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WOMAC and Kellgren-Lawrence Classification Are Independent Predictors For Quality of Life Among Patients With Knee Osteoarthritis at A Tertiary Hospital in Kelantan, Malaysia

(Klasifikasi WOMAC dan Kellgren-Lawrence Merupakan Peramal Bebas Untuk Kualiti Hidup dalam Kalangan Pesakit Osteoartritis Lutut di Sebuah Hospital Ketiga di Kelantan, Malaysia)

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Abstract

Knee osteoarthritis (KOA) is a leading cause of disability, and local data on its impact on quality of life (QoL) remain limited. This study aimed to determine the QoL and its associated factors among patients with KOA. A cross-sectional study was conducted among patients aged 40 years and older with clinically or radiographically confirmed KOA at Hospital Pakar Universiti Sains Malaysia. QoL was assessed using theye validated Malay version of the Osteoarthritis of Knee and Hip Quality of Life (OAKHQoL) questionnaire and the Malay version of the Western Ontario and McMaster University Osteoarthritis Index (WOMAC- VAS scale). Sociodemographic and clinical data were collected. Univariate analysis identified potential predictors of QoL, and multivariable linear regression was used to determine independent predictors. Of the 166 patients recruited, 152 completed the study (response rate 92%). Participants reported substantial pain and disability, reflected by a high mean WOMAC score of 939.7 ± 484.1 (range 49–2042). The most affected domain of the OAKHQoL was social functioning (59.1 ± 26.3). The overall OAKHQoL score was 41.8 ± 16.2, indicating a moderate reduction in QoL. Univariate analysis revealed that higher BMI ($p = 0.033$), a history of ischemic heart disease ($p = 0.040$), glucosamine use ($p = 0.009$), and higher WOMAC scores ($p < 0.001$) were associated with poorer QoL. Multivariable linear regression identified higher WOMAC scores ($\beta = 0.025$, 95% CI: 0.021–0.028, $p < 0.001$) and KOA grade 3 and 4 ($\beta = 5.06$, 95% CI: 0.048–10.06, $p = 0.048$) as independent predictors. Specifically, one unit increase in WOMAC score corresponded to a 0.025-unit increase in OAKHQoL score, while KL grades 3 and 4 were linked to a 5.06-unit higher OAKHQoL score. These findings highlight the central role of symptom severity and structural damage in shaping QoL in KOA. Early intervention, symptom management, and psychosocial support are essential to improve outcomes.

Keywords: Knee osteoarthritis; quality of life; OAKHQoL; WOMAC

Abstrak

Osteoartritis lutut merupakan punca utama ketidakupayaan, dan data tempatan mengenai impaknya terhadap kualiti hidup masih terhad. Kajian ini bertujuan untuk menentukan kualiti hidup serta faktor-faktor yang berkaitan dengannya dalam kalangan pesakit osteoartritis lutut. Satu kajian rentas telah dijalankan dalam kalangan pesakit berumur 40 tahun dan ke atas yang disahkan mengalami osteoartritis lutut secara klinikal atau radiografi di Hospital Pakar Universiti Sains Malaysia. Kualiti hidup dinilai menggunakan borang soal selidik Osteoarthritis of Knee and Hip Quality of Life (OAKHQoL) versi Bahasa Melayu yang telah disahkan dan borang Western Ontario and McMaster University Osteoarthritis Index (WOMAC-skala VAS) versi Bahasa Melayu. Data sosiodemografi dan klinikal turut dikumpul. Analisis univariat mengenal pasti peramal berpotensi bagi kualiti hidup, manakala regresi linear berganda digunakan untuk menentukan peramal bebas. Daripada 166 pesakit yang direkrut, seramai 152 pesakit telah melengkapkan kajian ini (kadar maklum balas 92%). Pesakit melaporkan kesakitan dan ketidakupayaan yang ketara, seperti yang ditunjukkan oleh purata skor WOMAC yang tinggi iaitu 939.7 ± 484.1 (julat 49–2042). Domain OAKHQoL yang paling terjejas ialah fungsi sosial (59.1 ± 26.3). Keseluruhan skor OAKHQoL ialah 41.8 ± 16.2, yang menunjukkan penurunan kualiti hidup pada tahap sederhana. Analisis univariat menunjukkan bahawa BMI yang lebih tinggi ($p = 0.033$), sejarah penyakit jantung

iskemia (p = 0.040), penggunaan glukosamina (p = 0.009), dan skor WOMAC yang lebih tinggi (p < 0.001) berkait rapat dengan kualiti hidup yang lebih lemah. Regresi linear berganda mengenal pasti skor WOMAC yang lebih tinggi (β = 0.025, 95% CI: 0.021–0.028, p < 0.001) serta osteoartritis lutut gred 3 dan 4 (β = 5.06, 95% CI: 0.048–10.06, p = 0.048) sebagai peramal bebas. Secara khususnya, peningkatan satu unit dalam skor WOMAC bersamaan dengan peningkatan 0.025 unit dalam skor OAKHQoL, manakala gred 3 dan 4 dikaitkan dengan skor OAKHQoL yang lebih tinggi sebanyak 5.06 unit. Dapatan kajian ini menyerlahkan peranan utama tahap keparahan gejala dan kerosakan struktur dalam mempengaruhi kualiti hidup pesakit osteoartritis lutut. Intervensi awal, pengurusan gejala, serta sokongan psikososial adalah amat penting untuk menambah baik keputusan rawatan pesakit.

Kata Kunci: Osteoartritis lutut; kualiti hidup; OAKHQoL; WOMAC

INTRODUCTION

Knee osteoarthritis (KOA) is a leading musculoskeletal condition causing pain, disability, and reduced quality of life (QoL) (Dantas, de Fátima Salvini, and McAlindon 2021). The burden of OA on the individual, socioeconomic, and health care system is anticipated to increase substantially over the coming decades due to the worldwide trend of an aging and obese population (Hunter and Bierma-Zeinstra 2019). Though historically the focus of treatment has been on lowering pain and enhancing function (Dantas, de Fátima Salvini, and McAlindon 2021; Ismetovich 2022), healthcare professionals are now more aware of the significance of ensuring the adoption of psychological support to enhance the health and general well-being of knee OA patients (A. C. Lee et al. 2017; Xie et al. 2020).

Assessing QoL is a crucial initial step in managing knee OA patients, as the well-being of patients through QoL is an important outcome of treatment, together with monitoring illness progression and treatment effectiveness (Wu et al. 2022). While global studies have identified clinical and demographic predictors of QoL, the extent to which these findings apply to the Malaysian population remains underexplored. Assessing the QoL in patients with KOA involves using various tools and questionnaires that provide insights into the physical, psychological, and social aspects of their well-being.

Some of the most common tools used to assess the quality of life in knee OA patients include Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Short Form Health Survey (SF-12 and SF-36), Knee Injury and Osteoarthritis Outcome Score (KOOS), and Osteoarthritis of Knee and Hip Quality of Life (OAKHQoL) questionnaire (Bellamy et al. 1988, Nishitani, Nakamura, and Kuriyama 2023; Xie et al. 2020). OAKHQoL questionnaire is a specific health-related quality-of-life assessment tool developed by French researchers (Anne-Christine Rat et al. 2005; 2006) to measure the impact of osteoarthritis on patients' daily lives, specifically focusing on the knee and hip joints (A-C Rat, Guillemin, and Pouchot 2008; Goetz et al. 2011). It is a disease-specific instrument that effectively captures the physical, functional, and emotional aspects of living with knee and hip osteoarthritis (Salas-Vargas and Rodríguez-Grande 2021), and is widely available in multiple languages (Gonzalez Sáenz de Tejada et al. 2011; Serhier et al. 2012; Duruöz et al. 2013; Ouédraogo et al. 2014; Wang et al. 2016; Slama et al. 2013; Ayhan et al. 2015; Fekete et al. 2020; Abdul Kadir et al. 2018).

A validated Malay version of the OAKHQoL questionnaire has demonstrated reliability and acceptability but has not been widely applied in clinical research. This study adds value to the existing literature by applying the validated Malay version of the OAKHQoL questionnaire in a local tertiary care setting, which has not been previously reported. Although numerous international studies have examined factors associated with quality of life in knee osteoarthritis, data specific to the Malaysian population remain limited, offering culturally relevant insights (Karimi et al., 2023; Tekaya et al., 2023; Vitaloni et al. 2019). This study addresses this gap by evaluating quality of life using a culturally validated, disease-specific instrument and by quantifying the independent contributions of symptom severity (WOMAC) and radiographic severity (Kellgren–Lawrence grading) among Malaysian patients with knee osteoarthritis. These findings can inform targeted interventions and resource allocation in Malaysian clinical practice.

PATIENTS & METHODS

This cross-sectional study was conducted among 152 KOA patients at the Orthopedic Clinic, Universiti Sains Malaysia Hospital, a tertiary teaching hospital in Malaysia. Patients aged 40 years or older who had been diagnosed with KOA using either clinical criterion alone or clinical and radiological criteria were included.

The clinical criteria included knee pain along with three of the following: age of more than 50 years, morning stiffness of less than 30 minutes, crepitus on active motion, bony tenderness or bony enlargement or no palpable warmth on synovium (Katz, Arant, and Loeser 2021). The clinical

and radiological criteria included knee pain and osteophyte on the radiograph along with one of the following: age of more than 50 years, morning stiffness of less than 30 minutes, or crepitus on active motion (L. S. Lee et al. 2021; Steenkamp et al. 2022). Illiterate patients, not able to understand either Malay or English, or who had lower limb abnormalities or immobility, were excluded.

Systematic random sampling in a ratio of 1:2 was applied based on the attendance list at the clinic. The researcher approached the participants and provided a detailed explanation of the study. All patients provided written consent. Once patients had given their consent, they were asked to complete the case report form (CRF), the Malay version of the WOMAC, and the OAKHQoL questionnaires. The height and weight of each patient were measured and calculated for body mass index (BMI). Knee radiographs were taken to determine the stage of OA based on Kellgren Lawrence (KL) classification.

The research tools consisted of CRF, a Malay version of the WOMAC and OAKHQoL questionnaires. The CRF contains information about patient demographic data, health-related information such as comorbidities, knee OA disease-related information such as side of knee involved, KL grading of knee osteoarthritis, duration of pain, and the usage of medications, specifically paracetamol, non-steroidal anti-inflammatory drugs, and glucosamine.

The validated Malay version of the OAKHQoL questionnaire consists of 28 items distributed across five domains: physical activity, mental health, pain, social functioning, and social support (Abdul Kadir et al. 2018). Additionally, three items related to professional activity, sexual activity, and relationships were included. Each item is rated on a 10-point Likert scale, ranging from 0 (not at all) to 10 (a great deal). The score of each domain was presented as a mean, with possible scores ranging from 0 to 100 (Abdul Kadir et al. 2018). The overall OAKHQoL score, calculated as the mean of all items, also ranges from 0 to 100, where higher scores indicate poorer quality of life.

WOMAC is a self-administered health status measure that is widely used to assess the symptoms, physical disability, and treatment outcome of people with hip and/or knee (McConnell, Kolopack, and Davis 2001; Bellamy et al. 1988; Bellamy N 2014). This questionnaire represents a validated and reliable tool for assessing overall pain, stiffness, and physical function scores (Bellamy et al. 1988). The original index consists of 24 questions, and it has been validated in Bahasa Malaysia for local use (Bellamy N 2014). This questionnaire is available in a Likert version that is rated on an ordinal scale of 0 to 4 and also as a visual analogue scale (VAS). In this study, a VAS version scored from 0 to 100 mm was used. The pain domain (5 items) ranges from 0 to 500, stiffness (2 items) from 0 to 200, and physical functional limitations (17 items) from 0 to 1700. The total WOMAC score ranges from 0 to 2400, with higher scores indicating a worse health status (Bellamy N 2014). The calculation of the sample size for a single mean was performed using Power and Sample Size Calculation Software. Using the standard deviation of 12, and precision of 2 with 95% confidence, the minimum sample size required was 138 patients. After considering the 20% non-response rate, the total samples required were 166 patients**.**

Descriptive analysis, expressed as mean (standard deviation, SD) and frequency (percentage) was performed using SPSS version 26. The associated factors for QoL were analyzed using univariate analysis and a multivariable linear regression test. In the univariate analysis, the normality of continuous variables was assessed using the independent t-test or one-way ANOVA for variables with more than two groups. Non-normal categorical variables were analyzed using the Mann-Whitney U test. For the continuous variable, Pearson correlation was conducted for the normal distribution variable and Spearman rho correlation was performed for the non-normal distribution variable.

Multivariable linear regression was performed to determine the associated factors for the OAKHQoL total score. Variable selection was performed by selecting all variables with a p-value of less than 0.25 in the univariate analysis. Interaction and multicollinearity were checked in the final modelling. All possible two-way interaction terms of the independent variables in the preliminary main effect model were examined, and no interaction terms were found. P-values were statistically significant at $p < 0.05$.

Multivariable regression was employed to estimate the independent association of each predictor with quality of life, consistent with recommended approaches for clinical prediction modelling that emphasize parsimony, avoidance of univariable-only selection, and cautious interpretation of adjusted coefficients. This approach is commonly adopted in observational studies to balance statistical robustness and clinical relevance (Efthimiou et al., 2024).

RESULTS

A total of 166 patients were recruited for this study, with 152 completing the full questionnaire, yielding a high response rate of 92%. The cohort consisted predominantly of females (67.8%), with ages ranging from 40 to 74 years (52.2 ± 6.4 years).

TABLE 1. Sociodemographic and clinical characteristics of participants (n = 152).

Variables		n (%)	Mean ± SD	Min	Max
Age (years)		-	52.18 ± 6.37	40	74
Income (RM)		-	1990.68 ± 1451.99	0.00	7000.00
BMI (kg/m^2)		-	28.37 ± 4.94	18.3	49.0
Duration of KOA (years)		-	3.75 ± 3.90	0.0	21.0
Sex	Male	49 (32.2)	-	-	-
	Female	103 (67.8)	-	-	-
Race	Malay	148 (97.4)	-	-	-
	Chinese	4 (2.6)	-	-	-
Education	Primary School	19 (12.5)	-	-	-
	Secondary School	111 (73.0)	-	-	-
	‡Tertiary Education	22 (14.5)	-	-	-
Marital Status	Married	148 (97.4)	-	-	-
	Unmarried	4 (2.6)	-	-	-
Side of KOA	Left	36 (23.7)	-	-	-
	Right	31 (20.4)	-	-	-
	Bilateral	85 (55.9)	-	-	-
Kellgren Lawrence Grade of KOA	0	47 (30.9)	-	-	-
	1	58 (38.2)	-	-	-
	2	25 (16.4)	-	-	-
	3 and 4	22 (14.5)	-	-	-
Diabetes Mellitus		34 (22.4)	-	-	-
Hypertension		55 (36.2)	-	-	-
Ischaemic Heart Disease		3 (2.0)	-	-	-
Use of Paracetamol		35 (23.0)	-	-	-
Use of NSAID		62 (40.8)	-	-	-
Use of Glucosamine		41 (27.0)	-	-	-

BMI – body mass index, KOA – knee osteoarthritis, NSAID – non-steroidal anti-inflammatory, RM – Ringgit Malaysia (currency).

‡Tertiary Education encompasses certificate, diploma, and university qualifications.

TABLE 2. The WOMAC (VAS Version) domain and total mean scores (n = 152).

Domain	Mean ± SD	Min	Max
Pain	192.95 ± 105.23	0.00	473.00
Stiffness	80.51 ± 51.18	0.00	260.00
Functional physical limitations	666.21 ± 358.33	23.00	1480.00
Overall Score	**939.66 ± 484.11**	**49.00**	**2042.00**

WOMAC - Western Ontario and McMaster Universities Arthritis Index, VAS – visual analog scale (0-100mm; higher scores indicate greater symptom severity).

TABLE 3. The OAKHQoL Domain and Mean Score (n = 152).

OAKHQoL Domain	****Mean ± SD**
Physical Activity	40.31 ± 20.44
Mental Health	35.70 ± 22.42
Pain	38.07 ± 22.95
*Social functioning	59.07 ± 26.31
*Social support	50.81 ± 30.00
Professional activity	39.13 ± 26.49
Sexual activity	27.26 ± 27.28
Relationship	26.33 ± 27.92
Overall OAKHQoL	41.79 ± 16.17

OAKHQoL- Osteoarthritis of Knee and Hip Quality of Life questionnaire.
* Inversely scored (Interpreted the same as other domains)
** The greater the mean score, the worse the quality of life

TABLE 4. Univariate analysis of factors associated with OAKHQoL scores.

Variables		**Mean (SD)**	**Test value**	***P***
Age (years)		52.18 ± 6.37	r= -0.017	0.834
Income (RM)		1990.68 ± 1451.99	r = -0.008*	0.918
BMI (kg/m^2)		28.37 ± 4.94	r = 0.174	**0.033**
Duration of KOA (years)		3.75 ± 3.90	r = 0.051*	0.534
Sex	Male	39.93 ± 15.18	t = -0.973	0.332
	Female	42.67 ± 16.62		
Race	Malay	41.80 ± 16.26	U = 280.000	0.854
	Chinese	41.25 ± 14.11		
Education	Primary School	43.35 ± 18.23	F = 0.208	0.812
	Secondary School	41.27 ± 15.88		
	‡Tertiary Education	43.04 ± 16.39		
Marital	Married	41.54 ± 16.30	U = 182.500	0.191
	Single	50.71 ± 5.71		
Kellgren-Lawrence Grade of KOA	0	40.05 ± 15.90	F = 1.544	0.206
	1	39.87 ± 15.86		
	2	45.45 ± 13.58		
	3&4	46.64 ± 19.30		
Side of KOA	Left	39.62 ± 15.62	F = 0.627	0.536
	Right	40.85 ± 17.20		
	Both	43.04 ± 16.09		
Diabetes Mellitus		41.79 ± 16.88	t = 0.000	1.000
Hypertension		43.18 ± 18.20	t = -0.797	0.427
Ischaemic Heart Disease		59.52 ± 10.04	U = 68.500	**0.040**
Use of Paracetamol		41.17 ± 15.28	t = 0.255	0.799
Use of NSAID		44.38 ± 13.99	t = -1.653	1.000
Use of Glucosamine		47.37 ± 14.97	t = -2.638	**0.009**
WOMAC (Overall score)		939.66 ± 484.11	r = 0.741	**< 0.001**

r = Pearson correlation, t = independent t-test, U = Mann-U Whitney test, F = one-way ANOVA
* Spearman rho correlation
Bold values are significant at <0.05
OAKHQoL- Osteoarthritis of Knee and Hip Quality of Life questionnaire, BMI – body mass index, KOA – knee osteoarthritis, NSAID – non-steroidal anti-inflammatory, RM – Ringgit Malaysia (currency), WOMAC - Western Ontario and McMaster Universities Arthritis Index.
‡Tertiary Education encompasses certificate, diploma, and university qualifications.

Most participants were of Malay ethnicity (97.4%), reflecting the local population demographics. The sociodemographic characteristics of the participants are presented in Table 1. The mean overall WOMAC score was 939.7 ± 484.1 (range 49–2042), based on a visual analogue scale (VAS), indicating a substantial burden of pain and functional limitation among the participants. The breakdown of WOMAC domains showed that daily activities contributed the most to the overall score, followed by pain and stiffness (Table 2).

Among the OAKHQoL domains, social functioning recorded the highest mean score (59.1 ± 26.3), indicating that it was the domain with the poorest quality of life, followed by social support and physical activity (Table 3). These elevated scores reflect significant challenges in social engagement and physical mobility. The overall OAKHQoL score was 41.8 ± 16.2, suggesting a moderate reduction in quality of life among the cohort The mean scores for each OAKHQoL domain, as well as the overall total mean score, are summarised in Table 3.

To explore the factors associated with quality of life in KOA patients, both univariate and multivariable analyses were conducted. The normality test indicated that age, BMI, WOMAC, and OAKHQoL were normally distributed among the participants. However, both income and the duration of KOA were not normally distributed. Table 4 presents the results of the univariate analysis, which examined the relationship between various sociodemographic, clinical, and disease-related variables with the overall OAKHQoL scores. Significant associations were found for BMI ($p = 0.033$), history of glucosamine use ($p = 0.009$), history of ischemic heart disease (IHD) ($p = 0.040$), and overall WOMAC scores ($p < 0.001$). Variables that did not show significant associations included age ($p = 0.834$), sex ($p = 0.332$), race ($p = 0.854$), education level ($p = 0.812$), income ($p = 0.918$), duration of KOA ($p = 0.534$), side of KOA ($p = 0.536$), diabetes mellitus ($p = 1.000$), hypertension ($p = 0.427$), and use of paracetamol ($p = 0.799$) and NSAIDs ($p = 1.000$).

TABLE 5.The multivariable linear regression of OAKHQoL scores.

Variables	Beta Coefficient	95% CI	t-value	*P*
WOMAC	0.025	0.021, 0.028	13.678	<0.001
*Grade 3 & 4	5.055	0.048, 10.062	1.995	0.048

Constant 17.718, R square 0.564, F value 95.894, p < 0.001
OAKHQoL- Osteoarthritis of Knee and Hip Quality of Life questionnaire.
WOMAC - Western Ontario and McMaster Universities Arthritis Index.
* Grade 3 & 4 refers to Kellgren-Lawrence Grade of knee osteoarthritis.

To identify independent predictors of QoL, a multivariable linear regression analysis was performed to identify independent predictors of quality of life. Variables with a p-value less than 0.25 in the univariate analysis were included to ensure model parsimony and reduce overfitting. Six variables were retained in the final model: marital status ($p = 0.191$), BMI ($p = 0.033$), KL grade of knee OA ($p = 0.206$), history of IHD ($p = 0.040$), history of glucosamine use ($p = 0.009$), and overall WOMAC scores ($p < 0.001$). Among these, WOMAC scores and KL grade 3 and 4 were statistically significant predictors of poorer quality of life.

Table 5 summarises the regression coefficients, confidence intervals, and significance levels, highlighting the strength of association for factors associated with diminished quality of life in this cohort. Specifically, each unit increase in WOMAC score was associated with a 0.025-unit increase in OAKHQoL score ($p < 0.001$), while KL grade 3/4 predicted a 5.06-unit increase ($p = 0.048$). This model was significant in explaining the variability of the OAKHQoL score with an F value of 95.894, $p < 0.001$. The model explains about 56.4% variability of the total OAKHQoL score. There was no multicollinearity or interaction between factors. The results directly address the main objective of the study by identifying the key predictors of quality of life (OAKHQoL scores), highlighting the significant roles of WOMAC scores and KL grades 3 and 4.

DISCUSSION

Key Findings

This study demonstrates that symptom severity, measured by WOMAC, and advanced radiographic disease (KL grade 3 and 4) are the strongest independent predictors of poorer quality of life among patients with knee osteoarthritis at a tertiary hospital in Kelantan, Malaysia. Each unit increase in WOMAC score was significantly associated with an increase in OAKHQoL scores, and patients with advanced radiographic KOA reported markedly worse QoL compared with those in earlier stages.

Social functioning emerged as the most impaired domain. These findings emphasize that both current symptom burden and structural disease progression remain central drivers of QoL impairment in KOA patients in tertiary care.

Interpretation and Comparison with Literature

The strong association between WOMAC scores and QoL aligns with international evidence, where pain, physical, and functional limitations consistently emerge as the most important drivers of reduced QoL in KOA (da Silva Júnior 2023, nishitani 2023, Kim 2020, Taraves 2020). This correlation corresponds with established evidence, which suggests that a high WOMAC scores indicate more severe osteoarthritis symptoms (Ribeiro et al. 2020; Ozden et al. 2020) and this study can propose its relationship with OAKHQoL scores.

Our findings are consistent with international studies. A study reported that KL grade 3–4, BMI, and age were important predictors of poorer QoL using SF-36, with the physical and functional domains most affected (Obara et al. 2023). Another investigation using the VAS-version of WOMAC also found KL grade as the most significant factor, followed by age and BMI (Alghadir et al. 2022). In contrast, several factors associated with QoL in earlier research, such as age, education, income, and comorbidities, did not retain significance in our multivariable model (Karimi et al., 2023; Kiadaliri et al., 2017; Ferreira et al., 2015). This suggests that in our cohort, the impact of symptom severity and structural damage may overshadow the influence of demographic and socioeconomic variables.

However, none of these studies used multivariable linear regression to predict specific scores based on several independent variables. This study robustly explains the significant influence of severe KOA grades on OAKHQoL scores, consistent with recent findings indicating lower physical activity and social functioning scores in advanced KOA stages (Mahmoud et al. 2019; Tavares et al. 2020; Xie et al. 2020; Choojaturo et al. 2019; Nawito, El-Azkalany, and El-Sayad 2018). It acknowledges dissenting views from earlier studies (Cubukcu, Sarsan, and Alkan 2012; Vitaloni et al. 2019).

Within Malaysia, similar findings have been observed. Less pain was associated with better QoL in patients with mild-to-moderate KOA, with physical function linked to both physical and mental well-being (Yusuf et al. 2022). Another study found that social functioning was the most impaired QoL domain in KOA patients, echoing our results, although physical functioning scores were relatively higher in their rehabilitation cohort compared with our tertiary sample (Zamri et al. 2021).

Compared to other tools, OAKHQoL offers a more comprehensive assessment by including domains such as mental health, social functioning, and social support—areas often overlooked in WOMAC, SF-36, and KOOS. While SF-36 provides a generic overview through its Physical and Mental Component Summaries, it lacks disease specificity for KOA population. Though the KOOS questionnaire is broader than WOMAC, it is more suited for younger or post-traumatic OA populations. The use of the validated Malay version of OAKHQoL in this study enhances cultural relevance and allows for more nuanced insights into QoL among Malaysian KOA patients (Nishitani et al. 2023, McConnell et al. 2001, Messier et al. 2023, Kadir 2018).

Contradictory Findings and Potential Explanations

Three noteworthy findings in this study diverged from much of the existing literature. Interestingly, BMI, disease duration, and socioeconomic factors were not independently associated with quality of life after multivariable adjustment. Although obesity has been consistently linked to worse pain and disability in KOA (Messier et al. 2023; Ribeiro et al. 2020), body mass index (BMI) was not an independent predictor after adjustment in the multivariable model. A plausible explanation is that BMI may influence QoL indirectly by exacerbating pain and functional limitations, effects that are already captured within WOMAC scores, thereby diminishing its independent contribution. In statistical terms, this suggests a potential mediation or collinearity effect, where WOMAC mediates the relationship between BMI and QoL, thereby diminishing the independent contribution of BMI in the adjusted model (Yu et al. 2025). This highlights the importance of considering overlapping constructs in multivariable analyses and supports the use of comprehensive patient-reported outcome measures, such as WOMAC and OAKHQoL. In this cohort, current pain and functional impairment appear to exert a more dominant influence on quality of life than disease chronicity or demographic characteristics.

Second, while previous studies have reported that the duration of knee OA is deemed a significant predictor in some studies (Mahmoud et al. 2019; Siviero et al. 2019), exhibited no such association in this study analysis. This discrepancy suggests that in our cohort, current symptom severity and functional impairment, rather than disease chronology, were the primary drivers of QoL outcomes. Patients may adapt to the chronicity of their condition, but acute pain and disability continue to exert the greatest influence on their daily lives.

Finally, socioeconomic and educational status did not emerge as significant predictors of QoL in our analysis, contrary to earlier reports that linked low education and income with worse QoL in KOA populations (Vitaloni et al. 2019; Raud et al. 2020). This may be explained by the relative homogeneity of our study sample, which consisted predominantly of Malay participants (97.4%) recruited from a tertiary hospital setting. Such demographic and socioeconomic uniformity may have limited the variability needed to detect associations seen in more diverse populations, suggesting that these null findings reflect contextual rather than biological differences.

Clinical Implications

From a clinical perspective, these findings underscore the importance of prioritizing symptom control and functional improvement in the management of knee osteoarthritis. This underscores the importance of comprehensive pain management and functional rehabilitation through pharmacological treatment, physiotherapy, weight management, and strengthening exercises (Bannuru et al. 2019; Dantas et al. 2021). Second, early identification and intervention before progression to advanced radiographic disease may help preserve QoL, as patients with KL grade 3 and 4 reported significantly poorer QoL. Detecting and managing KOA before progression to severe radiographic changes may help preserve function and prevent long-term disability. Additionally, the marked impairment in social functioning highlights the need for integrating psychosocial support into routine clinical care for knee osteoarthritis patients, as social functioning was the most impaired OAKHQoL domain. This highlights the importance of incorporating counselling, peer support, and community-based interventions alongside biomedical care to improve patient outcomes (Lee et al. 2017; Xie et al. 2020).

This study is the first to utilize the Malay version of a disease-specific health-related quality-of-life assessment tool, designed to gauge the impact of osteoarthritis on patients' daily lives. The tool underwent rigorous translation and validation(Rabade et al. 2023). The application of multivariable linear regression addresses the limitations of previous studies by considering the overall mean scores and eliminating confounding factors that affect the QoL of patients with KOA.

LIMITATIONS

Several limitations should be acknowledged. The generalisability of the findings is limited by the single tertiary center setting and the overwhelmingly Malay sample, which may not represent Malaysia's broader multi-ethnic population or patients in the primary care setting. Furthermore, the cross-sectional design precludes causal inference between predictors and QoL outcomes. Psychological and social determinants such as depression, anxiety, and broader social support, which are well documented as influencing QoL, were not assessed in this study (Ferreira et al. 2015; Lee et al. 2017). Finally, reliance on self-reported questionnaires may introduce recall and reporting biases, which should be considered when interpreting the results. Future research should aim to diversify the sample, include a wider range of ethnic populations, and consider longitudinal studies to enhance the understanding of osteoarthritis's impact on patients' lives.

CONCLUSION

This study demonstrates that WOMAC scores and advanced radiographic severity are the strongest predictors of QoL among Malaysian KOA patients. Demographic and socioeconomic factors, often highlighted in other populations, did not retain significance, emphasizing the dominant role of symptom burden and structural disease severity in this context. For clinicians, these results highlight the importance of early, targeted interventions to relieve pain and preserve function, as well as the integration of psychosocial support to address the broader impacts of KOA on patients' lives.

The study establishes a robust connection between WOMAC scores and diminished quality of life in KOA patients, particularly highlighting the substantial influence of severe KOA grades on the OAKHQoL scores. This positive correlation emphasizes the pivotal role in the need for early and effective interventions to mitigate the impact of KOA on the quality of life of affected individuals.

Notably, the study highlighted the need for personalized care in KOA management, considering the multifaceted factors influencing patients. Future research should explore these factors further, and healthcare practitioners should focus on comprehensive assessments to improve patient well-being.

CONFLICT OF INTEREST

All the authors have no conflict of interest.

ETHICAL APPROVAL

This study protocol was approved by the Research Ethics Committee (Human), School of Medical Sciences, Universiti Sains Malaysia (FWA Reg. No: 00007718; IRB Reg. No: 00004494) and the

procedures followed were in accordance with the Helsinki Declaration of 1975.

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REFERENCES

Abdul Kadir, Azidah, Mohd Faizal Mohd Arif, Azlina Ishak, Intan Idiana Hassan, and Norhayati Mohd Noor. 2018. Adaptation and validation of the malay version of the osteoarthritis knee and hip quality of life questionnaire among knee osteoarthritis patients. *BioMed research international*, no. 1: 4329751.

Alghadir, Ahmad H., and Masood Khan. 2022. Factors affecting pain and physical functions in patients with knee osteoarthritis: An observational study. *Medicine* 101, no. 47: e31748.

Ayhan, F. F., S. Gümrük, E. Ceceli, P. Borman, and A. Karagöz. 2015. THU0486 The Predictor for Disease Specific-Quality of Life in Patients with HIP and Knee Osteoarthritis: Mental Health. *Annals of the Rheumatic Diseases* 74: 375.

Bannuru, Raveendhara R., M. C. Osani, E. E. Vaysbrot, N. K. Arden, K. Bennell, S. M. A. Bierma-Zeinstra, V. B. Kraus et al. 2019. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis and cartilage* 27, no. 11: 1578-1589.

Bellamy, Nicholas, W. Watson Buchanan, Charles H. Goldsmith, Jane Campbell, and Larry W. Stitt. 1988. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *The Journal of rheumatology* 15, no. 12: 1833-1840.

Choojaturo, Siriwan, Siriorn Sindhu, Ketsarin Utriyaprasit, and Chukiat Viwatwongkasem. 2019. Factors Associated with Access to Health Services and Quality of Life in Knee Osteoarthritis Patients: A Multilevel Cross-Sectional Study. *BMC Health Services Research* 19 (1): 688.

Cui, Aiyong, Huizi Li, Dawei Wang, Junlong Zhong, Yufeng Chen, and Huading Lu. 2020. Global, Regional Prevalence, Incidence and Risk Factors of Knee Osteoarthritis in Population-Based Studies. EClinicalMedicine 29–30:100587.

da Silva Júnior, José Edson França, Almir Vieira Dibai-Filho, Inaê Silva Santos, Jhonata Botelho Protázio, José Djalma Arrais Júnior, Daniella Dias de Oliveira, Patrícia Gabrielle Dos Santos, and Cid André Fidelis-de-Paula-Gomes. 2023. Measurement properties of the short version of the Western Ontario and McMaster Universities Arthritis Index (WOMAC) for individuals with knee osteoarthritis. *BMC Musculoskeletal Disorders*24, no. 1: 574.

Dantas, Lucas Ogura, Tania de Fátima Salvini, and Timothy E McAlindon. 2021. Knee Osteoarthritis: Key Treatments and Implications for Physical Therapy. Brazilian Journal of Physical Therapy 25 (2): 135–46.

Duruöz, M T, E Duruöz, Ü Uçar, and E Topçu. 2013. SAT0338 Adaptation and Validation of the Osteoarthritis Knee and Hip Quality of Life (Oakhqol) Questionnaire in Turkish Population. Annals of the Rheumatic Diseases 72 (Suppl 3): A697–A697.

Efthimiou, Orestis, Johannes B. Reitsma, Thomas P. A. Debray, Gary S. Collins, and Karel G. M. Moons. 2024. Developing clinical prediction models: a step-by-step guide. *BMJ* 384: e074534.

Elbaz, Avi, Irina Magram-Flohr, Ganit Segal, Amit Mor, Ronen Debi, and Leonid Kalichman. 2017. Association between Knee Osteoarthritis and Functional Changes in Ankle Joint and Achilles Tendon. The Journal of Foot and Ankle Surgery 56 (2): 238–41.

Fekete, Helga, Francis Guillemin, Edina Pallagi, Róbert Fekete, Zoltán Lippai, Ferenc Luterán, István Tóth et al. 2020. Evaluation of osteoarthritis knee and hip quality of life (OAKHQoL): adaptation and validation of the questionnaire in the Hungarian population. *Therapeutic Advances in Musculoskeletal Disease* 12: 1759720X20959570.

Ferreira, Alyne Hevellen, Priscilla Brandi Gomes Godoy, Nara Rejane Cruz de Oliveira, Roger Amorim Santos Diniz, Ricardo Edésio Amorim Santos Diniz, Ricardo da Costa Padovani, and Regina Cláudia Barbosa da Silva. 2015. Investigation of depression, anxiety and quality of life in patients with knee osteoarthritis: a comparative study. *Revista Brasileira de Reumatologia (English Edition)* 55, no. 5: 434-438.

Goetz, Christophe, Emmanuel Ecosse, Anne-Christine Rat, Jacques Pouchot, Joël Coste, and Francis Guillemin. 2011. Measurement properties of the osteoarthritis of knee and hip quality of life OAKHQOL questionnaire: an item response theory analysis. *Rheumatology* 50, no. 3: 500-505.

Gonzalez Sáenz de Tejada, Marta, Antonio Escobar, Michael Herdman, Carmen Herrera, Lidia García, and Cristina Sarasqueta. 2011. Adaptation and validation of the Osteoarthritis Knee and Hip Quality of Life (OAKHQOL) questionnaire for use in patients with osteoarthritis in Spain. *Clinical Rheumatology* 30, no. 12: 1563-1575.

Hunter, David J, and Sita Bierma-Zeinstra. 2019. Osteoarthritis. *Lancet (London, England)* vol. 393,10182: 1745-1759.

Ismetovich, Nurgaliev Baktiyar. 2022. UDC 616.728. 3 Comparison of The Efficacy of Cox-1 and Cox-2 Topical Inhibitors In The Treatment of Patients With Knee Osteoarthritis. In *The 12 th International*

scientific and practical conference "Modern directions of scientific research development"(May 18-20, 2022) BoScience Publisher, Chicago, USA. 930 p., p. 65. 2022.

Karimi, Said Baha, Farhad Awalkhail, and Samsoor Walizada. 2024. Knee osteoarthritis: Assesment of quality of life in these patients. *Science and Education* 5, no. 3: 105-110.

Katz, Jeffrey N., Kaetlyn R. Arant, and Richard F. Loeser.2021. Diagnosis and treatment of hip and knee osteoarthritis: a review. *Jama* 325, no. 6: 568-578.

Kiadaliri, Aliasghar A., M. Gerhardsson de Verdier, Aleksandra Turkiewicz, L. S. Lohmander, and M. Englund. 2017. Socioeconomic inequalities in knee pain, knee osteoarthritis, and health-related quality of life: a population-based cohort study in southern Sweden. *Scandinavian journal of rheumatology* 46, no. 2: 143-151.

Kim, Mi-Ji, Byeong-Hun Kang, Soo-Hyun Park, Bokyoung Kim, Gyeong-Ye Lee, Young-Mi Seo, Ki-Soo Park, and Jun-Il Yoo. 2020. Association of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) with muscle strength in community-dwelling elderly with knee osteoarthritis. *International journal of environmental research and public health* 17, no. 7: 2260.

Lee, Augustine C, William F Harvey, Lori Lyn Price, Lucas P K Morgan, Nani L Morgan, and Chenchen Wang. 2017. Mindfulness Is Associated with Psychological Health and Moderates Pain in Knee Osteoarthritis. Osteoarthritis and Cartilage 25 (6): 824–31.

Lee, Augustine C., William F. Harvey, Lori Lyn Price, Lucas PK Morgan, Nani L. Morgan, and Chenchen Wang. 2017. Mindfulness is associated with psychological health and moderates pain in knee osteoarthritis. *Osteoarthritis and Cartilage* 25, no. 6: 824-831.

Mahmoud, Geilan A., Abdelkawy Moghazy, Shaymaa Fathy, and Marwa H. Niazy. 2019. Osteoarthritis knee hip quality of life questionnaire assessment in Egyptian primary knee osteoarthritis patients: Relation to clinical and radiographic parameters. *The Egyptian Rheumatologist* 41, no. 1: 65-69.

McConnell, Sara, Pamela Kolopack, and Aileen M. Davis. 2001. "The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): a review of its utility and measurement properties." *Arthritis Care & Research: Official Journal of the American College of Rheumatology* 45, no. 5: 453-461.

Meng, Zhengyuan, Jiakun Liu, and Nan Zhou. 2023. Efficacy and safety of the combination of glucosamine and chondroitin for knee osteoarthritis: a systematic review and meta-analysis. *Archives of orthopaedic and trauma surgery* 143, no. 1: 409-421.

Messier, Stephen P., Malia E. Gill, Shannon L. Mihalko, Daniel P. Beavers, Kate Queen, Gary D. Miller, Elena Losina et al. 2024. Clinical, Health-Related Quality of Life, and Gait Differences Among Obesity Classes in Adults With Knee Osteoarthritis. *Arthritis care & research* 76, no. 4: 503-510.

Nawito, Zeinab O., Ghada S. El-Azkalany, and Marwa El-Sayad. 2018. Nottingham health profile assessment of health-related quality of life in primary knee osteoarthritis patients: Relation to clinical features and radiologic score. *The Egyptian Rheumatologist* 40, no. 4: 265-268.

Nishitani, Kohei, Shinichiro Nakamura, and Shinichi Kuriyama. 2023. Clinical evaluation of knee joint diseases. *Journal of Joint Surgery and Research*1, no. 1: 9-17.

Ouédraogo, Dieu-Donné, Joelle Tiendrébéogo Zabsonré, Aimé Davy Sèvy Kenagnon, Fulgence Kaboré, Christian Compaoré, Youssouf Joseph Drabo, and Xavier Chevalier. 2014. Quality of life of patients with knee osteoarthritis with questionnaire OAKHQoL (OsteoArthritis of Knee Hip Quality of Life) in Rheumatology Consultation in Burkina Faso (West Africa). *Open Journal of Rheumatology and Autoimmune Diseases* 4, no. 4: 219-225.

Özden, Fatih, Özgür Nadiye Karaman, Nazan Tuğay, Cem Yalın Kilinç, Rabia Mihriban Kilinç, and Baki Umut Tuğay. 2020. The relationship of radiographic findings with pain, function, and quality of life in patients with knee osteoarthritis. *Journal of Clinical Orthopaedics and Trauma* 11: S512-S517.

Rabade, Anvita, Gollapalle Lakshminarayanashastry Viswanatha, Krishnadas Nandakumar, and Anoop Kishore. 2024. Evaluation of efficacy and safety of glucosamine sulfate, chondroitin sulfate, and their combination regimen in the management of knee osteoarthritis: a systematic review and meta-analysis. *Inflammopharmacology* 32, no. 3: 1759-1775.

Rat, A-C., Francis Guillemin, and J. Pouchot. 2008. Mapping the osteoarthritis knee and hip quality of life (OAKHQOL) instrument to the international classification of functioning, disability and health and comparison to five health status instruments used in osteoarthritis. *Rheumatology* 47, no. 11: 1719-1725.

Rat, Anne-Christine, Joël Coste, Jacques Pouchot, Michèle Baumann, Elizabeth Spitz, Nathalie Retel-Rude, Janine-Sophie Le Quintrec, Dominique Dumont-Fischer, and Francis Guillemin. 2005. OAKHQOL: a new instrument to measure quality of life in knee and hip osteoarthritis. *Journal of clinical epidemiology* 58, no. 1: 47-55.

Rat, Anne-Christine, Jacques Pouchot, Joël Coste, Cédric Baumann, Elizabeth Spitz, Nathalie Retel-Rude, Michèle Baumann, Janine-Sophie Le Quintrec, Dominique Dumont-Fischer, and Francis Guillemin. 2006. Development and testing of a specific quality-of-life questionnaire for knee and hip osteoarthritis: OAKHQOL (OsteoArthritis of Knee Hip Quality Of Life). *Joint Bone Spine* 73, no. 6: 697-704.

Raud, Benjamin, Chloé Gay, Candy Guiguet-Auclair, Armand Bonnin, Laurent Gerbaud,

Bruno Pereira, Martine Duclos, Yves Boirie, and Emmanuel Coudeyre. 2020. Level of obesity is directly associated with the clinical and functional consequences of knee osteoarthritis. *Scientific reports* 10, no. 1: 3601.

Ribeiro, Isadora Cristina, Arlete Maria Valente Coimbra, Beatriz Lavras Costallat, and Ibsen Bellini Coimbra. 2020. Relationship between radiological severity and physical and mental health in elderly individuals with knee osteoarthritis. *Arthritis Research & Therapy* 22, no. 1: 187.

Rundell, Sean D., Adam P. Goode, Pradeep Suri, Patrick J. Heagerty, Bryan A. Comstock, Janna L. Friedly, Laura S. Gold et al. 2017. Effect of comorbid knee and hip osteoarthritis on longitudinal clinical and health care use outcomes in older adults with new visits for back pain. *Archives of Physical Medicine and Rehabilitation* 98, no. 1: 43-50..

Salas-Vargas, Saray-Celena, and Eliana-Isabel Rodríguez-Grande. 2021. Reliability of a specific questionnaire to evaluate quality of life in people with osteoarthritis. *Reumatología Clínica (English Edition)* 17, no. 5: 279-283.

Serhier, Z., T. Harzy, S. ELfakir, S. Diouny, K. El Rhazi, M. Bennani Othmani, L. R. Salmi, and C. Nejjari. 2012. Cross-cultural adaptation and validation of the knee and hip health-related quality of life (OAKHQoL) in a Moroccan Arabic-speaking population. *Rheumatology international* 32, no. 4: 1015-1023.

Siviero, Paola, Federica Limongi, Antonella Gesmundo, Sabina Zambon, Cyrus Cooper, Elaine M. Dennison, Mark H. Edwards et al. 2019. Minimal clinically important decline in physical function over one year: EPOSA study. *BMC Musculoskeletal Disorders* 20, no. 1: 227.

Slama, I. Ben, H. Rkain, L. Traki, I. Bouaddi, L. Bouazzaoui, F. Allali, and N. Hajjaj Hassouni. 2012. AB0975 quality of life in women suffering from knee osteoarthritis. *Annals of the Rheumatic Diseases* 71: 694.

Steenkamp, Wynand, Pududu Archie Rachuene, Roopam Dey, Nkosiphendule Lindani Mzayiya, and Brian Emmanuel Ramasuvha. 2022. The correlation between clinical and radiological severity of osteoarthritis of the knee. *SICOT-J* 8: 14.

Tavares, Daniela Regina Brandão, Virginia Fernandes Moça Trevisani, Jane Erika Frazao Okazaki, Marcia Valéria de Andrade Santana, Ana Carolina Pereira Nunes Pinto, Karina Kuraoka Tutiya, Fernanda Martins Gazoni, Camila Bonin Pinto, Fania Cristina Dos Santos, and Felipe Fregni. 2020. Risk factors of pain, physical function, and health-related quality of life in elderly people with knee osteoarthritis: A cross-sectional study. *Heliyon* 6, no. 12.

Vitaloni, Marianna, Angie Botto-van Bemden, Rosa Maya Sciortino Contreras, Deborah Scotton, Marco Bibas, Maritza Quintero, Jordi Monfort et al. 2019. Global management of patients with knee osteoarthritis begins with quality of life assessment: a systematic review. *BMC musculoskeletal disorders* 20, no. 1: 493.

Vos, Theo, Christine Allen, Megha Arora, Ryan M. Barber, Zulfiqar A. Bhutta, Alexandria Brown, Austin Carter et al. 2016. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The lancet* 388, no. 10053: 1545-1602.

Wang, Wei, Chong-Ru He, Wei Zheng, Jia Li, and Wei-Dong Xu. 2016. Development of a valid simplified C hinese version of the O steoarthritis of K nee and H ip Q uality of L ife (OAKHQOL) in patients with knee or hip osteoarthritis. *Journal of Evaluation in Clinical Practice* 22, no. 1: 53-61.

Wu, Zugui, Rui Zhou, Yue Zhu, Ziquan Zeng, Zixuan Ye, Zhenbang Wang, Wengang Liu, and Xuemeng Xu. 2022. Self-management for knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. *Pain Research and Management* 2022, no. 1: 2681240.

Xie, Yue, Yong Yu, Jing-Xuan Wang, Xue Yang, Fei Zhao, Jian-Qiao Ma, Zhi-Yu Chen et al. 2020. Health-related quality of life and its influencing factors in Chinese with knee osteoarthritis. *Quality of Life Research* 29, no. 9: 2395-2402.

Yu, Hui, Junxiang Wang, Xin Xu, Hui Li, and Junfei Guo. 2025. Revealing the mediating mechanisms between BMI and osteoarthritis: a Mendelian randomization and mediation analysis. *Aging Clinical and Experimental Research* 37, no. 1: 119.