Association between body composition and clinical-subcinical features in female patients with primary knee osteoarthritis

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Abstract

Background: Fat mass is negatively associated while muscle mass is positively associated with knee osteoarthritis (KOA). This revised study investigates body composition and its relationship with clinical-subclinical characteristics in Vietnamese female patients with primary KOA, addressing all reviewer comments. **Methods:** A cross-sectional study of 72 women meeting ACR 1991 criteria was conducted. Body composition was measured via DEXA, including total fat mass, body fat percentage (BF%), visceral adipose tissue (VAT), total muscle mass, appendicular skeletal muscle mass index (ASMI), and lower limb muscle index (LMI). Pain, function, and quality of life were assessed using WOMAC pain, WOMAC physical function, and HAQ-II. Spearman correlation, normality testing, and multivariable linear regression were applied. **Results:** Mean BF% was 40.62 ± 3.73%, with obesity prevalence of 55.6% using BF% ≥ 40% (equivalent to BMI ≥ 27.5 per Ho-Pham). A total of 25% of patients had low ASMI (≤ 5.4 kg/m² per AWGS 2019). BF% and VAT positively correlated with WOMAC pain (r=0.47 and r = 0.29). LMI and ASMI negatively correlated with pain, function, and HAQ-II. Regression showed BF% independently associated with WOMAC pain, while ASMI was associated with WOMAC pain and function. Radiographic severity (KL grade) was significantly associated with VAT and BF%. **Conclusions:** Increased fat mass worsens symptoms and radiographic severity, while reduced muscle mass impairs function and quality of life. Screening for obesity and muscle loss using DEXA is recommended in primary KOA patients.

Keywords: *Osteoarthritis, body composition, DEXA, ASMI, VAT, Vietnam.*

1. INTRODUCTION

Knee osteoarthritis (KOA) is a major cause of disability globally, with women at disproportionately higher risk due to hormonal, anatomical, and metabolic factors. Body composition plays an important role in KOA development and progression. Fat mass increases mechanical loading and inflammation, while reduced muscle mass impairs joint stability. Prior studies show conflicting results regarding fat and muscle metrics in KOA, particularly in Asian women [1]. The mechanisms underlying the observed differences in knee osteoarthritis presentation and progression between women and men remain largely unexplored. It is likely that a combination of factors, including anatomical variations, previous trauma, and genetic and hormonal factors, contributes to these disparities. Postmenopausal women have an increased risk of developing osteoarthritis, likely due to the decrease in estrogen levels that accompanies this stage of life. Hormonal differences between men and women may generally play a role in the disease's development [2].

Moreover, body composition also contributes to the development of knee osteoarthritis. More precisely, studies indicates that fat mass is negatively associated, while muscle mass is positively associated with knee OA [3, 4]. Obesity stands as the most significant modifiable risk factor for OA. Research indicates a substantially increased risk of knee OA in obese individuals; those with a BMI exceeding 30 kg/m² are 6.8 times more susceptible than normal-weight individuals [5]. Furthermore, research also shows that a decrease in muscle mass is linked to increased severity of knee osteoarthritis [6, 7].

Vietnamese data remain limited, especially regarding visceral fat, ASMI, and their correlation with pain, function, quality of life, and radiographic severity. To address this gap, we conducted a study to investigate the body composition (BC) in these patients and to evaluate the relationship between body composition and various clinical and subclinical features.

2. MATERIALS AND METHODS

Study design and subjects

Study design: cross-sectional design from May 2023 to September 2024 at Hue University of Medicine and Pharmacy Hospital.

Ethical approval: The study was approved by the Institutional Ethics Committee. All participants provided written informed consent.

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Participants: 72 female patients meeting ACR 1991 criteria [8]. Exclusion: secondary KOA, prior knee surgery, severe comorbidities, medications affecting bone metabolism, DEXA contraindications, refusal to participate.

Body composition (DEXA): Total fat mass, BF%, VAT, total muscle mass, LMI, ASMI.

Obesity definition: BF% ≥ 40% (equivalent to BMI ≥ 27.5 based on Ho-Pham relationship) [9]. This ensures consistent comparison between BF% and BMI cutoffs.

Sarcopenia definition: ASMI ≤ 5.4 kg/m² (AWGS 2019) [10].

Clinical metrics: WOMAC pain, WOMAC function, HAQ-II [11, 12]. Radiographic severity: Kellgren-Lawrence (KL) grading [13].

Normality testing: Shapiro–Wilk test.

Statistics:

- Normal variables: mean ± SD; non-normal: median (IQR).
- Spearman correlation for BF%, VAT, LMI, ASMI and WOMAC/HAQ-II.
- Comparison between obesity cutoffs: Chi-square, Mann-Whitney U.
- Comparison between reduced ASMI vs normal ASMI groups.
- Multivariable linear regression adjusting for age and BMI.

3. RESULTS

Table 1. Clinical and subclinical features of female patients with primary knee osteoarthritis

Features		**n (%) or Mean ± SD**
Age (years)	< 50	2 (2.8)
	50 - 59	18 (25.0)
	60 - 69	27 (37.5)
	≥ 70	25 (34.7)
	Mean ± SD	66.04 ± 10.50
	Min - Max	46 - 88
BMI (kg/m²)	Underweight (< 18.5)	1 (1.4)
	Normal weight (18.5 - 22.9)	25 (34.7)
	Overweight (23.0 - 24.9)	11 (15.3)
	Obese (≥ 25.0)	35 (48.6)
	Mean ± SD	24.59 ± 2.84
WC (cm)	Normal	23 (31.9)
	High	49 (68.1)
	Mean ± SD	84.85 ± 8.75
WHR	Normal	22 (30.6)
	High	50 (69.4)
	Mean ± SD	0.89 ± 0.05
Knee joint X-ray (Kellgren/Lawrence)	Early stage (1,2)	54 (75.0)
	Late stage (3,4)	18 (25.0)
Disease duration (years)		3.39 ± 1.48
Fat mass	Total (kg)	22.96 ± 4.59
	VAT (cm²)	154.89 ± 44.84
	BF% (%)	40.62 ± 3.73
Muscle mass		
	Total (kg)	31.71 ± 4.06
	LMI (%)	17.62 ± 1.36
	ASMI (kg/m²)	6.01 ± 0.83

Abbreviations: BMI = Body Mass Index, WC = Waist Circumference, WHR = Waist-to-Hip Ratio, SD = Standard Deviation, VAT = Visceral Adipose Tissue, BF% = Body fat percentage, LMI = Lower limb muscle mass index, ASMI = Appendicular skeletal muscle mass index

Table 2. WOMAC and HAQ-II score in female patients with primary knee osteoarthritis

Variables	Median (Q1-Q3)
WOMAC pain score	5.50 (4.00 - 6.00)
WOMAC physical function score	22.00 (19.00 - 24.00)
HAQ-II score	1.40 (1.20 - 1.48)

Abbreviations: WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, HAQ-II = Health Assessment Questionnaire-II

Table 3. WOMAC and HAQ-II score of the patients according to obesity status

	Obesity defined by BMI			Obesity defined by BF%		
	No obesity (n = 37)	Obesity (n = 35)	p	No obesity (n = 32)	Obesity (n = 40)	p
WOMAC pain score	6.00 (4.50 - 6.50)	5.00 (4.00 - 6.00)	0.65	5.00 (4.00 - 5.75)	5.00 (4.00 - 6.00)	**< 0.01**
WOMAC physical function score	23.00 (20.00 - 24.00)	20.00 (17.00 - 23.00)	**0.03**	20.00 (16.25 - 24.00)	22.00 (20.00 - 24.00)	0.11
HAQ-II score	1.40 (1.30 - 1.50)	1.30 (1.00 - 1.40)	**0.04**	1.30 (1.03-1.40)	1.40 (1.30-1.50)	**0.02**

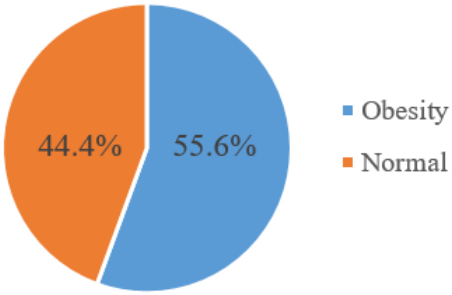

Chart 1. Prevalence of obesity according to BF%

Table 4. The correlation among body composition with WOMAC pain score, WOMAC physical function score, and quality of life HAQ-II score in female patients with primary osteoarthritis

Variables	WOMAC pain score		WOMAC physical function score		HAQ-II	
	rho	p	rho	p	rho	p
VAT (cm^2)	0.29	**0.01**	0.03	0.79	0.02	0.89
BF% (%)	0.47	**< 0.01**	0.15	0.22	0.22	0.06
LMI (%)	-0.46	**< 0.01**	-0.29	**0.01**	-0.51	**< 0.01**
ASMI (kg/m^2)	-0.26	**0.03**	-0.46	**< 0.01**	-0.52	**< 0.01**

Abbreviations: rho = Spearman correlation coefficient, VAT = Visceral adipose tissue, BF% = Body fat percentage, LMI = Lower limb muscle mass index, ASMI = Appendicular skeletal muscle mass index, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, HAQ-II = Health Assessment Questionnaire-II.

Table 5. Factor associated with WOMAC pain score, WOMAC physical function score, and HAQ-II

Variables	WOMAC pain score		WOMAC physical function score		HAQ-II	
	β (95 % CI)	p	β (95 % CI)	p	β (95 % CI)	p
Age (years)	-0.02 (-0.06; 0.02)	0.28	0.02 (-0.07; 0.12)	0.63	-0.01 (-0.01; 0.01)	0.58
BF%	0.16 (0.03; 0.28)	**0.02**	0.23 (-0.10; 0.55)	0.17	0.00 (-0.02; 0.02)	0.96
VAT (cm²)	0.01 (-0.01; 0.03)	0.11	0.01 (-0.02; 0.05)	0.52	0.00 (-0.01; 0.01)	0.66
LMI (%)	-0.39 (-0.79; 0.01)	0.06	-0.56 (-1.59; 0.48)	0.29	-0.06 (-0.12; -0.01)	**0.04**
ASMI (kg/m²)	-0.75 (-1.45; -0.04)	**0.04**	-2.21 (-4.02; -0.41)	**0.02**	-0.09 (-0.19; 0.01)	0.08

Abbreviations: BF% = Body fat percentage, VAT = Visceral adipose tissue, LMI = Lower limb muscle mass index, ASMI = Appendicular skeletal muscle mass index, CI = Confident Interval, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, HAQ-II = Health Assessment Questionnaire-II.

4. DISCUSSION

The study showed that patients with knee OA had an average total fat mass of 22.96 ± 4.59 kg and an average BF% of 40.62 ± 3.73%, which is higher than the results of Ho Pham Thuc Lan's study in 2015 [14]. This difference may be attributed to the higher average BMI in our study compared to that of the above author (24.59 ± 2.84 vs. 23.6 ± 2.9 kg/m²). The average VAT in our study was 154.88 ± 44.84 cm², which also exceeds the cutoff value proposed by Arang Lee et al. [15]. However, VAT varies by gender and ethnicity, highlighting the need for a reference VAT value specific to the Vietnamese population. Additionally, the obesity rate based on BMI was 48.6%, while it increased to 55.6% when assessed using BF%. Since BF% is considered the gold standard for diagnosing obesity, relying solely on BMI may result in misclassification of obesity rates [9].

The study also indicated an average total muscle mass of 31.71 ± 4.06 kg, consistent with Ho Pham Thuc Lan's findings in 2015 [14]. The mean LMI was 17.59 ± 1.40%, and the mean ASMI was 6.01 ± 0.83 kg/m². These values were lower than those reported by Lee S.Y. [16], likely due to differences in study populations: Lee's study included both men and women, whereas ours focused only on women.

We found a moderate positive correlation between BF% and pain levels assessed by the WOMAC score (r=0.47, p<0.01). This aligns with Tong B's study, which showed that patients with knee OA and obesity experienced more severe knee pain [17]. Furthermore, VAT also positively correlated with WOMAC pain scores (r=0.34, p=0.01). Similarly, Li reported comparable findings in a study involving 2,961 patients with knee OA over 5 years [18]. Both BF% and VAT are independent risk factors for pain in patients with knee OA. Increased visceral fat is associated with low-grade systemic inflammation, abnormal adipokine production, and suppression of adiponectin transcription, an anti-inflammatory cytokine that benefits joints. Additionally, visceral fat accumulation increases leptin production, which adversely affects cartilage cell metabolism [18]. Conversely, LMI was negatively correlated with WOMAC pain scores (r = -0.46, p<0.01). Our findings are consistent with Cheon's research, which demonstrated that patients with knee osteoarthritis and reduced LMI experienced more severe knee pain [19].

There was also a negative correlation between LMI, ASMI, and functional limitations, as assessed by WOMAC function and HAQ-II scores. However, in multivariable linear regression analysis adjusted for age and BMI, no significant association was found between LMI and these scores. Additionally, ASMI was independently associated with quality of life as measured by the HAQ-II score. Tong B's study similarly concluded that ASMI correlates with WOMAC physical function scores [17]. While muscle mass may play an important role in physical function, it is not the sole determinant of muscle strength, and reduced muscle mass does not always lead to decreased strength [20]. The role of muscles in the pathogenesis of knee osteoarthritis remains unclear, warranting further research into the impact of skeletal muscle on this condition to elucidate these relationships.

5. CONCLUSION

Obesity and muscle loss are highly prevalent in Vietnamese women with KOA. BF% and VAT worsen pain and radiographic severity, while reduced ASMI worsens functional impairment and quality of life. DEXA evaluation is recommended for accurate assessment of obesity and muscle status in KOA patients. Future research should evaluate interventions targeting fat reduction and muscle enhancement.

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