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RESEARCH ARTICLE

Estimation of Patellofemoral Joint Dysfunction in Obese Post menopausal Women

Akshaya JOSHİ[1], Sandeep SHİNDE[*2] and Pooja JAİN[2]

[1]Intern, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Krishna Institute of Medical Sciences Deemed to be University, Karad, Maharashtra / India
[2]Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Krishna Institute of Medical Sciences Deemed to be University, Karad, Maharashtra / India

*Correspondingauthor: drsandeepshinde24@gmail.com

Abstract

Purpose: The purpose of this research was to estimate Patellofemoral Joint Dysfunction in obese postmenopausal women. Methods: Depending on selection criteria, 100 obese postmenopausal women were selected by simple random sampling method. Written consent was taken and a detailed outcome assessment was done by using a Numerical Pain Rating Scale for pain assessment, Range of motion of hip, knee, ankle joint, Waldron Test, Eccentric Step-down Test, and Quadriceps angle. Statistical analysis was done and results were obtained. Findings: Among the 100 participants, 63% of women experienced pain during their daily activities. The mean pain intensity at rest was 2.25 ± 1.91, and during activity, it increased to 3.28 ± 2.606 (p value < 0.0001). The range of motion in the hip, knee, and ankle joints was reduced compared to that of individuals in the same age group without pain. Specifically, Hip extension-adduction, knee extension, and ankle plantarflexion-inversion-eversion had a p value of <0.0001. For hip flexion-abduction-medial and lateral rotation, knee flexion, and ankle dorsiflexion, the p values were 0.0003, 0.1952, 0.0001, 0.003, 0.0392, and 0.0333. Additionally, 35% of women had quadriceps angles greater than 18 degrees, while the remaining 65% had angles less than 18 degrees. 63% of women exhibited crepitus during activities like stair climbing and walking. 52% of women tested positive on the Waldron Test. 60% of women showed positive findings on the Eccentric Step-down Test. Conclusion: It concluded that there is significant Patellofemoral Joint Dysfunction in obese postmenopausal women.

Keywords
Menopause, Obesity, Patello-Femoral Pain, Patello-Femoral Dysfunction, Osteoarthritis

INTRODUCTION

One of the most incongruent joints is the patellofemoral joint. The distal femur and the posterior patella articulate at the patellofemoral joint. The patellofemoral joint, which can be subjected to forces up to two to three times the body weight during daily activities, plays a crucial role in the function of the knee by increasing the extensor torque by 30%at the end of the range of motion (Arrebola et al., 2020). It was observed that the patellofemoral joint is at the highest risk of dysfunction due to abnormal joint pathomechanics of muscle weakness or pull from vastus lateralis muscle, such as increased pressure on the lateral facets of the patella, lateral subluxation and lateral dislocation (Powers, 2003). Research indicates that females with narrower femoral notch, higher body mass, more laxity, and increased Q-angle have higher lateral force on the patella, causing pain and discomfort on the lateral side of the knee and progressive deterioration of joint cartilage (Kadav et al., 2023). Dysfunction is caused by a variety of reasons such as obesity, menopause, and hormonal

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imbalance, the presence of comorbidities, unhealthy lifestyle, and irregular diet. The dysfunction of the patellofemoral joint has been associated witha variety ofphysiological, psychological and physical variables. In particular, muscle strength and range of motion compromise in Patellofemoral Joint Dysfunction. Additionally, a higher BMI has been determined as a clinical indicator of Patellofemoral Joint Dysfunction (Arrebola et al., 2020; Powers, 2003; Ferreira et al., 2020)

A condition known as obesity is distinguished by an excessive quantity of body fat (Rajan P, 2011). Recently, there has been an increase in the percentage of obese women, particularly in developing nations, making this group more susceptible to Patellofemoral Joint Dysfunction. This is due to an increase in body mass and related metabolic factors. It may increase the mechanical demand and generate excessive stress on the knee's articular cartilage causing degenerative changes and further dysfunction (Arrebola et al.,2020; Ferreira AS et al.,2020). Following menopause, hormonal changes lead to the body fat being redistributed, increaseshealth risks and also decreased physical activity. Obesity is the second biggest cause of degenerative joint disease, osteoarthritis, disability and dysfunction (Arrebola et al., 2020; Ferreira et al.,2020; Foss et al.,2012).

Permanent cessation of menstruation is termed as menopause. Menopause is a physiological and normal life event. Menopause often starts between the ages of 48 and 52 years, with 49 being the average age (Karmakar et al., 2017). At menopause, the production of estrogen is reduced by 66%.The connective tissue and skeleton of the female body depends on estrogen.During the menopausal period's the lack of estrogen has a detrimental effect on the health of bone, muscle, ligament, tendon, cartilage and synovial membrane; these changes are closely related to ageing. There is increase risk of Patellofemoral Joint Dysfunction if there is early menopause. The degradation of the cartilage in the knee joint is linked to menopause over time (Karmakar et al., 2017; Khadilkar, 2019; Cunha-Henriques et al., 2011; Lou et al., 2016).

The musculoskeletal health of women is becoming more and more ofathreat to their health at the midline and beyond. It was observed that a reduction in bone mineral density, due to a decrease in bone mass, is termed as osteoporosis which is highly prevalent in postmenopausal women. Another condition such as sarcopenia is the agerelated loss of muscle mass and function. Sarcopenia is prevalent in women at the age of 50 years. Osteoarthritis is a joint inflammation that develops slowly and can be brought on by cartilage deterioration. It is now known that cartilage degeneration can result from a decrease in estrogen during menopause. Degeneration of the cartilage, synovial inflammation and thickening of the capsule resulting in joint deformity and stiffness (Cunha-Henriques et al., 2011; Lou et al.,2016).

Pain is an unpleasant feeling. Pain serves a crucial physiological function by either stimulating or interfering with the motor system while simultaneously shielding tissue from an actual or perceived threat of harm (Bhore & Shinde et al., 2023). In Patellofemoral Joint Dysfunction, anterior knee pain is most commonly seen. Pain is usually non- traumatic. There is diffused knee pain which is experienced during activities that cause the loading of joints in activities such as running, jumping, squatting, and stair climbing etc (Smith et al., 2018). The Patellofemoral joint dysfunction, which is common in women, results in anterior knee pain with obvious anatomical abnormalities, such as an elevated Q angle or notable articular cartilage pathologies. Other related symptoms include a functional impairment and crepitus. Some authors claim that the patellofemoral joint dysfunction will ultimately result in osteoarthritis (Petersen et al., 2014).

It was observed that ascending and descending stairs can induce or worsen pain in more severe conditions. Climbing stairs necessitates a concentric contraction of the quadriceps, which may not cause discomfort in less severe cases. However, because descending stairs places more compressive pressure on the articular cartilage, it necessitates an eccentric contraction that may cause pain. On the other hand, reports of pain are typically multi-factorial; a larger lateral valgus vector in women may contribute to the increased occurrence of patellofemoral pain in women when compared to men (Manske & Davies, 2016).

Menopause and obesity together have negative consequences on joint health. There is a need for research because patellofemoral joint dysfunction is a common musculoskeletal condition that can significantly impact the quality of life in individuals, particularly obese postmenopausal women. Due to multiple causes of Patellofemoral Joint Dysfunction diagnosis, inspection and

treatment are challenging. In this research, we are going to assess the Patellofemoral Joint with the help of six outcome measures. However, there is limited research available on the estimation and risk factors of this condition in this specific population group. This study aims to fill this research gap by estimating Patellofemoral Joint Dysfunction. In order to develop target-specific management following individual demands, it is crucial to estimate the Patellofemoral Joint.The purpose of this research is to estimate Patellofemoral Joint Dysfunction in obese postmenopausal women.

MATERIALS AND METHODS

Hundred women participants were randomly selected for this cross-sectional study, which wascarried out using the computerized SPSS software. The study included obese women with having body mass index of 30 to 40 and postmenopausal women, with age criteria between 45 to 55 years. This study excluded participants possessing a lower body mass index than30, and participants having recent fractures and lower limb surgery. This research followed ethical standards and received approval from the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth, KIMSDU dated 19/05/2023 and numbered 616/2022-2023. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. The goal of the study was explained to the participants,and they were informed about the procedure. Each participant was evaluated for pain using the Numerical Pain Rating Scale (NPRS), Crepitus, Range of motion of hip, knee, ankle joint, Waldron Test, Eccentric Step-down Test ,and quadriceps angle.

Data Collection Tools

Numerical Pain Rating Scale (NPRS)–

The Numerical Pain Rating Scale (NPRS) is frequently employed to measure pain intensity, in which patients are asked to select a number (from 0 to 10) to represent their pain severity. Test-retest reliability was ICC=0.991(Alghadir et al., 2018).

Range of Motion

Range of motion of hip, knee, and ankle joints was taken using a universal goniometer. The starting position of the women was relaxed supine lying on the plinth. Hip movements including flexion, extension, abduction, adduction, medial and lateral rotation and knee movements including flexion, extensionand ankle movements including dorsiflexion, plantarflexion, inversion and eversion were assessed.

Quadricep Angle (Q angle)

The Q angle is the angle between a line connecting the anterior superior iliac spine to the midpoint of the patella and a line connecting the tibial tuberosity and the midpoint of the patella.The participants were lying in a supine position with their hips and knees in a neutral position and extended, their feet in a neutral position, and their quadriceps femoris muscles contracted isometrically. A manual goniometer was used. Its axis was positioned over the center of the right patella, with the distal arm over the center of the tibial tuberosity and the proximal arm over the anterior-superior iliac spine.The reliability of goniometry-based Q angle is ICC= 0.88 (Weiss et al., 2013).

Waldron Test

During the Waldron test, the examiner evaluates the patellofemoral joint by palpating the patella while the patient undergoes slow, deep knee bends. Throughout this range of motion (ROM), the examiner focuses on various aspects. The examiner checks for the presence of crepitus, which refers to a crackling or grating sensation felt or heard during movement. Crepitus is deemed significant only if it accompanies pain. I f crepitus is detected, the examiner determines where it occurs within the ROM, whether it's at the beginning, middle, or end of the movement.The examiner assesses the patient's pain level during the movement. Pain may arise in conjunction with crepitus or independently. The examiner looks for any catching sensation or poor tracking of the patella as the knee moves through the ROM. This may indicate issues with patellar alignment or instability. If pain and crepitus coincide during the movement, the test is considered positive, suggesting potential pathology or dysfunction within the patellofemoral joint.Reliability is ICC =0.81 (Ferrari et al.,2014).

Eccentric Step-down Test

The test aims to assess the presence of pain or dysfunction during a controlled eccentric (lengthening) contraction of the lower limb muscles, particularly the quadriceps, hamstrings, and gluteal muscles, while stepping down from a

raised surface.The participant stands on the 15 cm high stool or step platform.The participant places her hands on her hips for stability.The participant is instructed to slowly and steadily lower one foot down from the stool to the ground, controlling the movement with the muscles of the lower limb.The therapist closely observes the participant's movement quality, particularly focusing on the knee joint for any signs of instability, excessive movement, or pain.The test is considered positive if the participant experiences pain during the test, indicating potential dysfunction or pathology in the lower extremity musculature or joint structures.The test should be performed under the supervision of a qualified healthcare professional.Participants with known lower extremity injuries or conditions should be carefully evaluated before performing the test to ensure safety and appropriate modifications as needed.Test-retest reliability was ICC = 0.94 (Loudon et al., 2002).

Statistical Analysis

Data collected was registered in an excel sheet and the statistical analysis was conducted using SPSS 26.0 for Windows (SPSS Inc., Chicago, IL, USA). For the purpose of describing the characteristics of the research sample, descriptive statistics were used. Participants descriptive data are presented as mean, percentage, standard deviation, p value calculation of pain assessment and range of motion. Also, the descriptive statistics was used as bar diagrams, tables and percentages. The threshold for statistical significance was established at $p < 0.05$.

RESULTS

This cross-sectional study was carried out among 100 participants.

Table1. Demographic variables

Variables	No. of individuals (%)
Age (Years)	
45-50	35 (35%)
51-55	65 (65%)
Body mass index (BMI)	
Obesity Grade 1	70 (70%)
Obesity Grade 2	20 (20%)
Obesity Grade 3	10(10%)
Comorbid conditions	
Hypertension	32 (32%)
Diabetes	43 (43%)
No any comorbidities	25 (25%)
Completed months of menopause	
Less than 6 months	30 (30%)
More than 6 months	70 (70%)

Interpretation

Table1 interprets that among the 100 participants, 35 % of women aged between 45-50 years, and 65% of womenaged between 51-55 years. Participants were categorized according to grades of obesity. 70 % of women had grade 1 obesity, 20 % of women had grade 2 obesity and 10 % of women had grade 3obesity. On the other hand, comorbidities were additionally taken into account. Among100 participants, 32% had hypertension, 43% women had diabetesand25 % women had noco-morbidities. 30 % of women had completed less than 6 months of menopause. 70% of women had completed their menopause for more than 6 months.

Pain assessment

Table 2. Pain according to numerical pain rating scale

	At rest	On activity
Mean	2.25	3.28
Standard deviation	1.914	2.606
P value	<0.0001	<0.0001

Interpretation

Hundredwomen were assessed, and 63% of women had pain. Among those 63% of women 49 % had pain in the retro patellar region and the remaining 14 % had anterior knee pain. The pain

assessment was carried out by usinga Numerical Pain Rating Scale at rest and during activity. The mean of pain at rest was 2.25±1.914 and during activity was 3.28±2.606 which shows a pvalue (<0.0001) on rest and during activity. These findings indicate significant mild intensity of pain at p<0.05 experienced by women. Participants reported pain during activities like climbing or descending stairs, stepping up and down, prolonged sitting, squattingand getting up from a chair.

Range of motion

Table 3. Range of Motion

	Mean	Standard Deviation	p value
Hip joint			
Flexion	116.18	10.780	0.000303
Extension	20.8	2.913	<0.0001
Abduction	41.54	5.327	0.195112
Adduction	20.35	3.849	<0.0001
Medial Rotation	31.97	2.204	0.00014
Lateral Rotation	32.71	2.564	0.003356
Knee joint			
Flexion	129.74	12.707	0.039237
Extension	8.32	3.133	<0.0001
Ankle joint			
Dorsiflexion	11.875	1.893	0.0033
Plantarflexion	42.26	4.019	<0.0001
Inversion	25.62	3.601	<0.0001
Eversion	12.42	1.793	<0.0001

Interpretation

The average values for the hip, knee and ankle range of motion are shown in the Table No. 3. A goniometer was used to assess the range of motion of the hip, knee and ankle joint. According to this study, Range of motion of the hip, knee and ankle joint were somewhat reduced when compared with the range of motion of joints of the normal individuals of thesame age group. It was observed that, obesityand the presence of pain significantly reduced the range of motion of joints.

Quadricep angle

Table 4. Quadricep angle

	No.of individuals (%)
Quadriceps angle $>18^0$	35 (35%)
Quadriceps angle $<18^0$	65 (65%)

Interpretation

According to research, it was observed that 35% of women have quadriceps angles of more than 18 degrees and the remaining 65% have quadriceps angles of less than 18 degrees. Q angle of more than 18 degrees is considered an indicator of Patellofemoral Joint Dysfunction.

Crepitus

Research revealed that 63% of women had shown positive findings for crepitus during activities like squatting, stair climbing and walking and 37% had shown negative findings for crepitus.

Waldron Test

After analyzing thedataitwas revealed that 52% ofwomentested were positive and 48% showed negative results (Figure 1).

Eccentric step-down Test

After analyzing the datait is revealed that 60% of women are showing positive findings and the remaining 40% showing negative findings (Figure).

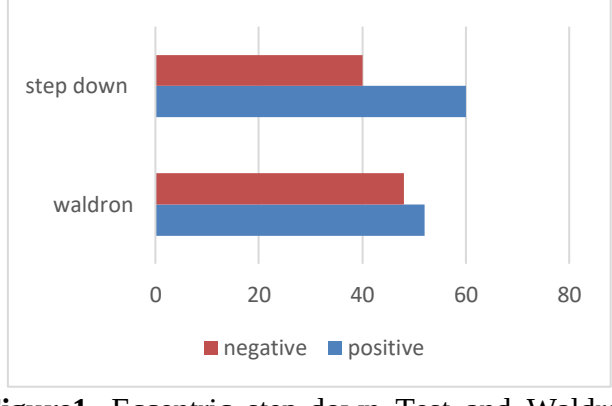

Figure1. Eccentric step-down Test and Waldron test

DISCUSSION

The purpose of this study is to estimate Patellofemoral Joint Dysfunction in obese postmenopausal women. In this study, 100 obese postmenopausal women were approached. After the selection of participants as per the criteria of the study, they were informed about thestudyand written consent was taken. Our investigations examined Patellofemoral Joint Dysfunction usingaNumericalPain Rating Scale for pain assessment, Range of motion of hip, knee, ankle joint, Quadriceps angle assessment, Waldron Test, and Eccentric Step-down Test. The tests have proven reliability and validity.

According toGao et al., 2013, 743 women between the ages of 35 and 64 were involved in this study, and 31.0% reported having knee discomfort regularly. In comparison to premenopausal women, postmenopausal women had a noticeably greater prevalence of musculoskeletal symptoms as per this study. Early menopause was the time when the prevalence of musculoskeletal problems peaked. Due to postmenopausal changes, body fat mass (kg) increases in women by 0.4 kg/year until the age of 50, at which point it increases more quickly until the age of 59, and then it slightly decreases after that. (Sahasrabuddhe et al., 2021) Along with increasing age the prevalence of joint stiffness and knee discomfort dramatically increased. Higher body mass index were linked to higher rates of joint stiffness and knee discomfort. The conclusion was that while musculoskeletal problems are known to rise with menopause, age and body mass index should also be taken into account.

Patellofemoral Joint Dysfunction suggests that the joint is afflicted by some sort of pathology. This illness could be caused by biomechanical reasons or physiological ones, including obesity or menopause related estrogen hormone insufficiency. Increased Patellofemoral Joint stress and subsequent articular cartilage wear and tear are linked with obesity and menopause, according to a widely accepted theory, that the etiology of Patellofemoral Joint Dysfunction results in Patellofemoral Joint pain. Commonly, people with Patellofemoral Joint problems experience pain during activities of daily living.

Several other studies have shown that Patellofemoral Joint Dysfunction is associated with pain in the retropatellar region. It is commonly observed that individuals with patellofemoral problems experience pain when climbing or descending stairs, when stepping up and down and with prolonged sitting when squatting and when getting up from a chair. According to Smith Be et. al., (2018), Patellofemoral pain (PFP) is one of the most common types of knee pain , with a prevalence reported to range from 15% to 45% . Knee pain is the second most common condition. It is characterized as non-traumatic and manifests as a diffused anterior knee discomfort during joint-loading movements including running, crouching and climbing and descending stairs. Crossley et al., (2004), mentioned that Numerical Pain Rating Scale assessment is reliable and valid and responsive in the assessment of Patellofemoral Joint Dysfunction.

In this study, we asked participants aboutpain, the location of pain, and activities that aggravate the pain. In this study it was observed that 63% of women had pain. Among those 49 % had pain in the retro patellar region and the remaining 14 % had anterior knee pain. Participants reported pain during activities like climbing or descending stairs, stepping up and down, prolonged sitting, squattingand getting up from a chair. Ersoz & Ergun (2003), concluded that hip range of motion is observed to be reduced by an increase in body mass index. It was found that hip rotation was higher in females than in males. It was found that,33 out of 40 knees evaluated (82.5%) in a sample of individuals with primary knee OA aged 44 to 76 reported extension limits ranging from 1 degree to 14 degrees. The results showed that, in contrast to the findings, the passive knee flexion range of motion was smaller in female subjects than in male subjects of the same age. On average, women's knee flexion was only 2 degrees less than men's.The women's lower knee flexion may have resulted from their higher BMI than the men's. According to Lichtenstein et al., (2000), among 647 community participants, it was discovered that those with higher BMIs had less range of motion in their knees than those with lower BMIs. Compared to their non-obese counterparts, subjects who were severely obese had an average loss of 13 degrees of knee flexion range of motion. The researchers found that for every unit increase in BMI, there was a loss of knee range of motion of at least 1 degree.

Nunes et al., (2013) reported that the patellar tilt and squatting test showed evidence of supporting a diagnosis of Patellofemoral Joint Dysfunction. Nunes et al., (2013) concluded that

clinical tests have more diagnostic accuracy in evaluating Patello femoral Joint Dysfunction. In this study we assessed individuals for special tests, Our findings showed 52% positive results for the Waldron Test and 60 % positive results for the Eccentric Step-down Test.

Dysfunction of the arch can cause the gait deformity, postural imbalance and other muscular imbalance (Sawant & Shinde, 2021). Ekim et al., (2017), concluded that a high Q angle was related with cartilage thickness which may further causePatellofemoral Joint Dysfunction. He used ultrasonography to measure Q angle. It was observed that high Q angle is a predictor for patellofemoral problems. The innate propensity of the patella to track laterally during dynamic motions is known as the law of valgus. The quadricep muscle linked to the femur is the cause of this valgus angulation. When compared to a smaller Q angle, a greater Q angle may result in a larger lateral vector and possibly a stronger inclination to lateral tracking. In our study, it was observed that 35 % of individuals had a Q angle of more than 18degree showing significant Patellofemoral Joint Dysfunction. 65% of individuals have a Q angle of less than 18degree. Grelsamer et al., (2005), concluded that a Q angle greater than 18 degrees is considered as Patellofemoral Joint Dysfunction.

Based on the findings, we can say that there is significant Patellofemoral Joint Dysfunction in obese postmenopausal women. We recommend that Patellofemoral Joint Dysfunction should be taken into account when treating knee joint related problems and an appropriate treatment program should be planned. The presence of pain and crepitus causes activity limitations which results in a decreased range of motion. An increase in Q angle may also cause significant impairments. All of these factors may affect the quality of life.

Activities of daily living may become painful. Sitting cross-leg, climbing ascending and descending stairs, squatting causes severe pain. With the help of assessment, range of motion assessment we can plan treatment. We can improve the quality of life of women so that they can perform their daily activities with more ease.

Limitations of this study were a smaller sample size and a smaller geographical area. In this study postmenopausal women were selected, so further attempts can select premenopausal women and future research should use larger samples to be better generalizability.

Clinical Implications

It provides an organised approach for medical professionals to identify and treat knee-related problems in this population, enhancing patient outcomes. The results may help prevent the advancement of joint dysfunction by providing targeted rehabilitation programmes to address the biomechanical issues faced by obese postmenopausal women. Through better care delivery and a contribution to the field of musculoskeletal health research, the study promotes functional independence and an enhanced quality of life.

Suggestions

Further studies can be conducted to determine patellofemoral dysfunction in postmenopausal women from other regions. Additional investigations could use more profound outcomes, such as X-rays (Knee Skyline Laurin View), to rule out patellar position for more accurate results.

Conclusion

According to the findings of this study, there was a significant Patellofemoral Joint Dysfunction in obese postmenopausal women. Along with retropatellar pain and crepitus, some participants reported anterior side of the knee pain. Significantly less lower limb range of motion was observed. Pain and high body mass index have been shown to limit the joint range of motionand an increased quadriceps angleindicate Patellofemoral Joint Dysfunction.The Eccentric Step-down Test and the Waldron Test both yielded positive results. The therapist must incorporate the research findings into the treatment plan to improve the patient's quality of life.

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Conflict of İnterest

Authors declare no conflict of interest.

Ethics Statement

This research followed ethical standards and received approval from the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth, KIMSDU dated 19/05/2023 and numbered 616/2022-2023.

Author Contributions

Study Design, PJ and SD; Data Collection, AJ; Statistical Analysis, SD; Data Interpretation, AJ and SD; Manuscript Preparation, PJ and SD; Literature Search, PJ, and AJ. All authors have read and agreed to the published version of the manuscript.

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