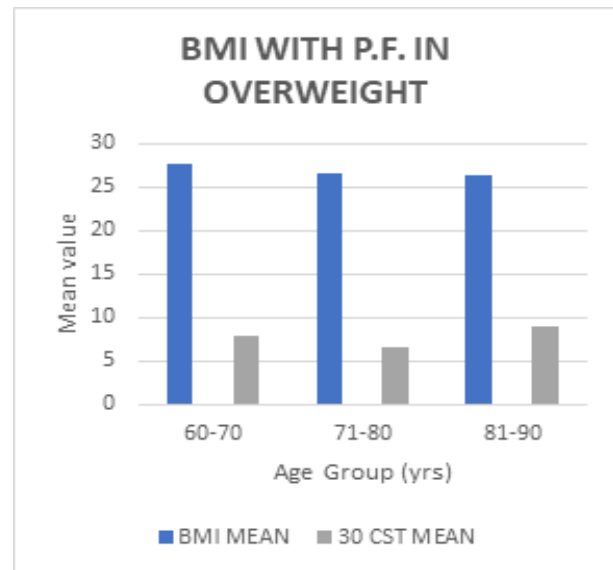


According to the score of 30 sec.chair stand test, the subjects having less than 8 score stands for Risk zone for falls. The age group of 60-70 includes 3 subjects, and 71-80 includes 2.

TABLE: Mean Values of BMI and 30 Sec. CST Scores in Overweight Subjects

Age Group (yrs)	No. of Subjects (N)	BMI		30 CST		No. of Subjects in Fall Risk Zone
		MEAN	SD	MEAN	SD	
60-70	26	27.6	1.56	7.8	1.98	16
71-80	3	26.5	0.43	6.66	1.15	3
81-90	2	26.35	0.35	9	2.82	1

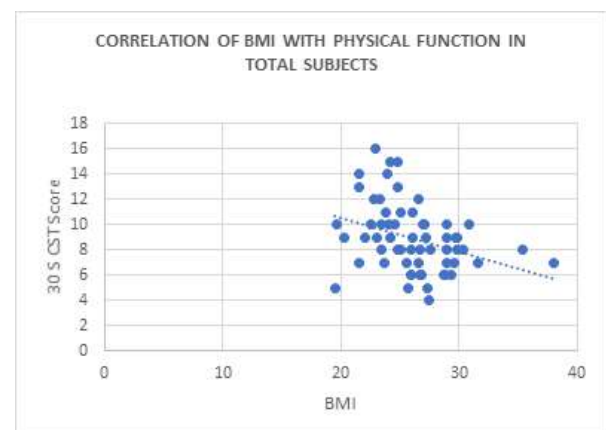
Graph shows the Mean Values of BMI and 30 Sec. CST Scores in Overweight Subjects



According to the score of 30 sec. Chair stand test, the subjects having less than 8 score stands for Risk zone for falls. The age group of 60-70 includes 16 subjects, 3 and 1 in the age group of 71-80 and 81-90 yrs, respectively.

CORRELATION OF BMI WITH PHYSICAL FUNCTION IN TOTAL SUBJECTS

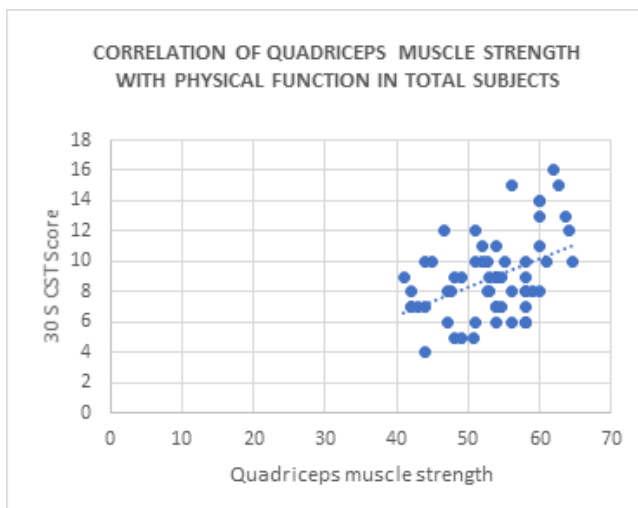
Spearman Rank Correlation (r)	95% Confidence Interval
- 0.3919	- 0.5925 to - 0.1457



There is a weaker negative relationship between BMI and Physical function in normal weight patients. There is a tendency for reduced physical function when BMI is increased.

CORRELATION OF QUADRICEPS MUSCLE STRENGTH WITH PHYSICAL FUNCTION IN TOTAL SUBJECTS

Spearman Rank Correlation (r)	95% Confidence Interval
0.3800	0.1319 to 0.5832



There is a weaker positive relationship between quadriceps muscle strength and Physical function in total patients. If the quadriceps muscle strength is increased, there will be an enhancement in physical function.

DISCUSSION

We examined the association between a physical function with BMI and Quadriceps strength in OA knee patients.

We found out the negative relationship between BMI and physical function in osteoarthritis knee patients, i.e., $r = -0.3919$, explaining that the physical function will reduce if there is a high BMI value.

And the fair, positive relationship between Quadriceps strength with physical function, i.e., $r = 0.3800$, means if quadriceps strength is reduced, then there will be a reduction in knee OA's physical performance patients and vice versa.

Young A, Stokes M, et al. explained in their study named size and strength of the

quadriceps muscle of old and young women" in 1984 that Quadriceps strength declines with age, with some evidence to suggest subsequent functional impairment.

According to McAlindon TE et al., in their research, he stated that knee extensor weakness leads to pain and physical disability in knee OA patients.¹¹ It is considered a risk factor for the progression of symptoms in persons with radiographic evidence of the disease. Therefore, improving quadriceps strength becomes crucial in persons with OA.

Obesity is one of the leading well-known risk factors for the incidence and prevalence of Osteoarthritis of the knee joint.

In patients with knee osteoarthritis, the relationship between BMI and physical function is relatively negative. Suggesting that much of the BMI affects physical ability to perform sit to stand activities, walking short and long distances, stair climbing up and down and ambulatory transitions (timed up and go test) in older people with knee osteoarthritis.

As expected, our present study results confirmed previous findings of the relationship between weight and knee OA, supporting the concept of excessive mechanical stress on the joint surface of obese individuals, resulting in damaged joint tissue.⁸⁻¹⁰

Moreover, it can be inferred that the compression of cartilage might activate mechanoreceptors on chondrocytes, inducing signalling cascades, and leading to the synthesis of inflammatory mediators and tissue remodelling. This observation confirmed that the mechanical factors of obesity appear to affect only weight-bearing joints.⁶

Hence, it suggests that obesity can worsen the physical function in older adults with knee osteoarthritis.

CLINICAL IMPLICATION: As in this study, the device used for assessing the quadriceps strength is a modified sphygmomanometer, which is a low cost, easy to use the tool in the community setup. Also, readily available, which doesn't require maintenance with high reliability.

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