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ORIGINAL ARTICLE

Correlation Between Body Mass Index, Physical Activity and Quadriceps Femoris Strength in Perimenopausal Women: A Pilot Study

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ABSTRACT

Background: Perimenopause is a transitional phase characterized by hormonal fluctuations that influence anthropometric measures and physical activity behavior, and muscle strength. These alterations can affect physical capabilities and overall health among middle-aged women.

Aims: To analyze the link between body mass index (BMI), physical activity, and quadriceps femoris strength among perimenopausal women.

Settings and Design: A pilot study was carried out between community-living women in Southern Karnataka.

Methods and Materials: Fourteen community-living perimenopausal women aged 40–60 ears were identified and enrolled through convenience sampling. Perimenopausal status was confirmed using the Menopause Rating Scale (MRS). Physical activity was assessed using the International Physical Activity Questionnaire–Short Form (IPAQ-SF), BMI was calculated using standard anthropometric measurements, and quadriceps femoris strength was measured using a Hand-Held Dynamometer (HHD).

Statistical Analysis Used: SPSS was used to analyze the dataversion 29.0. Descriptive statistics and Karl Pearson's correlation coefficient were used. Statistical significance was set at $p<0.05$.

Results: BMI exhibited ainverse relationship between physical exercise ($r=-0.009$, $p=0.975$) and a modest negative relationship with quadriceps strength ($r=-0.215$, $p=0.460$). Furthermore, physical activity demonstrated a low positive association with quadriceps strength ($r=0.295$, $p=0.307$). However, none of these observed relationships reached statistical significance.

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Conclusions: This pilot study foundbody mass index and no statistically significant correlation, physical activity, and quadriceps femoris strength among perimenopausal women.Nonetheless, weakly negative correlations were observed between BMI and both physical activity and quadriceps strength, while physical activity showed a weak positive association with quadriceps strength.

Future studies incorporating a larger participant population are necessary to support these observations.

KEYWORDS

• Perimenopause • Body Mass Index • Physical Activity • Quadriceps Femoris Strength • IPAQ-SF • Hand-Held Dynamometer

INTRODUCTION

Peri-menopause is a transitional phase that precedes the complete cessation of menstruation. As per the World Health Organization, peri-menopause refers to the gradual shift from regular menstrual cycles to the cessation of periods. Throughout this transition period, there is a gradual depletion of ovarian follicles, resulting in lower estrogen levels, which causes a significant disruption in normal bodily functions.[1]

Women spend an average of 7 years in perimenopause, with more than 80% experiencing physical and psychological symptoms. The menopause transition (MT) refers to the period leading up to a woman's final menstrual cycle—typically occurring around age 51—during which estrogen levels become erratic before ultimately declining. This transitional phase is linked to a range of adverse physiological changes, including shifts in body composition, disrupted metabolic function, elevated danger of heart disease, and the emergence of menopausal symptoms.[2]

The transition into menopause involves various biological and behavioral changes that, together with hormonal alterations, may contribute to ongoing weight gain. The problem of weight change and obesity in perimenopausal women, then ismay be better explained through an ecological model that examines determinants across multiple domains, from the culture and built environment of the community to family-related factors to individual factors, such as subjective norms, values, attitudes, and beliefs, and biological genetic predispositions.[3]

At this period of a woman's life, bone mass and lean body mass gradually decrease, energy expenditure also decreases, body fat and visceral BF increase, as well as an elevated risk of cardiometabolic complications (e.g. insulin resistance, dyslipidemia).[4]

Many women experience limitations in physical function during the perimenopausal and postmenopausal periods.In a US-based cross-sectional study involving approximately 14,000 women, close to one in five participants between 40 and 55 years of age reported experiencing some degree of restriction in their physical functioning.[5]

The physical activity of perimenopausal women may decrease due to menopause-associated hormonal deficiency.[6]

Sarcopenia is a well-known condition associated with aging. The decline in muscle mass observed in aging women has beenlinked to declining estrogenlevels.[7] Among women in the perimenopausal stage, losses in muscle power become detectable as early as the first year following menopause onset. Peak muscle strength is achieved in the early 40s; thereafter muscle strength gradually declines.[8]

Females, of 50 number of years are marked by the start of hormonal alterations denoting the transitional phase or the perimenopausal state.This stage is also marked by rising fat mass alongside declining lean mass—a pattern known as sarcopenic obesity—as well as musculoskeletal complaints and vasomotor symptoms such as hot flashes.[9]

Research examining neuromuscular alterations during perimenopause has

identified modest declines in maximal isometric force output of the quadriceps (MVC) and evoked twitch torque have been suggested larger cohort studies and scoping reviews of a wider age range of females covering each decade of the lifespan (20–80 years of age) suggest an accelerated decline in quadriceps Maximum Voluntary Contraction (MVC) occurring around perimenopause that might or might not be associated withreduction in skeletal muscle mass.[10]

Particularly, Women in the perimenopausal and postmenopausal stages face a higher likelihood of weight gain.[11] Reduced physical activity (PA) levels at this time frame can contribute to reduced energy costs and greater accumulation of abdominal fat. Consequently, insufficient PA could help with postmenopausal weight gain.[12]

The menopause transition has a connection to declining degrees of physical activity (PA). These adverse shifts in PA, body composition, and muscular capacity have been connected to reduced overall physical functioning.[13] Moreover, reduced lean mass, despite an increase in overall body mass, can also facilitate loss of bone mass, increased muscle fatigue, poor balance, falls, and osteoporotic fractures.[14]

Menopausal transition exposes women to an early decline in muscle force and motor function. Changes in muscle quality and function, especially in lower limbs, are crucial, as they expose individuals to increased risk of falls. These changes expose women to an early decline in muscle quality and motor function.[15]

Objectives:

1. To assess the relationship between physical activity and BMI.
2. To assess the relationship between physical activity and quadriceps femoris strength.
3. To assess relationship between BMI and quadriceps femoris strength.

MATERIALS AND METHODS

This was a pilot researchamong perimenopausal women aged 40-60 years living in the community in Southern Karnataka. Participants were alloted using convenience sampling. Perimenopausal status of women were confirmed depending on Menopause Rating Scale score. Women with neurological disorders, musculoskeletal conditions affecting mobility, BMI ≥ 40 kg/m^2, or every circumstance that hindered their participation were excluded.

Following the collection giving informed permission in writing, subjects undertook evaluation various levels of physical activity, body mass index (BMI), and Quadriceps Femoris strength using standardized assessment tools. Physical activity levels were measured using the International Physical Activity Questionnaire–Short Form (IPAQ-SF), while perimenopausal status was determined using the Menopause Rating Scale (MRS). Measurement of Body Mass Index (BMI). Evaluating Quadriceps Femoris strength was done using Hand Held Dynamometer.

The statistical analysis was carried by utilizing SPSS version 29.0 to investigate the connection between physical activity and, BMI, and Quadriceps Femoris strength in perimenopausal women.

RESULTS

The statistical analysis was carried with SPSS version 29.0 (Version of IBM SPSS Statistics for Windows 29.0; IBM Corp., Armonk, NY). Using descriptive statisticssummarize the data, where The expression for categorical data was frequency and percentage, and continuous variables were presented as mean ± standard deviation (SD). Correlation was performed using Karl-Pearson's correlation method. A p value less than 0.05 was regarded as statistically significant.

The research comprised 14 Perimenopausal women, 8 (57.1%) belonged to the 43–49 years age group, while 6 (42.9%) belonged to the 50–56 years age group. The total sample comprised 14 (100.0%) participants. The mean participant age was 49.429 ± 4.467 years.

Table 1: Descriptive Statistics of Age of Patients

		Frequency	Percent
Age	43-49 years	8	57.1
	50-56 years	6	42.9
	Total	14	100.0

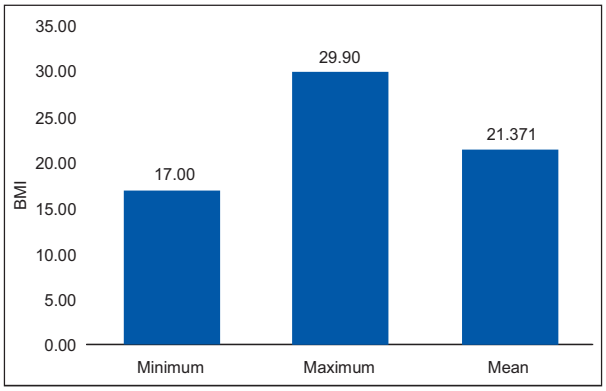


Figure 1: Representation of descriptive statistics of BMI

Body Mass Index (BMI) of participants ranged from 17.00 to 29.90, with a mean of 21.371 ± 3.514.

The International Physical Activity Questionnaire–Short Form (IPAQ-SF) scores ranged from 590.00 to 3000.00, with a mean of 1325.000 ± 673.575.

The Quadriceps Femoris Strength values ranged from 13.00 to 27.00, with a mean of 19.929 ± 4.653.

Table 2: Descriptive Statistics of Body Mass Index, Physical Activity, and Quadriceps Femoris Strength

	Minimum	Maximum	Mean	Std. Deviation
BMI	17.00	29.90	21.371	3.514
IPAQ-SF	590.00	3000.00	1325.000	673.575
Quadriceps	13.00	27.00	19.929	4.653

The investigation of the relationship between physical activity and body mass index (BMI) (IPAQ-SF) revealed a weak negative correlation (r= -0.009). There was no statistically significant correlation. (p=0.975), indicating that there was no meaningful connection between BMI and physical activity among the 14 perimenopausal women included in the study.

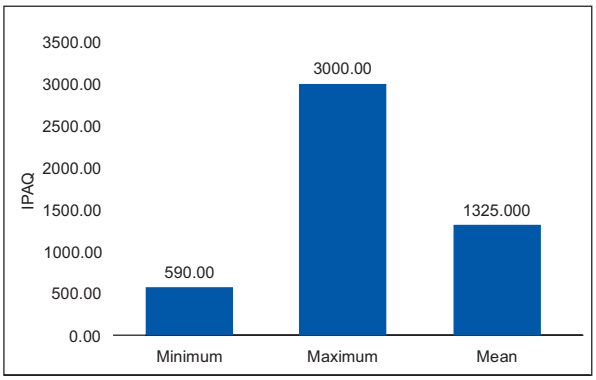


Figure 2: Representation of descriptive statistics of IPAQ

Table 3: Correlation Between Body Mass Index and Physical Activity (IPAQ-SF) Among Perimenopausal Women

		IPAQ
BMI	r value	-.009
	p value	.975
	N	14

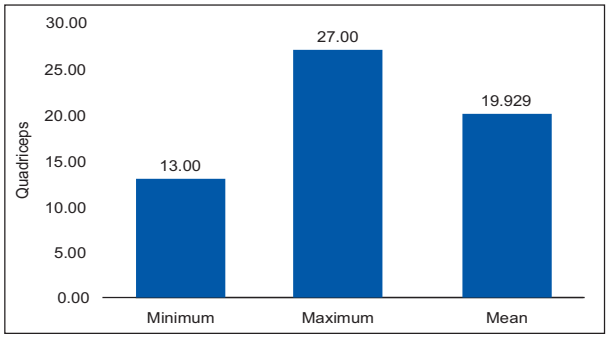


Figure 3: Representation of descriptive statistics of Quadriceps

The examination of the relationship between Body Mass Index (BMI) and Quadriceps Femoris Strength revealed a weak negative correlation (r = -0.215). There was no statistically significant correlation found(p=0.460), indicating that there was no significant relationship between BMI and Quadriceps Femoris Strength among the 14 perimenopausal women comprised of the study.

The examination of the relationship between physical activity (IPAQ-SF) and Quadriceps Femoris Strength revealed a weak positive correlation (r=0.295). The correlation did not meet statistical significance. (p=0.307), indicating that there was no meaningful connection between physical activity and Quadriceps Femoris Strength among the 14 perimenopausal women included in the study.

Table 4: Correlation Between Body Mass Index and Quadriceps Femoris Strength Among Perimenopausal Women

		Quadriceps
BMI	r value	-.215
	p value	.460
	N	14

Table 5: Correlation Between Physical Activity (IPAQ-SF) and Quadriceps Femoris Strength Among Perimenopausal Women

		Quadriceps
IPAQ-SF	r value	.295
	p value	.307
	N	14

DISCUSSION

The purpose of this pilot study was to investigate the relationship between Body Mass Index (BMI), physical activity, and quadriceps femoris strength in perimenopausal women. Perimenopause is characterized by progressive hormonal fluctuations, particularly declining estrogen levels, which may influence body composition, muscle function, and physical activity participation. These physiological alterations can affect musculoskeletal health and functional capacity during midlife.[1,2]

Participants had an average age of 49.429 ± 4.467 years, aligning with the age range commonly linked to perimenopause. The mean BMI was 21.371 ± 3.514 kg/m², demonstrating that the majority of participants were in the normal weight category. The average score for physical exercise was 1325.000 ± 673.575 MET-minutes/week, while the mean quadriceps femoris strength was 19.929 ± 4.653. These results give baseline dataregarding body composition, activity levels, and muscle strength among the womenincorporated into the research.

The initial goal was to ascertain the relationship between BMI and physical activity. The results revealed a weak negative correlation (r=-0.009, p=0.975), suggesting that greater BMI was linked to marginally reduced physical activity levels;however, the relationship was not statistically significant. This finding suggests that neither BMI nor physical exercise showed a strong relationship within this sample.

The menopause transition is frequently linked with alterations in body composition, characterized by greater fat accumulation and shifts in adipose tissue distribution.[3,4] Hormonal alterations, particularly reductions in estrogen levels, contribute to metabolic changes that may favor weight gain and increased adiposity.[21,23] Previous studies have suggested that reduced amounts of physical activity may contribute to diminished energy expenditure and weight gain in menopausal women.[11,12] Moore *et al*.[2] emphasizedthat body composition and exercise have a close relationshipduring menopause; however, this relationship is shaped by a range of lifestyle and behavioral influences. Similarly, Hyvärinen *et al*.[27] reported thatmetabolic health throughout the menopause transition is shaped by an interplay of physical activity, lifestyle habits, and physiological shifts.

Thelack of a significant association in this research could beattributed to the comparatively tiny sample size andminimal variability in BMI values. As most participants fell within the normal BMI range, variations in levels of physical exercise might not have been sufficiently captured through BMI alone. Additionally, factors such as occupation, caregiving responsibilities, motivation, and health awareness could influence physical activity independent of body weight. Consequently, Physical activity behavior may not be sufficiently captured by BMI aloneamong perimenopausal women.

The second objective was to evaluate the connection between BMI and quadriceps femoris strength. The findings demonstrated a weak inverse relationship (r=-0.215, p=0.460), indicating that BMI-higher women values tended to exhibit lower quadriceps strength. However, the relationship was not statistically significant.

This observation may be explained by physiological changes occurring during the menopausal transition,Falling Decreases in skeletal muscle mass, muscle quality, and neuromuscular function.[8,10] These changes may contribute to decreases in muscle strength and functional performance. Greeves *et al*.[28] reported a decline in muscle strength following menopause, while Smith-Ryan *et al*.[7] observed alterations in muscle size and quality during the menopausal transition. These findings suggest that hormonal shifts may adversely impact muscle function even prior to menopause onset.

Previous research has also indicated that excess body mass may adversely influence lower-limb muscle performance. Paolillo *et al*.[14] reported reduced quadriceps performance amongpostmenopausal women with higher body mass. Ward-Ritacco *et al*.[13] similarly found that adiposity was independently linked to reduced physical function and muscle quality. In a comparable manner, Kulkarni and Yadav[29] reported an inverse correlation between body mass and quadriceps strength in postmenopausal women.

Despite these findings, BMI has recognized limitations as a measure of body composition becauseit fails to differentiate between lean tissue and fat mass.[32] Individuals with

comparable BMI values can have substantially different body composition profiles. As a result, BMI alone may not adequately capture the factors influencing muscle strength. This constraint could partially explain the weak, non-significant relationship found in the current investigation.

The third objective was to look at the connection between physical activity and quadriceps femoris strength. The findings revealed a weak positive correlation (r=0.295, p=0.307), suggesting that participants engaging in increased physical activity levels tended to show greater quadriceps strength. Although this correlation did not achieve statistical significance, the positive trend corresponds with the known beneficial effects of physical activity on muscle function.

Consistent physical activity plays a key role in preserving muscle mass, enhancing neuromuscular efficiency, and maintaining functional capacity. Exercise promotes muscle protein synthesis and helps offset age-associated reductions in muscle strength.[39,40] Resistance and weight-bearing Physical activity is very beneficial for sustaining lower-limb muscle function in elderly and middle-aged women. Research on exercise interventions has repeatedly shown favorable effects on muscle strength, balance, and overall physical performance.[41,42]

The study's findings align with prior research. Pietrosimone *et al*.[30] discovered that stronger quadriceps was linked to higher physical activity levels. Bondarev *et al*.[31] observed that physically active women maintained better physical performance during the menopausal transition. According to these research, exercising may contribute to better muscle function and overall physical health.

The absence of statistical significance in this study might result from the limited sample size. Pilot studies are primarily intended to evaluate feasibility and produce first insights instead of confirm definitive relationships. With fewer participants, statistical power is reduced, increasing the chance of non-significant results even when meaningful trends exist. Additionally, physical activity was assessedvia a self-reported questionnaire, which is susceptible to recall bias and inaccuracies in reported activity levels.

Overall, the present study identified weak correlations among BMI, physical activity, and quadriceps femoris strength, with none of the associations reaching statistical significance. Nevertheless, the direction of the observed relationships is in line with previous research showing that body composition and physical activity could be involved in muscle strength during the menopause transition. The findings indicate that women with elevated BMI tended to exhibit lower physical activity and diminished quadriceps strength, while greater physical activity levels corresponded with higher quadriceps strength.

The primary limitation of study was the tiny sample size, which limited the capacity to detect statistically significant associations. Furthermore, BMI was used as an indirect measure of body composition muscle mass and adiposity. Physical activity was measured using self-report methods, which may introduce a degree of measurement bias. Despite these drawbacks, the research offers helpful initial understanding of how body composition, physical activity, and muscle strength interact among perimenopausal women.

Future research should use objective physical activity measurements and strive for larger sample numbersand body composition. Such research could offer greater clarity on the factors affecting quadriceps strength throughout the menopause transition, and support the development of targeted physiotherapy and lifestyle strategies to preserve musculoskeletal health and functional independence in perimenopausal women.

CONCLUSION

This preliminary investigation looked at the connection between BMI, exercise, and quadriceps femoris strength in perimenopausal women. Weak correlations emerged—negative BMI in relation to physical activity, negative among BMI and quadriceps strength, and positive link physical exercise and quadriceps strength—though none reached statistical significance. These patterns imply that increased physical activity may support muscle strength, while higher BMI may be linked to reduced strength, with multiple physiological and lifestyle factors likely playing a role. Larger future research could be beneficialclarify these relationships and inform

targeted interventions for perimenopausal women.

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Conflict of Interest: Nil

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