International Journal of Yoga, Physiotherapy and Physical Education
ISSN: 2456-5067; Impact Factor: RJIF 5.24
Received: 14-04-2019; Accepted: 17-05-2019
www.sportsjournal.in
Volume 4; Issue 4; July 2019; Page No. 44-48

Correlation between calf muscle endurance and physical function in subjects with advanced knee osteoarthritis

Padhmanabhan Suresh Babu Roshan[1], Dr. Umananda Mallya[2], Salbin Sebastian[3*]
[1] Assistant Professor, Laxmi Memorial College of Physiotherapy, Mangalore, Karnataka, India
[2] Professor, Department of Orthopedics, A.J Institute of Medical Sciences, Mangalore, Karnataka, India
[3] Post-Graduate Student, Laxmi Memorial College of Physiotherapy, Mangalore, Karnataka, India

Abstract
Introduction: Osteoarthritis is a chronic progressive disease which accounts for major disability in elderly population. More than 50 % adults aged over 65 years of age shows x ray evidence of knee osteoarthritis. In this population 45% of women present with symptoms of osteoarthritis. Incidence and progression of knee osteoarthritis is multifactorial. Prognoses of knee osteoarthritis cause changes in normal muscle physiology in and around the knee joint. Changes in calf muscle ability to sustain muscle contraction result in increased functional disability and reduction in quality of life. Reduction calf muscle endurance result in reduced ability to maintain the contraction. So, it is necessary to identify the association between calf muscle endurance and physical function in subject with advanced knee osteoarthritis.
Methodology: This cross sectional study was consisted of 41 subjects with advanced knee osteoarthritis. Subject who met both inclusion and exclusion criteria were recruited by using convenient sampling technique. Subjects were assessed for calf muscle endurance by using standing heel rise test and physical function was assessed using WOMAC scale which consisted of three subcategories pain, stiffness and physical function. Correlations between these were estimated by using Karl Pearson correlation test.
Result: Karl pearson correlational test shows a significant negative correlation between calf muscle endurance and sub scales of WOMAC scale such as pain(r=-0.835, p= 0.000), stiffness (r=-0.609, p=0.000), physical function(r= -0,785, p=0.000) and total WOMAC score (r= -0.845, p= 0.000)
Conclusion: In this study it shows a strong negative significant correlation between calf muscle endurance and WOMAC sub scores such as pain, stiffness and physical function and total WOMAC scores. It suggests the importance of calf muscle endurance based therapeutic interventions in rehabilitative management of knee osteoarthritis.

Keywords: knee osteoarthritis, disease progression, calf muscle endurance, physical function

1. Introduction

Osteoarthritis (OA) is the most common age-related joint disease in the elderly which affects more than 80% in older population aged over 65 years of age [1]. Global statistics reveal over 100 million people worldwide suffer from osteoarthritis which is one of the commonest causes of disability [1, 2]. More than 50% population around the world (>65 years) show x ray evidence of osteoarthritis of knee joint [2, 3]. In India osteoarthritis has a prevalence of 22% to 39% [4]. It is more common in women than men, and the prevalence increases dramatically with age. Nearly, 45% of women over the age of 65 years have symptoms and 70% of those over 65 year's radiological evidence of knee osteoarthritis [5]. In females knee Osteoarthritis is a major cause of mobility impairment and it is the 10th leading cause of nonfatal burden in the health care system [6, 7].

Between the ages of 30 and 65 years the prevalence of knee osteoarthritis has been reported to increase as much as ten times that of younger age group, affecting nearly 33.6% of people; and more than 65 years with an incidence of 1 in 10. Due to the overall increase in life expectancy, there is an alarming trend for future growth in the prevalence of knee osteoarthritis [8]. Along with an increase in age; there is an exponential increase in the associated risk factor of obesity. Sedentary lifestyle, diet routine and work environmental conditions also have their own contribution towards the disease. Besides these the upcoming diabetes has its own share towards delaying the healing process of the disease.

The factors which are contributing for the development of osteoarthritis are unclear. The common and studied factors which contribute to knee osteoarthritis are Ethnicity, Hormonal Status and Bone Density, Nutritional Factors, Genetics, Obesity, Mechanical loading and Environmental loading of the Joint and Articular Cartilage, Acute Joint Injury and Joint Deformity, Participation in high intensity sports, Occupational Factors and Muscle Weakness [9, 16].

Knee osteoarthritis (OA) is the most common disease which cause of difficulty walking and reduced functional capacity in older adults [17]. Radiographic features of knee Osteoarthritis does not always correlate with the severity of knee pain, and disability. There are some other factors that could better explain knee symptoms. One of the common factors which cause pain and disability in knee osteoarthritis is the involvement of periarticular muscles. Studies have reported that in the pathogenesis of knee osteoarthritis, the periarticular muscle has been involved [18].

It has been found out that prognosis of knee osteoarthritis cause some changes in normal muscle physiology in and around the knee joint. Among them deposition of intra muscular fat was associated with increased knee pain,

limitation of physical performance, and progression of radiographic features and disease severity. Fatty infiltration in calf and thigh intra Muscular compartment is one of the reasons for functional impairment and disease progression in knee OA [19]. Changes in calf muscles in subject with knee OA can also due to delayed or altered neuromuscular activation which can be a result of arthrogenous muscular inhibition. The osteoarthritic joint causes alterations in afferent impulses from degenerated joints surfaces which will trigger release neurotransmitter at the level of the spinal cord. Increased production of neurotransmitter inhibits the activity of the alpha-motor neurons, and causes secondary muscle atrophy due reduction in muscle activity, which is known as arthrogenic muscle inhibition also reflex atrophy [20].

In patients with Knee osteoarthritis reports impairment in functional capacity and reduced quality of life (QOL) than in normal adults. Impairment occurs due to the production of pain, stiffness and limitation in range of motion of the joint. Due to this Knee OA cause a significant economic burden in the community [21]. The contemporary management goal in knee osteoarthritis is control of pain and improvement in function and health-related quality of life.

Understanding the mechanisms that contribute to loss of functional capacity with osteoarthritis has significant implications for improving health and quality of life in subjects with knee osteoarthritis. Increased fatigability during walking occurs if normal endurance of the muscle to sustain contraction for a prolonged period of time is lost which can result in reduced functional capacity. Knee osteoarthritis is associated with secondary muscular pathologies such as muscular atrophy and weakness which can cause due to reduced mobility in joints, or restriction of mobility due to pain. The observed changes in the calf muscles in subject with knee OA are due to delayed or altered neuromuscular activation. It will result in decreased medial and increased lateral gastrocnemius activation. Gastrocnemius produces a flexor moment from its origin on the medial and lateral condyles of femur [22]. This causes changes in knee biomechanics in OA and may contribute to changes in gastrocnemius function and composition. In subjects with knee osteoarthritis reduction in muscle mass, endurance and strength could result in reduced ability to maintain the contraction or the initiation in muscle contraction. So, it is necessary to identify the association between calf muscle endurance and functional capacity in subject with chronic knee osteoarthritis, In order to prevent and reduce the functional limitation and improve quality of life.

2. Materials and Method

This cross sectional study was conducted using 41 subjects who have advanced knee osteoarthritis. The sample size estimation was done by using the equation n= $\frac{Z\alpha^2\sigma^2}{d^2}$, with reference to the article by Geoff P Bostick [23] *et al*. A total of 41 samples were collected from outpatient department by using convenient sampling technique. Subject's in the age group between 40 to 60 years of age, both male and female gender, Subjects with knee osteoarthritis, as defined by American College of Rheumatology Classification criteria for knee osteoarthritis, Subjects with knee pain for >25 of the past 30 days and osteophytes on knee X-ray, Subjects with unilateral advanced knee osteoarthritis, Subjects with grade 3 & 4 knee osteoarthritis defined by Kellegran & Lawrence system for classification of knee osteoarthritis and the Subjects who are willing to sign informed concern form were included.

The exclusion criteria was Severe uncorrected visual or hearing impairment, Knee pain due to factors other than osteoarthritis (e.g., rheumatoid arthritis, gout, and metastatic cancer), Large knee effusion interfering with function more than knee pain (by participant report), A history of corticosteroid or hyaluronic acid injection in the affected knee(s) during the preceding 3 Months, Immune suppression (e.g., systemic steroids or other immune suppressants and HIV/AIDS); anticoagulation therapy (warfarin and low molecular weight heparin), And presence of pacemaker.

The subjects were explained about the study and prior consent was obtained from the study subjects. Details were collected and filled up by the instructor pertaining to objective of the study from study subjects. The subjects fulfilling the inclusive criteria were taken for the study. Anthropometric characteristics (height, body mass and body mass index) were measured. Then complete clinical evaluation of each subject was taken.

Standing heel rise test was used to measure calf muscle endurance which excellent test–retest reliability [24]. Heel rise test was performed with subject in standing on one leg with their foot on a wedge such that the foot was approximately dorsiflexed to 10 degrees. Subjects were barefoot and kept balance by touching the wall with the fingertips of both hands at shoulder level. Subjects were instructed to lift the heel as high as possible until no further heel rises could be performed due to exhaustion. Number of heel rise will be recorded. Total number of heel rises is indicative of calf muscle endurance.

The functional capacity was assessed using Western and Ontario and McMaster Universities Osteoarthritis (WOMAC) index. The WOMAC consists of 24 items divided into 3 subscales. The pain scale includes five items asking about pain at activity or rest. The stiffness scale includes two questions. The function dimension explores the degree of difficulty in daily activities [25].

3. Result

Data were analysed by the statistical program for social science (SPSS). Karl Pearson's correlation coefficient was used to check the correlation between calf muscle endurance, pain, stiffness, physical function and total WOMAC score.

Table 1: descriptive properties of studied population.

Total population N = 41		Kellegran and Lawrence grade		Mean and SD					
				Age	Calf endurance	WOMAC Pain	WOMAC stiffness	WOMAC physical function	WOMAC total
Male	Female	Grade 3	Grade 4	52.73 ± 5.97	15.51 ± 7.43	12.19 ± 3.72	4.73 ± 1.58	41.85 ± 13.14	59.02 ± 17.23
16 (39%)	25 (61%)	32 (78%)	9 (22%)						

The table1 shows the gender distribution, kellegran and Lawrence grade distribution, mean and standard deviation of age, calf muscle endurance, WOMAC pain score, WOMAC stiffness score, WOMAC physical function and WOMAC total score.

Table 2: Correlations

		Womac pain	Womac stiffness	Womac physical function	Womac total score
Calf muscle endurance	Pearson Correlation	-.835**	-.609**	-.785**	-.845**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	41	41	41	41

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the correlation values among Calf muscle endurance, WOMAC pain score, WOMAC stiffness score, WOMAC physical function, and WOMAC total score.

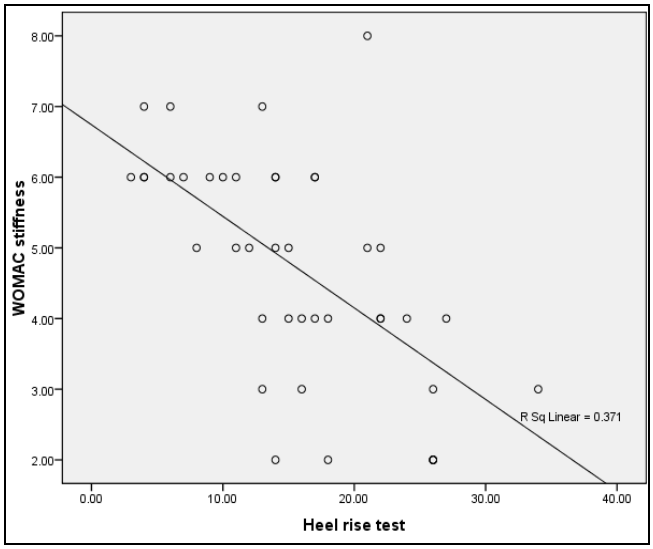

Fig 1: scatter diagram shows the relationship calf muscle endurance and WOMAC stiffness score.

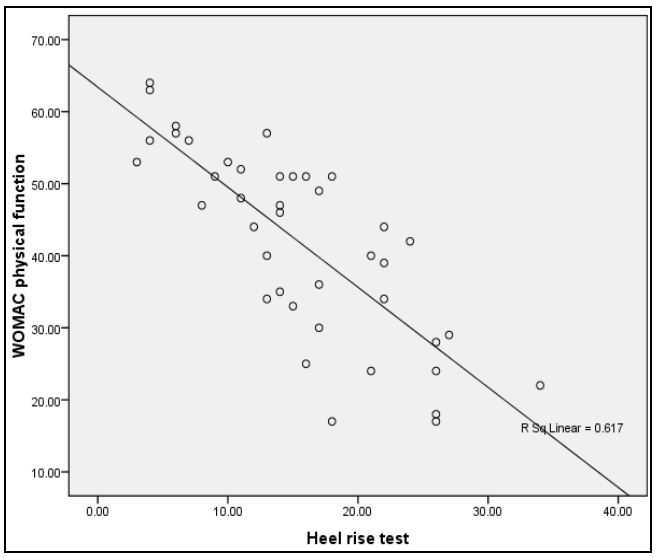

Fig 2: scatter diagram shows the relationship calf muscle endurance and WOMAC physical function score.

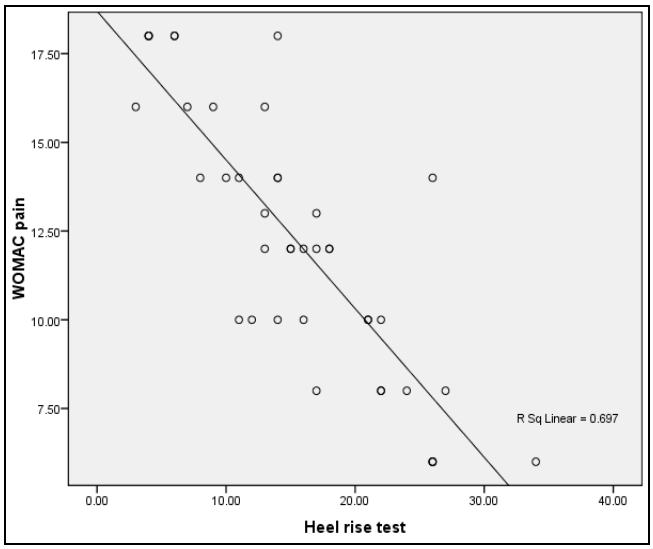

Fig 3: scatter diagram shows the relationship calf muscle endurance and WOMAC pain score.

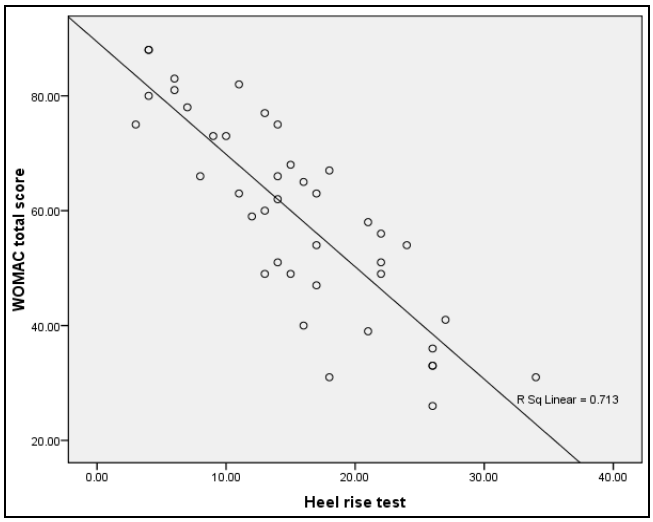

Fig 4: scatter diagram shows the relationship calf muscle endurance and WOMAC total score.

4. Discussion

Osteoarthritis is the most common joint disease, which are age related and affecting more than 80% of people in the age group 55 and above [26]. It gives more morbidity to

menopause woman and the risk is strongly associated with body mass index, and history of trauma to the joints. Common presentation of the disease is complaints of pain during stair climbing and descending, walking. It also associated with stiffness.

India has a huge amount of population beyond 55 years of age, because the population ages, the economic impact of osteoarthritis is expected to increase proportionately in coming decades [27]. As the age increases risk for the occurrence of knee osteoarthritis is also increasing. Age can also worsen the prognosis. The occurrence and worsening of knee osteoarthritis as the age increases can be due to many factors. Worsening of knee osteoarthritis can be due to cumulative exposure to various risk factors such degenerative changes and biologic changes which occur as the age advances such as hormonal imbalances and reduced muscle strength and endurance.

In this cross sectional study we recruited 41 subjects with advanced knee osteoarthritis as defined by Kellegran and Lawrence classification criteria. The mean age of the studied population was 52.7±5.79 and was consisted of 39 % males and 61% of females, among them 78 % had grade 3 knee osteoarthritis, and 22 % had grade 4 knee osteoarthritis. The sudden increase in the incidence and progression of knee osteoarthritis is more in women than in males. It can be because women in the age of menopause shows some amount of hormonal changes compared with their male counterparts and it may play a role in the development and progression of knee osteoarthritis [31].

The mean calf muscle endurance of the studied population by heel rise test was 15.51 ± 7.43 repetitions. The mean WOMAC scores for pain, stiffness, physical function and the total scores were 12.19 ± 3.72, 4.7 ± 1.58, 41.85 ± 13.14 and 59.02± 17.23 respectively. The Karl pearson correlation value between the calf muscle endurance and WOMAC scores for pain, stiffness, physical function and the total scores were r = -0.835 (p=0.000), -0.609 (p=0.000), -0.785 (p=0.000) and -0.845 (p=0.000) respectively. This show that the calf muscle endurance and WOMAC subscale scores has a significant negative correlation between the variables.

The progression of knee osteoarthritis can be slow, sudden chronic progression, or a relatively stable period with intermittent worsening of symptoms. One of the reasons which are associated with the disease progression is pain, in order to reduce pain there is a natural tendency to reduce activity. This can result in reduction in muscle bulk, strength and endurance of lower extremity muscles over a time, especially in the muscles which cross the knee joint. This is suggested as one of the reason which leads to decreased joint stability and increase stiffness in knee joint [30].

The reduction in calf muscle endurance and strength can be due to arthrogrnous muscular inhibition 37 which is, any abnormality in afferent impulses arise from the nociceptive nerves from degenerated joints surfaces will trigger increased production of neurotransmitter which in turn reduces the activity of the alpha-motor neurons and cause reduction in muscular activity and causes secondary muscle atrophy. The reduction in calf muscle property can also due to infiltration of intra muscular fat deposition as a result of prognosis of knee osteoarthritis [29].

A study has done by Michael J. Davison *et al* in 2017 shows similarities to the present study result. Their results concluded that in subject with knee osteoarthritis poor physical performance can be a result reduced normal muscle properties such as strength and endurance [29]. They also pointed that reduction in normal muscle physiology is due to increased intramuscular fat deposition in the lower limb muscle compartment. Which is not only limited to quadriceps compartment but also in the calf muscle compartment.

Ratzlaff CR *et al* from their study concluded that activity decreases over time in order to prevent noxious painful stimuli in knee osteoarthritis [28]. This will result in reduction of muscle bulk, strength and endurance of the muscles which cross over knee joint. Because of gastrocnemius is the muscle which cross knee joint and it contribute to knee flexion moment, changes in the ability of calf muscle to sustain the muscle contraction for a long period can result in increased disability and poor physical performance in knee osteoarthritis.

In summary, calf muscle endurance has a significant influence on physical function in subjects with advanced knee osteoarthritis. Our result shows that pain, stiffness and physical function are inversely correlated with calf muscle endurance. In individuals with reduced calf muscle endurance shows higher impairments in their physical function and increased pain and stiffness. This highlights the importance calf muscle endurance assessment and training in rehabilitation programme in order to prevent and reduce disabilities associated with knee osteoarthritis. Identification of calf muscle endurance deficits in early stage of knee osteoarthritis may helpful in delaying progression of knee arthritis or preventing disabilities associated with it.

Our study has few limitations; firstly our sample procedure was not a random sampling technique. This may limit the application of our result to the whole population of subject with knee osteoarthritis. Secondly we did not include other factors which may contribute to reduction in functional status and calf muscle endurance such as BMI, intensity of pain and educational level. Lastly, because of the study design we were unable to find the causative factor for reduction of disability and calf muscle endurance. Our study suggests the importance of calf muscle endurance based therapeutic interventions and exercise programs to improve functional ability in persons with knee osteoarthritis.

5. Conclusion

In this present study, results conclude that calf muscle endurance is a factor which contributes to reduction in functional ability. In this study it shows a strong negative significant correlation between calf muscle endurance and WOMAC sub scores such as pain, stiffness and physical function and total WOMAC scores. It suggests the importance of calf muscle endurance based therapeutic interventions in preventive, therapeutic and rehabilitative management of knee osteoarthritis.

6. References

1. Population Reference Bureau. India's Aging Population. Today's Research on Aging. Program and Policy Implications. No. 2012; 25:1-6.
2. Bhatia D, Bejarano T, Novo M. Current interventions in the management of knee osteoarthritis. Journal of pharmacy & bioallied sciences. 2013; 5(1):30.
3. Felson DT, Nainmark A, Anderson J, Kazis L, Castelli W, Meenan RF *et al*. The prevalence of Knee Osteoarthritis in the elderly. Arthritis Rheum.1987; 31(8):924-8.

4. Muraki S, Oka H, Akune T, Mabuchi A, En-Yo Y, Yoshida M, Saika A, Suzuki T, Yoshida H, Ishibashi H, Yamamoto S. *et al* Prevalence of radiographic knee osteoarthritis and its association with knee pain in the elderly of Japanese population-based cohorts: the ROAD study. Osteoarthritis and cartilage. 2009; 117(9):1137-43.
5. Chandra PP, Pulkesh S, Sanjay C, Kaushal KP, Ashok V. Epidemiology of knee osteo arthritis in india and related factor. Indian. J. Orthop. 2016; 50(5):518-522.
6. Klussmann A, Gebhardt H, Nübling M, Liebers F, Quirós Perea E, Cordier W, *et al*, authors. Individual and occupational risk factors for knee osteoarthritis: Results of a case-control study in Germany. Arthritis Res Ther. 2010; 12:88.
7. Cooper C, McAlindon T, Coggon D, Egger P, Dieppe P, authors. Occupational activity and osteoarthritis of the knee. Ann Rheum Dis. 1994; 53:90-3.
8. Chang. Impaired varus-valgus proprieption and neuromuscular stabilization in Medial Knee Osteoarthritis. Journal of Biomechanics. 2014; 47(2):360-366.
9. Jordan JM, Linder GF, Renner JB, Fryer JG. The impact of arthritis in rural populations. Arthritis Care Res. 1995; 8:242-50.
10. Self-Reported Osteoarthritis, Ethnicity, BMI and other Associated Risk Factors in Postmenopausal Women---Results from the Women's Health Initiative
11. Wright NC, Riggs GK, Lisse JR, Chen Z. Self-Reported Osteoarthritis, Ethnicity, Body Mass Index, and Other Associated Risk Factors in Postmenopausal Women-Results from the Women's Health Initiative. Journal of the American Geriatrics Society. 2008; 56(9):1736-43.
12. Clark AG, Jordan JM, Vilim VV, Renner JB, Dragomir AD, Luta G, *et al*. Serum cartilage oligomeric matrix protein reflects osteoarthritis presence and severity: the Johnston County Osteoarthritis Project. Arthritis Rheum. 1999; 42:2356-64.
13. Sandmark H, Hogstedt C, Lewold S. Osteoarthrosis of the knee in men and women in association with overweight, smoking, and hormone therapy. Ann Rheum Dis. 1999; 58:151-155.
14. Hannan MT, Anderson JJ, Zhang Y, Levy D, Felson DT. Bone mineral density and knee osteoarthritis in elderly men and women. The Framingham Study. Arthritis Rheum. 1993; 36:1671-80.
15. Frei B. Reactive oxygen species and antioxidant vitamins: mechanisms of action. Am J Med. 1994; 97:5-13.
16. McAlindon TE, Jacques P, Zhang Y, Hannan MT, Aliabadi P, Weissman B, *et al*. Do antioxidant micronutrients protect against the development and progression of knee osteoarthritis? Arthritis Rheum. 1996; 39:648-56.
17. Guccione AA, Felson DT, Anderson JJ, Anthony JM, Zhang Y, Wilson PW, *et al*. The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. Am J Public Health. 1994; 84(3):351-8.
18. Brandt KD, Heilman MS, Slemenda C, Katz BP, Mazzuca S, Braunstein EM, *et al*. Quadriceps weakness is a risk factor for knee osteoarthritis but not for progression of radiographic severity. J Rheumatol.
19. Davison MJ, Maly MR, Adachi JD, Noseworthy MD, Beattie KA. Relationships between fatty infiltration in the thigh and calf in women with knee osteoarthritis. Aging clinical and experimental research. 2017; 129(2):291-9.
20. Wiewiorski M, Dopke K, Steiger C, Valderrabano V. Muscular atrophy of the lower leg in unilateral post traumatic osteoarthritis of the ankle joint. International orthopaedics. 2012; 136(10):2079-85.
21. Garratt AM, Brealey S, Gillespie WJ, Damask Trial Team. Patient assessed health instruments for the knee: a structured review. Rheumatology (Oxford). 2004; 43:1414-1423.
22. Li L, Landin D, Grodesky J, Myers J. The function of gastrocnemius as a knee flexor at selected knee and ankle angles. Journal of Electromyography and Kinesiology. 2002; 112(5):385-90.
23. Geoff PB, NM jomha, AA Suchak. Factors associated with calf muscle endurance recovery 1 year after Achilles tendon rupture repair, J. Orthop Sports Physther. 2010; 40:435-351.
24. Svantesson U, Herbert-Losier K, Wessman C, Alricsson M, The standing heel-rise test: reference values and test–retest reliability for healthy individuals from 20 to 81 years of age, wcpt congress 2015 / physiotherapy. 2015; 101(1):1238-1642.
25. Angst F, Aeschlimann A, Steiner W, Stucki G. Responsiveness of the WOMAC osteoarthritis index as compared with the SF-36 in patients with osteoarthritis of the legs undergoing a comprehensive rehabilitation intervention. Ann Rheum Dis. 2001; 60:834-40.
26. Weinstein SL, Buckwalter JA. Rheumatic diseases diagnosis and management. In Weinstein SL, Buckwalter JA, eds. Turek's Orthopaedics Principles and Their Application, 6th Edition. Philadelphia, PA: Lippincott Williams & Wilkins, 2005, 154-162.
27. Population Reference Bureau. India's Aging Population. Today's Research on Aging. Program and Policy Implications. No. 2012; 25:1-6.
28. Ratzlaff CR, Liang MH. Prevention of injury-related knee osteoarthritis: opportunities for the primary and secondary prevention of knee osteoarthritis. Arthritis Research & Therapy. 2010; 12(4):215.
29. Davison MJ, Maly MR, Adachi JD, Noseworthy MD, Beattie KA. Relationships between fatty infiltration in the thigh and calf in women with knee osteoarthritis. Aging clinical and experimental research. 2017; 1; 29(2):291-9.
30. Palo N, Chandel SS, Dash SK, Arora G, Kumar M, Biswal MR, *et al*. Effects of Osteoarthritis on Quality of life in Elderly Population of Bhubaneswar, India: A Prospective Multicenter Screening and Therapeutic Study of 2854 Patients. Geriatric orthopaedic surgery & rehabilitation. 2015; 6(4):269-75.
31. Hannan MT, Anderson JJ, Zhang Y, Levy D, Felson DT. Bone mineral density and knee osteoarthritis in elderly men and women. The Framingham Study. Arthritis Rheum. 1993; 36:1671-80.