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ORIGINAL ARTICLE

Analysis of the Quality-of-Life Domain in Knee Injury an Osteoarthritis Outcome Score as an Expansion of Western Ontario and McMaster Universities Osteoarthritis Index for Evaluating Knee Osteoarthritis Therapy Outcomes

Agung Hidayatulloh[1], Gde Ganjar Oka Narasara[2]

[1]General Practitioner, RSI Sakinah Mojokerto, Mojokerto, Jawa Timur, Indonesia
[2]Physical Medicine and Rehabilitation Specialist, RSI Sakinah Mojokerto, Mojokerto, Jawa Timur, Indonesia

ABSTRACT

Introduction: Knee osteoarthritis is a degenerative joint disease-causing pain and functional limitation, with rising prevalence globally and in Indonesia. Outcomes are commonly assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which evaluates pain, stiffness, and function, but excludes quality of life (QOL). Rehabilitation medicine emphasizes not only symptom relief but also recovery and life quality. The Knee Injury and Osteoarthritis Outcome Score (KOOS) add a QOL domain for more comprehensive evaluation.

Method: A pre-post observational study was conducted on 24 knee osteoarthritis patients receiving ultrasound diathermy and transcutaneous electrical nerve stimulation (USD TENS). KOOS scores for pain, activities of daily living (ADL), and QOL were recorded before and after intervention. Paired t-tests or Wilcoxon tests analyzed score changes, while Pearson or Spearman tests assessed correlations between ΔQOL and Δpain, ΔADL, and ΔWOMAC.

Result: KOOS scores improved significantly after therapy (pre = 58.96; post = 33.29; $p < 0.001$), including QOL ($p = 0.002$), pain (pre = 52.50; post = 30.63; $p = 0.000$), and ADL (pre = 58.13; post = 37.92; $p = 0.000$). However, QOL changes were not significantly correlated with Δpain ($r = 0.399$; $p = 0.053$), ΔADL ($\rho = 0.306$; $p = 0.146$), or ΔWOMAC ($\rho = 0.356$; $p = 0.088$).

Conclusion: The QOL domain in KOOS reflects a distinct dimension not captured by WOMAC. KOOS thus offers a more holistic and patient-centered evaluation of therapeutic outcomes, highlighting the importance of including QOL in rehabilitation medicine.

Keywords: knee osteoarthritis, KOOS, WOMAC, quality of life, USD TENS

Correspondence Detail:
Agung Hidayatulloh
General Practitioner, RSI Sakinah Mojokerto, Mojokerto, Jawa Timur, Indonesia
Email: dr.hiday92@gmail.com

INTRODUCTION

Knee osteoarthritis (KOA) is a degenerative joint disease characterized by progressive cartilage loss, pain, and functional limitation[1]. Globally, KOA is one of the leading causes of disability, with prevalence and disease burden increasing in the past decade[1,2]. In Indonesia, the Global Burden of Disease (GBD) 2019 study reported that KOA prevalence more than doubled between 1990 and 2019, accompanied by rising incidence and years lived with disability[3]. Major risk factors include older age, female sex, obesity, prior joint injury, and genetic predisposition[2].

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is among the most widely used instruments to evaluate KOA outcomes, assessing three domains: pain, stiffness, and physical function in activities of daily living (ADL)[4,5]. While WOMAC is reliable, it does not include a quality of life (QOL) domain, limiting its ability to fully capture patient-centered outcomes[4,5].
To address this limitation, the Knee Injury and Osteoarthritis Outcome Score (KOOS) was developed, incorporating all WOMAC items plus additional domains to capture broader patient experiences[6]. KOOS comprises five domains: pain, other symptoms, ADL, sport/recreation, and knee-related QOL[6,7]. By incorporating a QOL domain, KOOS reflects the philosophy of rehabilitation medicine, which emphasizes holistic, patient-centered outcomes that integrate physical, psychological, and social dimensions of health (6,9,10). Given its broader scope, KOOS is better positioned to evaluate the multidimensional impact of KOA and its treatment.

Ultrasound diathermy (USD) and transcutaneous electrical nerve stimulation (TENS) are widely applied non-pharmacological modalities in KOA rehabilitation. Both have shown efficacy in reducing pain, disability, and improving function and QOL when measured by WOMAC or generic instruments[9,10]. Pain reduction is expected to improve activities of daily living (ADL), which in turn may enhance patients overall quality of life (QOL). However, the strength of this relationship remains unclear in patients undergoing combined USD and TENS therapy. Only few studies have evaluated their effects using KOOS, particularly the QOL domain, and the relationship between improvements in QOL and changes in pain or function remains underexplored[8,11].

Therefore, this study aimed to evaluate changes in KOOS, particularly the QOL domain, before and after combined USD and TENS therapy, and to examine correlations between QOL changes and changes in pain, ADL, and WOMAC scores.

METHODS

Study Design and Setting

This was a quasi-experimental pre–post study without a control group, conducted at the Physical Medicine and Rehabilitation Department, RSI Sakinah Mojokerto, East Java, Indonesia, between March and June 2025 (four months).

Participants

A total of 24 consecutive patients with knee osteoarthritis were recruited from the outpatient rehabilitation clinic during the study period. Patients who were clinically and radiologically diagnosed with knee osteoarthritis according to the American College of Rheumatology (ACR) criteria were invited to participate, completed baseline assessment, received therapy, and were reassessed after eight therapy sessions.

Inclusion criteria were: (1) age ≥ 40 years, (2) diagnosis of KOA according to ACR criteria, (3) willingness to participate, and (4) ability to complete the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire. Exclusion criteria included: (1) knee surgery in the past 6 months, (2) acute knee injury within the last 3 months, (3) severe neurological deficits, and (4) other musculoskeletal disorders affecting lower limb function.

A consecutive sampling approach was used, in which all eligible patients who presented during the study period and met the criteria were included. No a priori sample size or statistical power calculation was performed, as the sample represents real-world clinical cases within a limited research time frame.

Ethical Considerations

This study was reviewed and approved by the Research Ethics Committee of Universitas Pesantren Tinggi Darul Ulum Jombang (Approval No. 103-KEP-Unipdu/02/2025). Written informed consent was obtained from all participants prior to data collection and treatment.

Intervention

All participants received a combined therapy consisting of ultrasound diathermy (USD) and transcutaneous electrical nerve stimulation (TENS), administered two times per week for four consecutive weeks (a total of eight sessions). The interventions were delivered by licensed physiotherapists under the supervision and prescription of a rehabilitation medicine specialist. USD and TENS were applied to the affected knee region corresponding to the patient's area of pain. Specific device parameters (frequency, intensity, and pulse width) were not standardized, as treatment settings were adjusted according to the patient's tolerance and clinical response, based on the supervising physician's clinical judgment.

Outcome Measures

Patient-reported outcomes were assessed using KOOS, focusing on three domains: pain, activities of daily living (ADL), and quality of life (QOL). For comparison, WOMAC scores were derived from the KOOS pain and ADL subscales, which has been validated in previous studies (Ebrahimzadeh et al., 2015; Paradowski et al., 2006). Measurements were taken before and after the intervention. The questionnaire was self-administered by each participant under the supervision of the principal investigator, who provided clarification when necessary and was responsible for scoring and data entry. All KOOS and WOMAC domain scores were converted into percentage values (%) using the formula: (obtained score / maximum possible score) × 100%, with higher percentages indicating greater symptom severity (100% = maximum impairment; 0% = no impairment). We focused on pain, ADL, and QOL domains, as these represent the most clinically relevant outcomes in rehabilitation and are most directly related to patients perceived quality of life.

Statistical Analysis

Data were analyzed using SPSS version 22. Normality was tested with the Shapiro–Wilk test. For normally distributed variables, paired t-tests were performed; otherwise, the Wilcoxon signed-rank test was applied. Correlations between changes in QOL (ΔQOL) and changes in pain (Δpain), ADL (ΔADL), and WOMAC (ΔWOMAC) were examined using Pearson's correlation coefficient for normally distributed data and Spearman's rank correlation coefficient for non-normally distributed data. All tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of 24 patients with knee osteoarthritis participated in this study. The demographic and clinical characteristics of the participants are summarized in Table 1. The mean age was 59.17 ± 8.51 years (range: 46–75 years), and the majority were female (75%). The mean height, weight, and BMI were 155.46 ± 6.33 cm**,** 64.33 ± 7.31 kg, and 26.71 ± 1.99 kg/m², respectively, indicating that most participants were within the overweight category. The affected side was bilateral in 45.8%**,** right-sided in 41.7%, and left-sided in 12.5% of participants.

Table 1. Demographic and clinical characteristics of participants

Variable	Mean ± SD	n (%)	Range
Age (years)	59.17 ± 8.51	—	46–75
Height (cm)	155.46 ± 6.33	—	145–165
Weight (kg)	64.33 ± 7.31	—	52–78
BMI (kg/m²)	26.71 ± 1.99	—	—
Sex (Female / Male)	—	18 (75%) / 6 (25%)	—
Affected side	—	Right: 10 (41.7%)	—
		Left: 3 (12.5%)	
		Bilateral: 11 (45.8%)	

Values for continuous variables are presented as mean ± standard deviation (SD), as all numerical data were normally distributed based on the Shapiro–Wilk normality test. Categorical variables are presented as number (percentage).

KOOS and WOMAC Changes After USD TENS

All KOOS and WOMAC scores were expressed as percentages (%) of maximum impairment, with lower values indicating clinical improvement. A significant improvement was observed across all domains after four weeks of combined USD and TENS therapy (Table 2).

Table 2. KOOS and WOMAC scores before and after intervention

Domain	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Test statistic	p-value
KOOS Pain	63.75 ± 20.38	35.83 ± 14.65	Z = –4.29	< 0.001
KOOS ADL	57.33 ± 16.13	33.75 ± 11.54	t(23) = 8.69	< 0.001
KOOS QOL	77.25 ± 14.51	44.21 ± 14.42	Z = –3.13	0.002
KOOS Total (Pain + ADL + QOL)	66.69 ± 14.52	36.54 ± 9.79	t(23) = 11.18	< 0.001
WOMAC Total (Pain + ADL)	60.83 ± 18.93	31.96 ± 10.35	Z = –4.28	< 0.001

Z values represent results of Wilcoxon signed-rank tests for non-normally distributed data; t values represent results of paired t-tests for normally distributed data. A significance level of $\alpha = 0.05$ was applied.

Correlation Between QOL Change and Other Domains

Correlations between changes in QOL (ΔQOL) and other domains were analyzed using Spearman's or Pearson's correlation coefficients, based on the normality of each dataset. No significant correlations were found between ΔQOL and changes in pain, ADL, or WOMAC scores. The correlation results are summarized in Table 3.

Table 3. Correlation between changes in quality of life (ΔQOL) and other outcome domains

Domain comparison	Test used	Correlation coefficient	*p*-value
ΔQOL vs ΔPain	Pearson	$r = 0.399$	0.053
ΔQOL vs ΔADL	Spearman	$\rho = 0.306$	0.146
ΔQOL vs ΔWOMAC (Pain + ADL)	Spearman	$\rho = 0.356$	0.088

r values represent Pearson correlation coefficients for normally distributed data; ρ values represent Spearman's rank correlation coefficients for non-normally distributed data.

DISCUSSION

This study found that Quality of Life (QOL) improved significantly following combined ultrasound diathermy (USD) and transcutaneous electrical nerve stimulation (TENS), but these improvements did not strongly correlate with reductions in pain or activities of daily living (ADL). This suggests that QOL reflects broader psychosocial and functional perceptions beyond physical symptoms alone. The novelty of this study lies in the use of the KOOS-QOL subscale, which specifically measures knee-related quality of life rather than general well-being. Unlike broader instruments such as the SF-36 or WHOQOL-BREF, the KOOS-QOL domain captures patients' subjective perception of their knee function, symptoms, and confidence in daily activities. To our knowledge, this is the first study in Indonesia to examine KOOS-QOL changes in response to USD + TENS, highlighting its unique contribution to rehabilitation research.

KOOS was developed as an extension of WOMAC by adding the Quality of Life (QOL) domain as an important dimension previously absent in WOMAC, thereby providing a more comprehensive picture of the patient's condition[13]. Validation studies have shown that KOOS, including its QOL subscale, demonstrates good reliability and validity as a more comprehensive assessment tool compared to WOMAC, with the QOL domain capturing aspects distinct from physical function[14].

When compared with previous studies, our findings align with evidence showing that both TENS and USD contribute to improvements in pain,

function, and QOL among KOA patients. For instance, Yildiz et al. (2015) reported significant improvements in pain and function with ultrasound therapy in a randomized controlled trial[11]. Similarly, systematic reviews have confirmed that TENS can enhance QOL beyond reductions in pain intensity, suggesting broader neuromodulatory and psychosocial effects[7,10].

The lack of strong correlation between ΔQOL and Δpain or ΔADL in our study suggests that QOL is influenced by multiple domains beyond physical symptoms. Several plausible mechanisms may explain this finding. First, TENS is known to modulate pain through gate control theory and descending inhibitory pathways, which not only reduce pain perception but also influence central processing of discomfort and emotional well-being. Second, QOL domains capture psychosocial and emotional factors such as self-efficacy, confidence in mobility, and reduced anxiety, which are not directly measured by pain or ADL scores[12]. Third, USD may enhance tissue healing and joint circulation, contributing to a subjective sense of recovery even before measurable gains in daily function occur[19]. Lastly, cultural and contextual factors may shape how patients perceive "quality of life," meaning that reductions in pain may not linearly translate to improved QOL if social participation or independence remain restricted[20].

These findings underscore the importance of including QOL assessment in osteoarthritis outcome evaluation. Evaluating therapy outcomes based only on pain or ADL risks overlooking relevant patient-centered aspects. This implies that rehabilitation in Indonesia should integrate KOOS-QOL into clinical monitoring, beyond WOMAC alone, to provide a more holistic evaluation of patient progress.

This study has several limitations, including a small sample size (n=24) and the absence of a control group, which limit the generalizability of the findings and reduce statistical power. In addition, the intervention protocol was not standardized across participants, and only three KOOS domains (pain, ADL, and QOL) were analyzed, while the sport/recreation and symptoms domains were excluded[6,7]. A strength of this study is the use of KOOS percentage scoring, which allowed comparability across domains and facilitated direct interpretation of severity levels.

Future studies should adopt randomized controlled trial (RCT) designs with larger and more diverse populations, ideally multi-center, and should also investigate cross-cultural validity of KOOS in Indonesian populations, given that cultural differences may influence how patients perceive and report QOL[18]. Long-term follow-up would also be valuable to determine whether the benefits observed here are sustained over time.

CONCLUSION

This study demonstrates that the Quality of Life (QOL) domain in the KOOS improved significantly but showed weak correlation with pain and activities of daily living (ADL), suggesting that QOL captures subjective dimensions beyond physical symptoms. These findings support the conceptual expansion of KOOS over WOMAC, as KOOS integrates patient-perceived well-being and life satisfaction that are not represented in WOMAC. Therefore, KOOS provides a more comprehensive framework for evaluating knee osteoarthritis therapy outcomes. Further studies with larger sample sizes and randomized controlled designs are warranted to strengthen these findings.

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