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RELATIONSHIP OF FATIGUE SEVERITY WITH PAIN LEVEL, OBESITY INDICES AND FUNCTIONAL PERFORMANCES IN WOMEN WITH KNEE OSTEOARTHRITIS

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ABSTRACT

Knee osteoarthritis (KOA) is a common condition among women with obesity, affecting their musculoskeletal system. The pain experienced in KOA can hinder daily activities, leading to fatigue and reduced motivation to engage in meaningful tasks. This study aimed to explore the relationship between pain levels, obesity indicators, functional performance, and fatigue severity in women with KOA. This cross-sectional study recruited women aged 40 to 65 diagnosed with unilateral KOA and referred for physiotherapy management. Measurements included fatigue severity using the Fatigue Severity Scale, pain intensity using the Numerical Rating Scale, and obesity indicators such as body mass index (BMI), body fat percentage, and waist circumference. Functional performance was assessed through handgrip strength, the 5 Times Sit-to-Stand Test, the Timed Up and Go Test, the 6-Minute Walk Test and quality of life (QoL) using the WOMAC questionnaire. A total of 96 women (mean age = 54.76 years, SD = 5.54) participated in the study, with an average fatigue severity score of 34.51 (SD = 14.03). Participants with lower fatigue levels experienced less intense pain, lower body fat, and better QoL. Simple linear regression showed significant associations between fatigue severity and pain intensity ($\beta = 4.089$, $p < 0.001$), body fat percentage ($\beta = 0.825$, $p < 0.001$), and QoL ($\beta = 0.304$, $p < 0.001$). Pain management targeted weight reduction, and personalized exercise programs are essential in addressing fatigue in women with KOA. Further research with larger samples is recommended to better understand the dynamic relationship between pain, obesity, and fatigue.

Keywords: Functional performance, knee osteoarthritis, obesity, pain, quality of life

INTRODUCTION

Knee osteoarthritis (KOA) is a joint disease that tends to affect older individuals, with a higher occurrence, in women compared to men. This is due to differences in body structure, movement patterns and hormonal influences. Around 18% of women experience KOA while 9.6% of men are affected [1,2]. In women with KOA, the disease often progresses to stages and causes more intense pain compared to men [3].

The main symptom of KOA is pain, which significantly limits activities such as walking, getting up from a seated position, doing household chores, climbing stairs and maintaining an upright sitting posture [4 6]. This limitation can lead to reduced activity and increased feelings of tiredness or lack of energy known as fatigue [7]. Interestingly, 40% of individuals with osteoarthritis report experiencing lower levels of fatigue that greatly disrupt their social life and everyday activities [8,9].

Understanding the factors that contribute to fatigue in women with KOA is crucial due to its impact on their quality of life (QoL). However, current literature on this matter primarily focuses on the relationship between pain and fatigue as well as their combined effect, on physical activity. This gap, in knowledge, makes it unclear how other potential factors contribute to fatigue in women with KOA [9].

Strategies for managing KOA include educating patients encouraging exercise and promoting weight loss. These strategies aim to alleviate pain and improve exercise tolerance [10]. However aside from understanding the relationship between pain and fatigue, there is a lack of research on how obesity indicators (such as body mass index, percentage of body fat, waist circumference) and functional abilities (such as strength, balance or mobility, exercise capacity and QoL are related to the levels of fatigue in women with KOA.

The objective of this study is to bridge this knowledge gap by examining the relationship between the severity of fatigue and various factors such as pain level, obesity indicators and functional abilities in women diagnosed with KOA. The findings from this study are expected to offer insights for practice by improving the management and treatment approaches, for KOA specifically in women.

MATERIAL AND METHOD

The protocol for this study received ethical approval from the Research Ethics Committee of Universiti Teknologi MARA (UiTM) [Approval no. 600 IRMI (5/1/6)]. This cross-sectional study was specifically designed for women who have been diagnosed with knee osteoarthritis (KOA) and referred for physiotherapy. To be included in the study participants needed to meet criteria such as; having a diagnosis of KOA in one knee, being between 40 and 65 years old, being fluent in either Malay or English and received a referral from a medical professional. Individuals who had undergone knee arthroplasty were pregnant, had limitations in knee motion or deformities due to KOA, had surgeries or had other major medical conditions like rheumatic diseases, cardiovascular problems or neurological issues were excluded from the study.

The Fatigue Severity Scale (FSS) is a questionnaire that participants completed on their own. It consists of nine items that measure how fatigue impacts motivation, and physical functioning and interferes with work, family life and social life. The questionnaire uses a seven-point Likert scale where participants rate their agreement level ranging from disagree (1) to strongly agree (7). The total scores on the FSS range, from 9 to 63 indicating increasing severity of fatigue. The Fatigue Severity Scale (FSS) is well known for its ability to accurately and consistently assess levels of fatigue [11,12].

To determine the intensity of pain, we used a Numerical Rating Scale (NRS) which has been established as an effective tool that ranges from 0 (no pain), to 10 (the worst imaginable pain). Participants were asked to choose the number on the scale that best represented their level of pain in their affected knee. This scale has proven to be highly reliable as evidenced by its test reliability and intra-class correlation coefficients [13].

To calculate participants' body mass index (BMI) (kg/m^2), we measured their body weight (kg) and height (m) using the TANITA weighing scale and SECA Model Body meter, respectively.

For measuring body percentage, we utilized the TANITA (Bielectrical Impedance Analysis) (BIA) machine. Participants stood on footpads while holding handles on the BIA platform. This method provides efficient analysis of body composition with results in less, than 30 seconds.

To assess obesity and its associated health risks we measured the waist circumference (diameter between the ribs and iliac crest) using an elastic cloth tape with an accuracy of 0.5 cm.

For evaluating the upper limb strength (handgrip), we used the Jammar Analogue Hand Dynamometer. Participants were instructed to squeeze the dynamometer as hard as they could. Each hand's grip strength was assessed three times with a minute of rest in between attempts. We recorded the average of all measurements, where higher values indicate handgrip strength [14,15].

To measure the lower limb strength, we conducted the Five Times Sit to Stand Test (5STS). During this test, participants were timed as they stood up and sat down five times consecutively without using their legs against the chair and with arms folded. The faster completion time reflects the stronger the limb strength.

We employed the Time Up and Go Test (TUG) to assess balance performance. This test involved standing up from a chair, walking three meters, turning around and then sitting down. The time taken to complete this task was measured using a stopwatch. It is worth noting that this test has demonstrated reliability, among raters [16,17].

The 6-Minute Walk Test (6MWT) is a type of exercise test that evaluates how far a person can walk and their exercise capacity, over a period of time. It follows the guidelines provided by the American Thoracic Society. The test has shown good test-retest reliability among patients with KOA [18-20].

The Western Ontario McMaster University Osteoarthritis Index (WOMAC) is a questionnaire designed to assess the QoL or health status of patients with hip or knee osteoarthritis. It measures pain, stiffness and physical functions with scores indicating severe symptoms. The WOMAC is well known for its reliability and validity in evaluating the severity of KOA [21].

During the recruitment phase, potential participants were approached at a physiotherapy clinic. They were given information about the study's purpose and procedures. Eligibility was determined

based on criteria and informed consent was obtained before proceeding with data collection. Participants completed all measurements except, for the 6MWT, which was conducted on either the second or third day based on participant preference. To prevent fatigue, we strategically organized the sequence of tests starting with less demanding assessments. The principal researcher securely stored all the data and remained the only person to have access to the data.

We used SPSS version 26 to analyze the data setting a significance level at $p < 0.05$. Descriptive statistics were employed to present the means and standard deviations. To determine differences between participants with levels of fatigue we conducted a t-test analysis. Additionally, we examined the relationships between fatigue severity and the related variables using Pearson correlation analysis. By conducting regression analysis, we identified predictors of fatigue severity. We calculated a sample size of 96 to ensure an effect size and sufficient power for regression analysis. The Durbin-Watson value confirmed independent errors assumption and variation inflation factors indicated no multicollinearity among the variables [22, 23].

RESULTS AND DISCUSSION

Participants Characteristics

Ninety-six women (mean age=54.76, SD=5.54) with KOA participated in this study. Table 1 illustrates the measurement characteristics, revealing significant differences in pain level, body fat percentage, and QoL between low and high fatigue levels. Those with low fatigue reported lower pain levels, lower body fat percentages, and better QoL.

Table 1. Participants' characteristics (N=96)

Variables	Fatigue Severity Mean (SD)			*p*-value
	ALL (N=96)	Low (n=47)	High Severity (n=49)	
Age (years)	55.70 (6.90)	54.98 (6.75)	54.39 (7.04)	0.320
Height (m)	1.55 (0.53)	1.56 (5.32)	1.54 (5.25)	0.170
Bodyweight (kg)	70.16 (12.13)	68.91 (11.74)	71.35 (2.49)	0.327
BMI (kg/m^2)	29.14 (5.00)	28.34 (4.95)	29.90 (4.99)	0.128
Fat %	40.04 (6.41)	38.07 (6.06)	41.93 (6.23)	0.003**
WC (cm)	94.62 (11.11)	94.27 (10.85)	94.96 (11.45)	0.761
Pain level	2.63 (1.51)	2.11 (1.13)	3.12 (1.67)	0.001**
Fatigue	34.51 (14.03)	22.32 (7.24)	46.20 (7.60)	<0.001**
UL strength (kg)	18.83 (5.09)	18.29 (5.87)	19.35 (4.20)	0.309
LL strength (s)	13.11 (5.64)	13.06 (4.81)	13.15 (6.38)	0.940
Mobility (s)	11.65 (2.98)	11.21 (2.36)	12.08 (3.45)	0.158
ES (m)	304.54 (56.38)	307.68 (57.73)	301.54 (55.49)	0.596
QoL	23.65 (18.16)	13.58 (10.96)	28.34 (19.01)	0.002**

Note: t-test significant at *p<0.05 and **p< 0.01; SD – Standard Deviation

The Pearson correlation analysis revealed associations between fatigue severity and various factors in women diagnosed with knee osteoarthritis (KOA). Pain level demonstrated a strong positive correlation with fatigue severity ($r = 0.467$, $p < 0.001$), indicating that higher pain levels were associated with increased fatigue. Additionally, body fat percentage ($r = 0.375$, $p < 0.001$) exhibited a positive correlation, suggesting that higher fat percentages were linked to elevated fatigue levels. QoL also displayed a strong positive correlation with fatigue severity ($r = 0.459$, $p < 0.001$), indicating that diminished QoL was associated with higher levels of fatigue. These findings suggest the significant influence of pain, body fat percentage, and QoL on fatigue severity in individuals with KOA. Simple linear regression (Table 2) revealed that pain level, fat %, and QoL are significantly associated with fatigue severity. However, after controlling for pain level, only fat % remained to be significantly associated with fatigue severity.

Table 2. Crude and Adjusted (pain level) Simple Linear Regressions of Fatigue Level

Variable	SLR[a]			SLR[b]		
	β[c]	s.e.	*p*-value	β[d]	s.e.	*p*-value
Age	0.34	0.21	0.108	0.05	0.20	0.795
Pain level	4.09	0.80	<0.001**			
Body mass index	0.34	0.29	0.244	0.17	0.26	0.520
Fat %	0.82	0.21	<0.001**	0.58	0.20	0.005**
Waist circumference	-0.02	0.13	0.858	-0.09	0.12	0.433
Upper limb strength	0.15	0.28	0.607	0.27	0.25	0.283
Lower limb strength	-0.07	0.26	0.786	-0.27	0.23	0.236
Mobility	0.95	0.48	0.050	0.22	0.46	0.625
Exercise capacity	-0.02	0.03	0.419	-0.01	0.02	0.768
Quality of life	0.30	0.07	<0.001**	0.15	0.09	0.084

SLR[a]: Simple linear regression; SLR[b]: Simple linear regression adjusted for pain level; s.e.: Standard error; β[c]: Crude regression coefficient; β[d]: Adjusted regression coefficient;
The regression coefficient is significant at $p<0.001$**

This research aimed to explore the relationship between the severity of fatigue and several factors, including pain level, obesity indices (BMI, body fat percentage, waist circumference) and functional performances (upper and lower limb strength, balance, exercise capacity and QoL) in women diagnosed with knee osteoarthritis (KOA). The results indicated that the average fatigue level was 34.51 (SD 14.03) which falls between high fatigue levels. About 51% of the participants experienced high levels of fatigue. These findings are consistent with studies suggesting that chronic pain can have an impact on physical activity leading to increased feelings of fatigue [24].

The study also emphasized an association between pain level and fatigue severity. Pain was found to interact with body measurements and functional abilities about fatigue. In addition, the current study's findings also observed that pain limits daily activities and mobility while potentially instigating fear of movement resulting in reduced physical activity. This lack of activity can further weaken muscles and intensify the sensation of pain since weaker muscles may struggle to bear knee load [25,26]. It should be noted that chronic pain increases energy expenditure during walking which often leads individuals to adopt energy-conserving strategies [27,28]. These findings suggest that timing exercises after taking pain medication or splitting exercise sessions could be beneficial. Additionally, recommending weight-bearing exercises such as swimming or static cycling may help reduce stress on the joints.

Among the measures of obesity, participants with fatigue showed a notably higher body fat percentage, which was significantly linked to the severity of fatigue. It is important to note that all obesity indices had values exceeding thresholds indicating a trend towards excessive body weight or obesity among the participants. This is a known risk factor for knee osteoarthritis (KOA) [29]. A study suggested that increased total body fat could increase the risk of cartilage defects potentially leading to pain and limited physical activity [30].

Regarding functional performances, even though there were no significant differences in all measures except for QoL, we noticed that participants with a higher fatigue level also presented with a lower mean in all measures of functional performance than those with a lower fatigue level. In terms of functional performance measures, even though there were no significant differences in all measures except for QoL, it was noted that those with a higher fatigue level also presented with a lower mean in all measures of functional performance than those with a lower fatigue level. Interestingly participants with higher fatigue levels showed better upper limb strength, which may compensate for declining lower limb functions. The walking patterns of patients with KOA may be altered due to painful knees resulting in increased energy expenditure and reduced habitual gait speed. This could explain the decrease in balance and exercise capacity [28]. Arthritic pain can affect quadriceps strength influencing gait patterns and leading to lower gait speed, prolonged support times and an extended duration to complete the five times sit to stand test [31,32]. The interaction, between these variables could result in a lower QoL as indicated by the WOMAC scores in participants experiencing more severe fatigue.

This study had limitations. The sample size was determined for 80% power, which might have affected the significance of the findings related to predicting fatigue severity for variables. We did not measure the duration of KOA, which could potentially impact fatigue due to prolonged inactivity. Nevertheless, this study provides insights into the factors that influence fatigue in KOA. It highlights

the importance of research in developing intervention guidelines to promote long-term adherence to physical activity.

CONCLUSION

In summary, the results of this study indicate that the severity of fatigue is likely to be associated with pain levels, body fat percentage and QoL. On the other hand, it is worth noting that addressing obesity indices should be a priority for intervention since most participants exhibited high levels of obesity indices. Future studies should consider a larger sample size and examine how the duration of KOA influences these factors. Additionally, a longitudinal study would offer insights into how pain severity affects fatigue as the disease progresses. These findings have implications for healthcare professionals and physiotherapists who should prioritize pain management, weight management and modifications to exercise and physical activity.

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ETHICS APPROVAL AND INFORMED CONSENT

The study was conducted by the Declaration of Helsinki and approved by the Research Ethics Committee of Universiti Teknologi MARA (Approval number: 600-IRMI (5/1/6).

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper**.**

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