Chettinad Health City Medical Journal
Volume 12, Issue 2 - 2023, Pg. No. 41-45
Peer Reviewed & Open Access Journal

Research Article

Effect of Body Mass on Quadriceps Muscle Strength among Postmenopausal Women

Ketaki Yogesh Kulkarni, Trupti Yadav

Department of Physiotherapy, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
DOI: https://doi.org/10.24321/2278.2044.202326

I N F O

Corresponding Author:
Ketaki Yogesh Kulkarni, Department of Physiotherapy, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
E-mail Id:
ketakiyk2001@gmail.com
Orcid Id:
https://orcid.org/0009-0009-3098-279
How to cite this article:
Kulkarni KY, Yadav T. Effect of Body Mass on Quadriceps Muscle Strength among Postmenopausal Women. Chettinad Health City Med J. 2023;12(2):41-45.

Date of Submission: 2022-12-23
Date of Acceptance: 2023-03-14

A B S T R A C T

Introduction: Obesity is a major public health problem, which can lead to a reduction in functional capacity and an increase in the risk of mortality. Along with this, there are detrimental effects of menopause which can cause a decrease in functional capacity. The aim of this study was to understand the effect of obesity or increased weight on quadriceps muscle strength as age-related morphological changes are more pronounced in quadriceps.

Methods: Sixty postmenopausal women aged between 50 and 70 years were divided into two groups according to body mass index (BMI): obese (n = 35) and not obese (n = 25). To assess quadriceps muscle strength, a modified sphygmomanometer was used. The procedure was done 3 times and the mean score was recorded. The same procedure was done for both legs.

Results: The results obtained by comparing the left and right quadriceps muscle with normal and increased body mass index show extreme significance with p value < 0.0001. Mean and standard deviation were used as measurements.

Conclusion: Our results show obesity or increased weight causes a decrease in quadriceps muscle strength as observed in postmenopausal women with increased body mass index.

Keywords: Obesity, Body mass index, Postmenopausal women, Quadriceps muscle strength

Introduction

Obesity and overweight are major contributing risk factors for most diseases as well as disorders which can lead to the risk of mortality.[1] According to WHO, obesity and overweight can be defined as abnormal or excessive accumulation of fat.[2] It may be measured as Body Mass Index (BMI) or Quetelet index. It is defined by a person's weight in kilograms divided by the square of that person's height in meters (kg/m^2). A higher BMI can be considered a risk factor for developing obesity along with other health issues which can reduce one's functional capacity. WHO classification of BMI is shown in Table 1.

Table 1.Cassification of BMI as per WHO

Category	BMI
Underweight	< 18.0
Normal range	18.5-24.9
Overweight	25.0-29.9
Obese type 1	30.0-34.9
Obese type 2	35.0-39.9
Obese type 3	≥ 40.0

Menopause is defined as the permanent cessation of menstruation and marks the end of the reproductive life of women.[3] Menopause is followed by the peri-menopause period which begins around 40 years or mid-40s in the Indian female population. Early menopausal symptoms include hot flushes, sweating, insomnia, headache, irritability, tiredness, dyspareunia, depression, lack of concentration, loss of memory, urinary stress incontinence, vaginal dryness, palpitation, dry mouth and eyes, restless leg, reduced skin elasticity, and muscle and joint pain.[4-6] Menopause period is characterised by various hormonal changes in which first inhibin B decreases along with a rise in follicle-stimulating hormone in the early stage followed by a decrease in oestrogen and inhibin A.[3] Obesity can be due to reduced levels of oestrogen along with poor habits. Sedentary lifestyle results in an excessive amount of fat mass contributing to loss of muscle mass and function. Women tend to lose muscle strength around the age of 50-60 years mainly due to menopause with loss of muscle mass.[7] With ageing, there is an increased risk of limitation in function along with physical disability due to decreased muscle strength and mass. There are multiple factors contributing to this phenomenon, some of which mainly contribute to a decrease in muscle strength, which includes the following:

- Loss of oestrogen and muscle mass: The oestrogen fibres are less in postmenopausal women than in men and children[8] which has an anabolic effect by stimulating IGF-1 receptors[9].
- Fibre type distribution: Type II muscle fibres have more oestrogen receptors[10] which reduce in size as well as number in the postmenopausal period.
- Contractile properties: Adenosine monophosphate kinase is a protein whose activity gets altered in menopause. It is mainly required by muscles for glucose uptake[11] and lipid oxidation. Along with this, the capacity of muscle to metabolise triglyceride gets reduced leading to an increase in fat mass and insulin resistance[12] in menopause.
- Power output, isokinetic, and isometric force: Women tend to lose muscle strength around 60 years of age due to a reduction in functional motor units[13] which can cause sarcopenia. There is evidence of reduced strength in menopause due to the reinnervation of type II fibres with type I motor units.[14]
- Exercise: To reduce or prevent muscle strength loss due to ageing, proper dietary supplements along with resistance exercise are important as muscle strength is required in everyday life activities.
- Hormone replacement: Hormone replacement therapy plays an important role in increasing muscle strength and power.[15-19]

Method

Participants

This is a comparative study conducted from May 2022 to October 2022 at Krishna Institute of Medical Sciences, Karad. The inclusion criterion was women between 50 and 70 years of age with menopause while exclusion criteria for the study were women less than 50 years of age even with menopause, women with hysterectomy done before, signs and symptoms of any neurological disease, use of any hormone therapy, history of knee injury or pain, and women who did not want to participate in the study. Therefore based on inclusion and exclusion criteria, a total of 60 postmenopausal women between the ages of 50 and 70 years participated in the study (Figure 1). Their height and weight were taken and BMI was calculated. The project was approved by the Ethics Committee of Krishna Institute of Medical Sciences deemed to be University, Karad. Informed consent was taken before the assessment.

According to WHO's BMI classification, participants were divided into two groups:

- Obese (BMI ≥ 25)
- Not obese (BMI - 18.5 to 25)

25 participants were in the not obese group and 35 participants were in the obese group.

ISSN: 2278-2044
DOI: https://doi.org/10.24321/2278.2044.202326

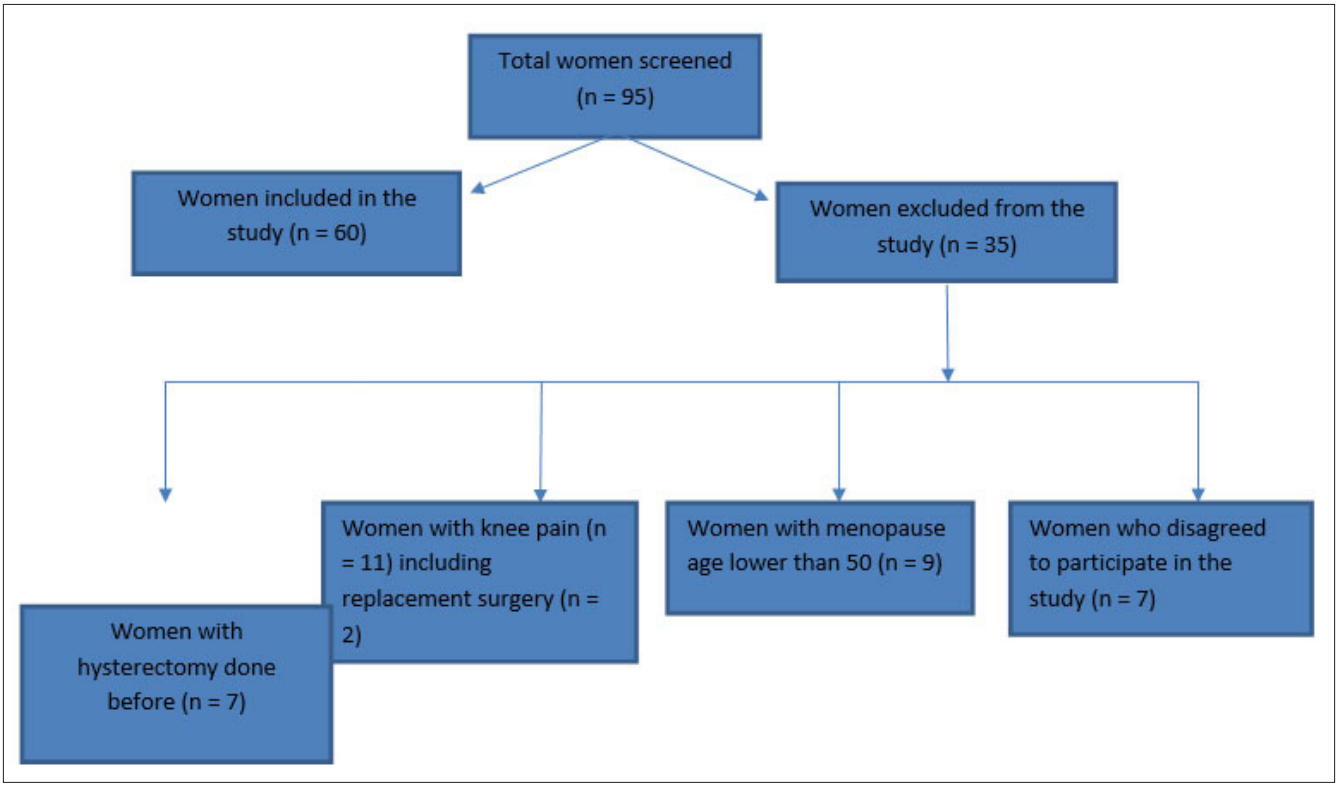

Figure 1.Screening of Participants

Table 2.Association of Quadriceps Strength with BMI

Variables	Normal BMI (Non-obese Group)	Increased BMI (Obese Group)	p Value
Age (years)	56.48	58.88	NS
Right quadriceps strength	115.32	80.286	S
Left quadriceps strength	111.40	76.000	S
BMI	22.476	28.800	S

S: Significant; NS: Not significant; Values are mean

Muscle Strength Assessment

Dynamic muscle strength of knee extensor of the left and right leg was assessed by using a modified sphygmomanometer. The bag method of modified sphygmomanometer was used.[20] For testing, the patient was seated with legs hanging naturally over the edge of the table at an approximately right angle and hands were kept on the thigh. Equipment placement was done distal and anterior to the leg such that it was parallel to the segment in a way to resist movement of the testing muscle group.[21] The patient was asked to perform knee extension thrice against the resistance of equipment placed with the maximum effort possible and the mean score was recorded. The same procedure was done for both legs.

Statistical Analysis

Mean and standard deviation were used as measurements. Unpaired t-test was used for comparing obese and not obese postmenopausal women with normal and increased BMI. The software Instat was used for statistical analysis.

Results

As seen in Table 2, the association of right and left quadriceps strength with normal body mass index (mean 115.32 and 111.40 respectively) and increased body mass index (mean 80.286 and 76.000 respectively) is significant with p value < 0.0001.

Discussion

The main aim of this study is to evaluate and compare

ISSN: 2278-2044
DOI: https://doi.org/10.24321/2278.2044.202326

quadriceps muscle strength between obese and non-obese postmenopausal women in rural areas. As we know, after menopause, muscle strength gets affected and factors like obesity, diet, awareness about exercises, cultural background, and overall lifestyle attitude have an impact on the overall health of women. Proximal muscles of the lower extremity are more affected by strength losses than those of the upper extremity due to age-related morphological changes.[22] Muscles of the lower limb are important because they help in carrying out day-to-day activities. Therefore, for a better quality of life, attention should be concentrated on the muscle strength of the lower limb which undergoes the effect of ageing.[23]

Quadriceps femoris muscle is the most voluminous muscle of the human body. It consists of four muscles mainly rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius which insert into the patella through a common tendon. Located in the anterior compartment, these collectively constitute one of the most powerful muscles in the body and form the main bulk of the thigh. Quadriceps is a highly active muscle that is involved in climbing, squatting, jumping, running, cycling, and other weight-bearing activities along with sports activities. The quadriceps is hip flexor and knee extensor; vastus medialis adducts the thigh and also extends and externally rotates it and stabilises the knee cap. Therefore, it is necessary to maintain strength in the quadriceps muscle as in postmenopausal women, with ageing, disorders like osteoarthritis, osteoporosis, and cartilage wear and tear which affect muscle strength, are very common. With ageing, there is a decline in androgen levels. This reduction increases in women after menopause.[24] Also, reduced levels of oestrogen cause obesity[25] along with other physiological changes which lead to a decrease in muscle mass and strength.

In our study, we have taken the age group between 50 and 70 years according to exclusion and inclusion criteria as there is a muscle ageing process that occurs in the fifth decade of life leading to a decrease in muscle mass.[26]

From our observations in the study, it is clear that there is significantly more muscle strength in the dominant (right) leg than that in the non-dominant (left) leg, irrespective of BMI. Our study supports the fact that muscle strength decreases in obese postmenopausal women while according to other studies, muscle strength is maintained up to the age of 40 years and there is an increase in isometric and dynamic strength up to the end of the third decade, with strength maintenance of quadriceps muscles up to the sixth decade.[26]

Conclusion

Menopause is the period after which various physiological changes occur. It leads to a decline in levels of oestrogen which reduces muscle mass and strength. We evaluated the strength of quadriceps muscle in postmenopausal women according to their body mass index and found that obese women have reduced muscle strength as compared to non-obese women. Therefore we conclude that a decrease in muscle strength occurs in postmenopausal women having increased body mass index.

Source of Funding: None

Conflicts of Interest: None

References

1. Paolillo FR, Milan JC, Bueno PG, Paolillo AR, Borghi-Silva A, Parizotto NA, Arena R, Kurachi C, Bagnato VS. Effects of excess body mass on strength and fatigability of quadriceps in postmenopausal women. Menopause. 2012 May;19(5):556-61. [PubMed] [Google Scholar]
2. World Health Organization [Internet]. Obesity and overweight; 2021 Jun [cited 2022 Dec 10]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
3. Messier V, Rabasa-Lhoret R, Barbat-Artigas S, Elisha B, Karelis AD, Aubertin-Leheudre M. Menopause and sarcopenia: a potential role for sex hormones. Maturitas. 2011 Apr 1;68(4):331-6. [PubMed] [Google Scholar]
4. Kaunitz AM, Manson JE. Management of menopausal symptoms. Obstet Gynecol. 2015 Oct;126(4):859. [PubMed] [Google Scholar]
5. Oldenhave A, Jaszmann LJ, Haspels AA, Everaerd WT. Impact of climacteric on well-being. A survey based on 5213 women 39 to 60 years old. Am J Obstet Gynecol. 1993 Mar;168(3):772-80. [PubMed] [Google Scholar]
6. Hunter MS. Psychological and somatic experience of the menopause: a prospective study [corrected]. Psychosom Med. 1990;52(3):357-67. [PubMed] [Google Scholar]
7. Maltais ML, Desroches J, Dionne IJ. Changes in muscle mass and strength after menopause. J Musculoskelet Neuronal Interact. 2009;9(4):186-97. [PubMed] [Google Scholar]
8. Wiik A, Ekman M, Johansson O, Jansson E, Esbjörnsson M. Expression of both oestrogen receptor alpha and beta in human skeletal muscle tissue. Histochem Cell Biol. 2009 Feb;131(2):181-9. [PubMed] [Google Scholar]
9. Sitnick M, Foley AM, Brown M, Spangenburg EE. Ovariectomy prevents the recovery of atrophied gastrocnemius skeletal muscle mass. J Appl Physiol (1985). 2006 Jan;100(1):286-93. [PubMed] [Google Scholar]
10. Brown M. Skeletal muscle and bone: effect of sex steroids and aging. Adv Physiol Education. 2008

Jun;32(2):120-6. [PubMed] [Google Scholar]
11. Jørgensen SB, Richter EA, Wojtaszewski JF. Role of AMPK in skeletal muscle metabolic regulation and adaptation in relation to exercise. J Physiol. 2006 Jul 1;574(1):17-31. [PubMed] [Google Scholar]
12. Ley CJ, Lees B, Stevenson JC. Sex- and menopause-associated changes in body-fat distribution. Am J Clin Nutr. 1992 May;55(5):950-4. [PubMed] [Google Scholar]
13. Campbell MJ, McComas AJ, Petito F. Physiological changes in ageing muscles. J Neurol Neurosurg Psychiatry. 1973 Apr;36(2):174-82. [PubMed] [Google Scholar]
14. Morley JE, Baumgartner RN, Roubenoff R, Mayer J, Nair KS. Sarcopenia. J Lab Clin Med. 2001 Apr;137(4):231-43. [PubMed] [Google Scholar]
15. Phillips SK, Rook KM, Siddle NC, Bruce SA, Woledge RC. Muscle weakness in women occurs at an earlier age than in men, but strength is preserved by hormone replacement therapy. Clin Sci (Lond). 1993 Jan;84(1):95-8. [PubMed] [Google Scholar]
16. Carville SF, Rutherford OM, Newham DJ. Power output, isometric strength and steadiness in the leg muscles of pre-and postmenopausal women; the effects of hormone replacement therapy. Eur J Appl Physiol. 2006 Feb;96(3):292-8. [PubMed] [Google Scholar]
17. Greeves JP, Cable NT, Reilly T, Kingsland C. Changes in muscle strength in women following the menopause: a longitudinal assessment of the efficacy of hormone replacement therapy. Clin Sci (Lond). 1999 Jul;97(1):79-84. [PubMed] [Google Scholar]
18. Kurina LM, Gulati M, Everson-Rose SA, Chung PJ, Karavolos K, Cohen NJ, Kandula N, Lukezic R, Dugan SA, Sowers M, Powell LH, Pickett KE. The effect of menopause on grip and pinch strength: results from the Chicago, Illinois, site of the Study of Women's Health Across the Nation. Am J Epidemiol. 2004 Sep 1;160(5):484-91. [PubMed] [Google Scholar]
19. Skelton DA, Phillips SK, Bruce SA, Naylor CH, Woledge RC. Hormone replacement therapy increases isometric muscle strength of adductor pollicis in post-menopausal women. Clin Sci (Lond). 1999 Apr;96(4):357-64. [PubMed] [Google Scholar]
20. Helewa A, Goldsmith CH, Smythe HA. The modified sphygmomanometer—an instrument to measure muscle strength: a validation study. J Chronic Dis. 1981 Jan 1;34(7):353-61. [PubMed] [Google Scholar]
21. Souza LA, Martins JC, Moura JB, Teixeira-Salmela LF, De Paula FV, Faria CD. Assessment of muscular strength with the modified sphygmomanometer test: what is the best method and source of outcome values? Braz J Phys Ther. 2014 Mar;18:191-200. [PubMed] [Google Scholar]
22. Candow DG, Chilibeck PD. Differences in size, strength, and power of upper and lower body muscle groups in young and older men. J Gerontol A Biol Sci Med Sci. 2005 Feb;60(2):148-56. [PubMed] [Google Scholar]
23. Afriduddin G, Joshi DD. Quadriceps muscle strength in healthy individuals of different age groups: a cross sectional study. Int J Appl Res. 2022;8(6):276-9. [Google Scholar]
24. Siparsky PN, Kirkendall DT, Garrett Jr WE. Muscle changes in aging: understanding sarcopenia. Sports Health. 2014 Jan;6(1):36-40. [PubMed] [Google Scholar]
25. Clegg DJ. Minireview: the year in review of estrogen regulation of metabolism. Mol Endocrinol. 2012 Dec;26(12):1957-60. [PubMed] [Google Scholar]
26. Doherty TJ. Invited review: aging and sarcopenia. J Appl Physiol (1985). 2003 Oct;95(4):1717-27. [PubMed] [Google Scholar]

ISSN: 2278-2044
DOI: https://doi.org/10.24321/2278.2044.202326