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ORIGINAL RESEARCH

Factors Influencing Postoperative Recovery after Lower-Extremity Surgery: A Prospective Cohort Study

Amornrat Sangsaikaew[1], Apinya Koontalay[2], Khunphitha Junsevg[1], Arunrat Utaisang[1]

[1]*Department of Adult and Aging Nursing, Boromarajonani College of Nursing Nakhon Phanom, Nakhon Phanom University, Nakhon Phanom, Thailand*
[2]*Independent Researcher, Melbourne, Australia*

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Corresponding Author:
Khunphitha Junsevg
Boromarajonani College of Nursing Nakhon Phanom, Nakhon Phanom University, Nakhon Phanom, Thailand
Email: khunphitha@gmail.com

Abstract

Background: Suboptimal health-related quality of life (HRQoL) during recovery from lower-extremity surgery can increase healthcare costs and reduce patients' overall well-being. However, evidence regarding factors influencing HRQoL trajectories remains limited.
Purpose: This study examined predictors of HRQoL and self-efficacy at weeks 1 and 4 after hospital discharge in patients undergoing lower-extremity orthopedic surgery.
Methods: This prospective cohort study used consecutive sampling to recruit 90 patients undergoing lower-extremity orthopedic surgery (hip, femur, knee, tibia) at a tertiary hospital in Thailand. Collected data included demographic characteristics, clinical factors, anthropometric measurements (body mass index [BMI] and waist circumference), and surgical variables. Outcomes were assessed at weeks 1 and 4 after discharge using the 12-Item Short Form Health Survey (SF-12) to measure HRQoL and a validated 25-item questionnaire to measure self-efficacy. Multiple regression analysis was used to identify independent predictors of postoperative HRQoL, while paired-samples t-tests were used to examine changes in HRQoL and self-efficacy between weeks 1 and 4.
Results: This study found that BMI independently predicted poorer physical-domain HRQoL at week 1 ($\beta = -0.54$, $p = 0.023$) and week 4 ($\beta = -0.62$, $p = 0.008$). Waist circumference emerged as an additional predictor of the physical domain of HRQoL at week 4 ($\beta = -0.58$, $p = 0.002$). The regression models explained 22.8% of the variance at week 1 ($R^2 = 0.228$, $p < 0.001$) and 21.8% at week 4 ($R^2 = 0.218$, $p < 0.001$). Self-efficacy improved substantially from week 1 to week 4 (MD = 14.33, SDD = 9.86, Cohen's d = 2.03, $p < 0.001$). In contrast, the SF-12 physical component summary (PCS) scores remained unchanged (week 1: M = 28.21, SD = 1.66; week 4: M = 28.11, SD = 1.30; MD = -0.10, SDD = 1.35, Cohen's d = 0.07, $p = 0.571$), revealing a marked dissociation between improved psychological confidence and stable outcomes in the physical domain of HRQoL.
Conclusion: Elevated BMI consistently predicts poorer postoperative HRQoL following lower extremity surgery, with improvements in the physical domain of HRQoL often lagging behind improvements in patients' self-efficacy. Perioperative nurses should emphasize routine BMI assessment and targeted weight-management education to bridge the gap between perceived self-efficacy and physical HRQoL outcomes in perioperative care protocols.

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1. Introduction

Lower extremity trauma requiring surgical intervention represents a significant healthcare burden, with bone and joint surgeries being among the most frequently performed orthopedic procedures. The bony structures of the lower extremity, including the femur, tibia, and fibula, play critical roles in weight-bearing and locomotion, making injuries to these structures particularly debilitating (Rasmussen & Koelling, 2021). These injuries can result in complications such as wound-related issues, venous thromboembolism (VTE), rhabdomyolysis, and heterotopic ossification. Rather than merely prolonging hospital length of stay, these complications can

severely affect patient outcomes by delaying early mobilization, limiting weight-bearing capacity, and hindering overall functional recovery and the restoration of independence, ultimately resulting in reduced quality of life (Aprisunadi et al., 2023).

Health-related quality of life (HRQoL) after following lower extremity surgery is a complex, multidimensional construct encompassing both physical and mental well-being. Despite standardized surgical techniques and rehabilitation protocols, substantial interindividual variation in HRQoL outcomes persists, suggesting that modifiable factors warrant investigation (Ferraz et al., 2019). Previous research has identified several key determinants of HRQoL. Anthropometric factors, including obesity (BMI ≥ 30 kg/m²), have been associated with higher complication rates and delayed wound healing (Zierle-Ghosh & Jan, 2025). Psychosocial factors, such as kinesiophobia, depression, and low self-efficacy, have been shown to predict long-term disability, reduced participation in physical activity, and worse outcomes in the mental and physical domain of HRQoL in surgical populations (Master et al., 2021). Pain and mobility limitations in the early post-discharge period directly affect activities of daily living and adherence to exercise (Taniguchi et al., 2020; Tao et al., 2023). However, most existing studies have examined these factors in isolation or focused on specific procedures, leaving gaps in understanding how these variables interact over time during the critical early recovery phase.

Furthermore, few studies have systematically assessed HRQoL trajectories across multiple time points during the transition from supervised hospital care to self-management at home. The temporal nature of postoperative HRQoL trajectories requires repeated assessments to capture dynamic changes in outcomes. The postoperative timeline progresses through sequential phases: immediate postoperative care (days 0–2), early post-discharge transition (week 1), and continued functional restoration (weeks 2–4 and more), during which physical and psychological determinants may differentially affect outcomes (Master et al., 2021). For example, Shan et al. (2024) developed predictive models showing that early self-efficacy and fear of movement, measured in the first week, significantly predicted the physical domain of HRQoL and functional status at 6 weeks after knee arthroplasty. Similarly, Master et al. (2021) showed that postoperative depression and kinesiophobia assessed within the first 2 weeks predicted long-term disability at 6 months following various orthopedic procedures. These findings underscore the importance of evaluating both physical factors (anthropometric measurements, pain intensity, mobility status) and psychological factors (self-efficacy, confidence in functional activities) at key early time points, specifically around week 1 (initial home transition) and week 4 (early functional recovery), to identify phase-specific predictors.

Despite progress in perioperative care pathways, including enhanced recovery protocols and multimodal pain management, critical knowledge gaps remain regarding the magnitude and direction of associations between anthropometric measures (BMI, waist circumference) and patient-reported HRQoL during the early post-discharge period after diverse lower extremity procedures; the temporal evolution of self-efficacy from initial hospital discharge through early recovery and its relationship with HRQoL outcomes at different time points; and the relative contributions of physical versus psychological factors to HRQoL at weeks 1 and 4 post-discharge. Therefore, this prospective cohort study aimed to: (1) identify factors, including anthropometric measurements (BMI, waist circumference), clinical characteristics (pain, mobility, comorbidities), and psychosocial factors (self-efficacy), that independently predict HRQoL at weeks 1 and 4 following hospital discharge in patients undergoing lower-extremity orthopedic surgery; and (2) examine the temporal evolution of self-efficacy and its relationship with HRQoL outcomes during this critical early post-discharge period.

2. Methods

2.1 Research design

This prospective cohort study examined factors influencing postoperative recovery at weeks 1 and 4 following lower extremity surgery to establish a clear temporal sequence between baseline characteristics and outcomes, and to ensure rigorous, standardized real-time data collection for subjective variables, such as pain and self-efficacy, that are often inadequately documented in retrospective records (Polit & Beck, 2017). Assessment time points were selected to capture two phases: (1) week 1, the early home transition period when patients are at the highest risk for complications; and (2) week 4, the early functional recovery period when measurable improvements should be evident.

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2.2 Setting and samples

The study was conducted at a tertiary care hospital in Thailand. Eligible participants were adults aged ≥ 18 years who underwent lower-extremity bone surgery (hip, femur, knee, tibia, or fibula), were cognitively intact (Glasgow Coma Scale ≥ 15), could communicate in Thai, and provided informed consent. Patients were excluded if they had active malignancy under treatment, cognitive impairment preventing consent, medical complications precluding follow-up, or had undergone bilateral procedures. Using consecutive sampling, all eligible patients during the six-month period were invited to participate.

Sample size was calculated using G*Power 3.1.9.7 software. The analysis utilized the 'F tests' family and the 'Linear multiple regression: Fixed model, R^2 deviation from zero' statistical test. The calculation used a medium effect size ($f^2 = 0.15$), following Cohen's (1988) guidelines. A medium effect size was clinically justified as it aligns with the moderate explanatory power typically observed in multifactorial models predicting postoperative recovery and avoids the practically unfeasible sample size required to detect a small effect size. With a significance level (α) of 0.05, statistical power ($1-\beta$) of 0.80, and eight predictor variables (age, gender, BMI, waist circumference, pain, mobility, comorbidity, baseline self-efficacy), the minimum required sample size was 85 respondents. Accounting for an anticipated 10% attrition rate during the four-week follow-up period, our initial recruitment target was 94 respondents. While 94 eligible patients initially participated, four patients were lost to follow-up at week 4, resulting in a final analyzed sample of 90 respondents (as detailed in Figure 1). This final sample size of 90 remained above the minimum requirement of 85, ensuring sufficient statistical power for the regression analysis.

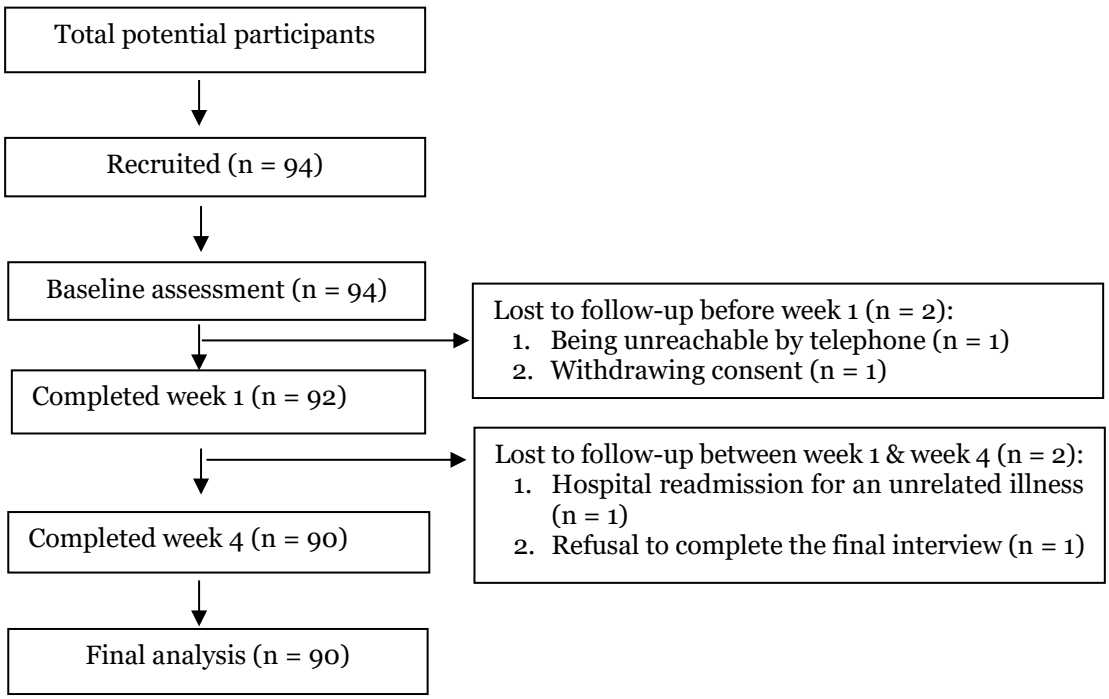


Figure 1. CONSORT diagram of participants' flow

2.3 Measurement and data collection

The dependent variable, HRQoL, representing postoperative recovery, was measured using the Short Form Health Survey (SF-12). Independent variables included demographic and clinical characteristics (age, gender, education, occupation, income, type of surgery, mechanism of injury, comorbidities, body mass index [BMI], and waist circumference), postoperative pain intensity, and self-efficacy for postoperative recovery.

Demographic and clinical data were obtained using a structured form. Anthropometric data were measured by the researchers who had completed a standard half-day training session on anthropometric measurement protocols and standardization, using standard hospital-grade equipment (a digital scale accurate to 0.1 kg, a stadiometer accurate to 0.1 cm, and a non-elastic

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measuring tape accurate to 0.1 cm) calibrated according to hospital maintenance protocols. BMI was calculated as weight (kg)/height squared (m^2). Postoperative pain intensity over the previous 24 hours was assessed using the 11-point Numeric Rating Scale for Pain (NRS), ranging from 0 ("no pain") to 10 ("worst imaginable pain"). Pain scores were categorized as mild (1–3), moderate (4–6), and severe (7–10). As a single-item standardized scale, formal internal consistency testing was not applicable, but its construct validity and test-retest reliability are well-established in adult populations (Hawker et al., 2011; Karcioglu et al., 2018).

Self-efficacy for postoperative recovery was measured using the 25-item Self-Efficacy Questionnaire for Surgical Patients (Bandura, 1997; Schwarzer & Warner, 2013). The instrument evaluates patients' confidence in performing recovery-related activities across five domains on a 5-point Likert scale (1 ="not at all confident" to 5 ="extremely confident"). Total scores range from 25 to 125, with higher scores indicating greater self-efficacy. A Thai-language version was developed using standard forward–backward translation guidelines (Sousa & Rojjanasrirat, 2011). In the current study, the instrument demonstrated excellent internal consistency, with a Cronbach's alpha of 0.87.

The HRQoL was measured using the 12-Item Short Form Health Survey (SF-12) (Ware et al., 1996). The SF-12 yields two summary scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). To ensure comparability with existing literature, these summaries were computed using standard norm-based scoring algorithms, standardized to a general population mean of 50 and a standard deviation of 10 (Ware et al., 1996). Higher scores indicate better HRQoL. A Thai version of the SF-12 was translated and adapted for the current study using a standard forward-and-back translation protocol, followed by an expert committee review to ensure content validity and cross-cultural equivalence. In the current study sample, the SF-12 demonstrated good reliability, with a Cronbach's alpha of 0.85.

Data were collected between January and June 2021. At baseline (pre-discharge), eligible patients were approached individually to explain the study's purpose, procedures, and confidentiality protections. After obtaining written informed consent, baseline demographic data were collected via structured face-to-face interviews, clinical data were extracted from medical records, and anthropometric measurements were taken using calibrated ward equipment following standardized hospital protocols.

During the early (week 1 post-discharge; 7 ± 1 days) and late (week 4 post-discharge; 28 ± 2 days) recovery phases, participants were contacted by telephone to complete structured follow-up assessments. Telephone administration of patient-reported outcome measures has been shown to yield data comparable in validity to in-person administration (Rutherford et al., 2016). Approximately 15 to 20 minutes were spent per call to evaluate self-efficacy (Self-Efficacy Questionnaire for Surgical Patients), postoperative pain (NRS), and health-related quality of life (SF-12) by telephone. To ensure data quality and consistency, all follow-up assessments were conducted by a single trained researcher using a standardized, pre-piloted telephone script. For unreachable participants, up to three contact attempts were made before classifying them as lost to follow-up.

2.4 Data analysis

All analyses were performed using IBM SPSS Statistics version 26. Statistical significance was set at a two-tailed α of 0.05. Prior to conducting inferential analyses, data were screened for accuracy, missing values, and conformity to the assumptions of the intended statistical tests. Data from the four participants who were lost to follow-up were completely excluded from the final dataset. For the remaining participants, missing item-level data were minimal (< 5% for any variable) and handled by listwise deletion, which is appropriate with such low rates of missingness (Tabachnick & Fidell, 2019). Descriptive statistics were computed for all study variables. The normality of continuous variables was assessed using the Shapiro–Wilk test and visual inspection of Q–Q plots. Normally distributed variables were summarized as mean ± standard deviation (SD) and non-normally distributed variables were presented as medians and interquartile ranges (IQR). Categorical variables were reported as frequencies and percentages.

Bivariate relationships among the variables at each time point (week 1 and week 4) were examined using correlation coefficients appropriate to the variable types: Pearson's r for continuous-continuous pairs, point-biserial correlation for dichotomous-continuous pairs (Schober et al., 2018), and the phi coefficient for dichotomous-dichotomous pairs. The magnitude

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of correlation was interpreted following Cohen's (1988) guidelines with |r| = 0.10–0.29 for small, |r| = 0.30–0.49 for medium, and |r| > 0.50 for large correlations.

To identify independent predictors of postoperative recovery at weeks 1 and 4, separate multiple linear regression analyses using the Enter method were conducted. In these models, the Physical Component Summary (PCS) of the SF-12 was designated as the primary outcome variable representing postoperative recovery. This specific focus was chosen because the study population consisted of patients undergoing lower extremity bone surgery; therefore, physical functioning, mobility, and role limitations are the most directly affected and clinically relevant domains during the early 4-week recovery phase. Predictor variables were entered based on significant bivariate correlations ($p < 0.05$) or theoretical relevance (e.g., age, gender, body mass index). Prior to regression modeling, all relevant assumptions were thoroughly evaluated: linearity was checked via partial regression plots; homoscedasticity via scatterplots of residuals versus predicted values; independence of residuals via the Durbin–Watson statistic with an acceptable range of 1.5–2.5; normality of residuals via histograms and Q–Q plots; multicollinearity via variance inflation factor (VIF) of less than 10 and tolerance of more than 0.10; and influential outliers via Cook's distance of less than 1.0 and standardized residuals within ±3 SD.

Model fit was assessed with R^2, adjusted R^2, and the overall F-test. Results were presented with unstandardized coefficients (B), standardized coefficients (β), 95% confidence intervals, and *p*-values. Changes in self-efficacy and recovery scores between weeks 1 and 4 were examined using paired-samples t-tests. For each comparison, the mean difference, 95% confidence interval, t-statistic, degrees of freedom, and *p*-value were reported. Effect sizes were computed as Cohen's d and interpreted as small (0.20–0.49), medium (0.50–0.79), and large (≥ 0.80) (Cohen, 1988).

Effect sizes for paired-samples comparisons were calculated as Cohen's d_{av} (Lakens, 2013), defined as the absolute mean difference divided by the pooled standard deviation of the two time points ($SD_{pooled} = \sqrt{SD_1^2 + SD_2^2/2}$. Effect sizes were interpreted as small (≥ 0.20), moderate (≥ 0.50), and large (≥0.80).

2.5 Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Ethical approval was obtained from the Institutional Review Board of Nakhon Phanom Hospital (Protocol No. NP-EC11-NO.1/2021, approved January 15, 2021) prior to recruitment. Participant protections included voluntary participation with the right to withdraw, written informed consent, confidentiality through coded identifiers and secure data storage, privacy during assessments, and access to researcher contact information. All data were stored in locked cabinets and password-protected electronic files accessible only to the research team.

3. Results

3.1 Characteristics of the participants

A total of 90 participants completed the study, yielding a retention rate of 95.7%. The sample had a mean age of 50.03 years (SD = 17.82), with 57.8% of participants being male. The majority of participants were married (68.9%), had completed primary education (74.4%), worked in agriculture (56.7%, n=51), and had undergone femoral fracture fixation (38.9%) or tibial fracture fixation (31.1%). The mean operative time was 86.21 minutes (SD = 25.19), while the mean surgical incision length was 9.90 cm (SD = 4.12). Participants' demographic, anthropometric, and clinical characteristics are summarized in Table 1.

3.2 Temporal changes in pain, self-efficacy, and postoperative HRQoL

Table 2 presents a comparison of study variables between weeks 1 (day 7) and 4 (day 30) post-discharge. The results demonstrated significant improvements in self-efficacy and specific functional domains, alongside a marked reduction in pain. Participants reported a statistically significant reduction in pain intensity from 4.87 (SD = 1.92) to 2.34 (SD = 1.45), representing a large reduction (MD = -2.53, SDD = 1.68, t = -14.28, p <.001, Cohen's d = 1.49). Similarly, total self-efficacy scores increased significantly from 109.14 (SD = 9.85) to 123.47 (SD = 0.64), demonstrating substantial psychological growth (MD = +14.33, SDD = 9.86, t = -13.79, p < .001, Cohen's d = 2.05).

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Regarding overall SF-12 summary measures, physical recovery remained limited as the Physical Component Summary (PCS) score showed no significant change from 28.21 (SD = 1.66) to 28.11 (SD = 1.30) (MD = -0.10, SDD = 1.35, t = -0.57, p = .571, Cohen's d = 0.07). In contrast, the Mental Component Summary (MCS) showed a statistically significant moderate improvement from 28.47 (SD = 2.13) to 29.85 (SD = 1.87) (MD = +1.38, SDD = 3.09, t = -4.23, p <.001, Cohen's d = 0.69). Domain-specific SF-12 subscale analyses revealed heterogeneous recovery trajectories. Substantially, large-magnitude gains were observed in bodily pain (d = 1.70, p < .001), physical functioning (d = 0.96, p < .001), role-physical (d = 0.81, p <.001), mental health (d = 0.73, p < .001), and general health (d = 0.40, p = .007). Conversely, vitality (p = .539) and role-emotional (MD = +0.12, p = .266) showed no significant changes. Social functioning exhibited a moderate secondary decline (MD = -0.47, SDD = 1.15, t = 3.89, p < .001, Cohen's d = 0.55), reflecting increased perceived social limitations as participants attempted to resume daily social roles despite persistent functional deficits.

Table 1. Characteristics of the study participants (n = 90)

Characteristic	Mean (SD)	Frequency (f)	Percentage (%)
Demographic characteristics			
Age (years)	50.03 (17.82)		
Gender			
Male		52	57.8
Female		38	42.2
Marital status			
Single		20	22.2
Married		62	68.9
Widowed		8	8.9
Educational level			
Primary school		67	74.4
Secondary school		20	22.2
Diploma		2	2.2
Bachelor's degree		1	1.1
Anthropometric characteristics			
BMI (kg/m²)	22.65 (3.31)		
Waist circumference (cm)	85.41 (9.02)		
Clinical & surgical characteristics			
Procedure type			
Femoral fracture fixation		35	38.9
Tibial fracture fixation		28	31.1
Other lower-extremity fracture fixations (e.g., fibula, ankle, patella, foot)		27	30.0
Cause of injury			
Traffic accidents		52	57.8
Falls		31	34.4
Others		7	7.8
Operative time (min)	86.21 (25.19)		
Surgical incision length (cm)	9.90 (4.12)		

Notes. BMI = body mass index; SD = standard deviation. Percentages were calculated based on the total sample (n = 90).

3.3 Correlations between study variables and postoperative HRQoL

Table 3 presents the bivariate correlations between demographic, clinical, and psychological variables and the physical domain of HRQoL (SF-12 PCS) at weeks 1 and 4. At week 1, early postoperative HRQoL was significantly hindered by higher BMI (r = -0.618, p < .001), larger waist circumference (r = -0.534, p < .001), longer operative time (r = -0.512, p < .001), and higher pain intensity (r = -0.445, p < .001). Marital status was also significantly associated with early physical HRQoL (χ^2 = 30.72, p < .05). Conversely, self-efficacy exhibited a significant positive correlation with early physical HRQoL (r = +0.287, p = .007). Age, gender, and surgical incision length were not significantly correlated with week 1 physical HRQoL (p > 0.05).

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By week 4, the pattern of significant correlates had shifted notably. Intraoperative and demographic factors had less influence, with operative time and marital status no longer significantly associated with physical HRQoL ($p > 0.05$). Pain intensity (r = -0.368, $p < .001$), BMI (r = -0.465, $p < .001$), and waist circumference (r = -0.412, $p < .001$) maintained statistically significant negative correlations with physical HRQoL, although the magnitudes of these relationships were attenuated compared to week 1. In contrast, the positive correlation between self-efficacy and physical HRQoL strengthened significantly by week 4 (r = +0.394, $p < .001$).

Table 2. Pain intensity, self-efficacy, and HRQoL scores at weeks 1 and 4 post-discharge (n = 90)

Variables	Week 1 Mean(SD)	Week 4 Mean(SD)	MD	SDD	t	*p*	Cohen's d	Interpretation
Pain Intensity (NRS)	4.87(1.92)	2.34(1.45)	-2.53	1.68	-14.28	<.001	1.49	Large pain reduction
Self-Efficacy (Total)	109.14(9.85)	123.47(0.64)	+14.33	9.86	-13.79	<.001	2.05	Large improvement
SF-12 Component Summaries:								
SF-12 Physical Component Summary (PCS)	28.21(1.66)	28.11(1.30)	-0.10	1.35	-0.57	.571	0.07	Stable physical recovery
SF-12 Mental Component Summary (MCS)	28.47(2.13)	29.85(1.87)	+1.38	3.09	-4.23	<.001	0.69	Moderate improvement
SF-12 Sub-Domains:								
Physical Functioning	3.42(0.85)	4.18(0.72)	+0.76	1.14	-6.34	<.001	0.96	Large improvement
Role-Physical	2.87(0.91)	3.56(0.78)	+0.69	1.28	-5.12	<.001	0.81	Large improvement
Bodily Pain	2.34(0.88)	3.78(0.81)	+1.44	1.26	-10.87	<.001	1.70	Very large improvement
General Health	3.15(0.94)	3.52(0.89)	+0.37	1.26	-2.78	.007	0.40	Moderate improvement
Vitality	3.68(0.76)	3.74(0.71)	+0.06	0.92	-0.62	.539	0.08	No significant change
Social Functioning	3.92(0.83)	3.45(0.88)	-0.47	1.15	3.89	<.001	0.55	Moderate decline
Role-Emotional	4.23(0.94)	4.35(0.87)	+0.12	1.02	-1.12	.266	0.13	No significant change
Mental Health	3.47(0.91)	4.08(0.76)	+0.61	1.02	-5.67	<.001	0.73	Moderate improvement

Notes: MD = mean difference (Week 4 - Week 1); SDD = standard deviation of differences. Cohen's d_{av} represents the effect size for paired samples calculated using the pooled standard deviation of the two time points: $d_{av} = \frac{MD}{\sqrt{(SD_1^2 + SD_2^2)/2}}$ (Lakens, 2013)

Table 3. Correlation between participant characteristics and SF-12 PCS scores at weeks 1 and 4 (n = 90)

Variables	Week 1				Week 4		
	M (SD)	f(%)	r/χ^2	*p*	M (SD)	*r*	*p*
SF-12 PCS	28.21 (1.66)				28.11 (1.30)		
Self-efficacy	109.14 (9.85)		+0.287	.007[a]	123.47 (0.64)	+0.394	< .001[a]
Age (years)	50.03 (17.82)		-0.125	.241[a]	-	−0.098	.358[a]
Sex (female)		38 (42.2)	1.12[a]	.290[b]	-	0.60	.442[b]
Marital status (married)		62 (68.9)	30.72[a]	<.05[b]	-	2.01	.156[b]
BMI (kg/m²)	22.65 (3.31)		−0.618	<.001[a]	-	−0.465	<.001[a]
Waist circumference (cm)	85.41 (9.02)		−0.534	<.001[a]	-	−0.412	<.001[a]
Operative time (min)	86.21 (25.19)		−0.512	<.001[a]	-	−0.182	.087[a]
Surgical incision length (cm)	9.90 (4.12)		−0.198	.061[a]	-	−0.114	.285[a]
Pain intensity (NRS)	4.87 (1.92)		−0.445	<.001[a]	2.34 (1.45)	−0.368	<.001[a]

Note. r = Pearson correlation; χ^2 = Chi-square; BMI= Body Mass Index; NRS = Numeric Rating Scale; [a]Pearson's correlation test, [b]Chi-square test

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3.4 Predictors of recovery at weeks 1 and 4

Multiple linear regression analyses using the Enter method were conducted to identify independent predictors of the physical domain of postoperative HRQoL at both weeks 1 and 4. Both regression models were statistically significant, with the included predictors explaining 22.8% of the variance in week 1 SF-12 PCS (R^2 = 0.228, F(6, 83) = 4.09, p < 0.001) and 21.8% of the variance in week 4 SF-12 PCS (R^2 = 0.218, F(6, 83) = 3.86, p < 0.001). Regression assumptions were adequately met, with no multicollinearity concerns (VIF < 2.8) and normally distributed residuals. As detailed in Table 4, the influence of independent predictors shifted across the recovery timeline. At week 1, BMI was the only statistically significant independent predictor, showing a strong negative association with the physical domain of early HRQoL (β = -0.54, p = 0.023). By week 4, BMI remained a significant negative predictor of HRQoL outcomes (β = -0.62, p = 0.008). Additionally, waist circumference emerged as a significant negative predictor of the physical domain of intermediate HRQoL (β = -0.58, p = 0.002) when controlling for BMI and other covariates in the model. Other variables, including surgery time, wound characteristics, pain, and self-efficacy, did not reach independent statistical significance in either the early or intermediate recovery phase (p > 0.05).

Table 4. Comparative multiple regression analysis: Independent predictors of the physical domain of postoperative HRQoL at weeks 1 and 4 (n = 90)

Predictors	Week 1					Week 4				
	β	*p*	R^2	*F*	*p*	*β*	*p*	R^2	*F*	*p*
Body mass index (BMI)	-0.54	.023	0.228	4.09	<0.001	-0.62	.008	0.218	3.86	<0.001
Waist circumference	-0.08	.310				-0.58	.002			
Surgery time	-0.16	0.17				0.05	0.70			
Surgical wound size	-0.10	0.40				-0.06	0.62			
Pain intensity (NRS)	-0.05	0.74				-0.19	0.10			
Self-efficacy	-0.09	0.53				0.00	1.00			

Note: β = standardized beta coefficient; R^2= coefficient of determination; F = ANOVA F-statistic.

4. Discussion

This prospective observational study examined factors influencing postoperative HRQoL after lower extremity surgery at weeks 1 and 4 among 90 patients. Three principal findings emerged: elevated BMI persistently predicted poorer outcomes in the physical domain of HRQoL; waist circumference showed a significant negative association with week 4 HRQoL when controlling for BMI; and while self-efficacy and specific HRQoL dimensions (such as pain reduction) showed substantial improvement, the overall composite score for the physical domain of HRQoL remained stable. Together, these findings indicate that postoperative recovery is a multidimensional process characterized by divergent trajectories across physical, psychological, and social domains, rather than a uniform progression toward pre-injury status.

Elevated BMI independently predicted diminished outcomes in the physical domain of HRQoL at both assessment time points. This sustained impact aligns with established literature documenting the adverse effects of obesity on orthopedic outcomes, complication rates, and rehabilitation trajectories (Pean et al., 2023). Mechanistically, the prolonged negative influence of BMI stems from both biomechanical and physiological burdens. Excess body mass imposes disproportionate mechanical loading on healing structures, delaying mobilization and increasing the difficulty of fundamental transfers and ambulation (Shadyab et al., 2018). Beyond mechanical stress, adipose tissue functions as an active endocrine organ, generating pro-inflammatory cytokines (such as TNF-α and IL-6) that create a systemic inflammatory environment antagonistic to optimal wound healing and tissue regeneration (Avery et al., 2025). Clinically, these findings highlight the necessity of identifying patients with elevated BMI for enhanced perioperative pathways, integrating closer complication surveillance, modified physical therapy, and nutritional counseling to support tissue healing without iatrogenic weight gain.

Consistent with our expectations, waist circumference demonstrated a significant negative association with week 4 HRQoL outcomes when controlling for BMI. This contrasts with broader metabolic evidence identifying central adiposity as a strong predictor of functional decline and mobility limitations (Shadyab et al., 2018). However, when statistically controlling for total body

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mass, a larger waist circumference may indirectly reflect preserved truncal and upper-body lean muscle mass, which is critical for executing non-weight-bearing mobility techniques and utilizing assistive devices during the early recovery phase (Box et al., 2025). Alternatively, this relationship may represent a statistical suppressor effect, a phenomenon in multivariate analyses in which highly correlated predictors yield coefficients with opposite signs (Farmus et al., 2020). While intriguing, this finding requires cautious interpretation. Future investigations employing precise body composition assessments, such as bioelectrical impedance or DEXA, are necessary to determine whether this protective effect reflects genuine preservation of muscle mass or merely a statistical artifact.

An analysis of HRQoL trajectories over time revealed a striking dissociation between psychological adaptation and objective functional restoration. While overall composite physical functioning scores remained stable, self-efficacy improved significantly between weeks 1 and 4. This temporal pattern reflects the transitional phase of mechanical recovery documented in trauma populations (Arnolda et al., 2017) and mirrors findings that adequate time is required for experiential learning and mastery of functional tasks (Taniguchi et al., 2020). This divergence can be understood through contemporary applications of health self-efficacy frameworks (Zou et al., 2024) and the modernized concept of "response shift" as operationalized in recent systematic reviews evaluating patient-reported outcomes (Vanier et al., 2024). As patients gained experience with their postoperative limitations, they likely recalibrated their goals and developed effective coping strategies, resulting in higher perceived confidence in managing persistent limitations rather than overcoming them entirely.

Importantly, the apparent stability of the composite physical score masked significant heterogeneity in domain-specific HRQoL. Basic physical functioning, role-physical dimensions, and bodily pain demonstrated substantial improvement, aligning with the expected resolution of acute inflammation and fracture stabilization (Box et al., 2025). Conversely, vitality remained low, indicating persistent postoperative fatigue. Most notably, social functioning declined between weeks 1 and 4. This counterintuitive drop likely stems from a collision between expanding social expectations at week 4 and the frustrating reality of residual mobility barriers. As patients attempt to resume valued social roles, they may discover that physical limitations create greater barriers to participation than initially anticipated. Ultimately, these trajectories underscored that postoperative care must evolve beyond physical healing to provide targeted, phase-specific interventions across psychological and social HRQoL domains.

The temporal shift in predictors from week 1 to week 4 highlighted a critical transition in the recovery trajectory. Variables demonstrating significant correlations with early recovery outcomes, such as operative duration, lost their independent predictive significance by week 4, whereas anthropometric measures, such as BMI, maintained a sustained prognostic influence. This indicates that while acute surgical factors primarily govern the immediate postoperative period, intrinsic patient characteristics dictate intermediate global functional status as the acute impact of surgery is absorbed over time (Cheng et al., 2018). Furthermore, the divergent recovery trajectories, in which psychological confidence outpaced physical ability, underscored a psychological–physical mismatch during early rehabilitation. The observed decline in social functioning by week 4 may further suggest that, as patients attempt to reintegrate into their normal routines, they likely face unexpected social limitations due to persistent, unmitigated physical deficits.

5. Implications and limitations

This investigation provides valuable longitudinal data on HRQoL trajectories after lower-extremity surgery in a Thai population, contributing to understanding functional restoration in underrepresented geographic contexts. The prospective design allowed for temporal analysis of the critical early post-discharge phase. Furthermore, the study findings offer two critical implications for optimizing the hospital-to-home patient transition. The first is early risk stratification. Nurses should use patient characteristics at admission rather than perioperative metrics to identify individuals who need intensive transitional care. While acute surgical variables, such as operative time, should guide short-term postoperative monitoring, an elevated BMI serves as a long-term indicator for complex discharge planning, specialized assistive equipment, and vigilant home wound surveillance to prevent metabolism-related healing delays. The second is targeted transitional education. Discharge interventions must bridge the gap

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between patients' psychological confidence and their actual physical capacities. Nurses should provide realistic, timeline-specific education on mobility limitations to prevent falls at home or premature overexertion. Care plans must also anticipate social reintegration challenges by offering practical strategies to manage persistent fatigue and adapt the home environment for safe social participation.

However, several limitations warrant acknowledgment. First, the follow-up period was restricted to four weeks, capturing only the acute recovery phase rather than long-term outcomes. Second, the predictors examined were limited. Variables such as psychological status (stress, depression), physiological markers (blood glucose, hemoglobin), sleep quality, and social support mechanisms were not included. Third, the reliance on a generic health status measure (SF-12) might reduce sensitivity to domain-specific functional changes compared to disease-specific or objective, performance-based measures (e.g., gait speed). Fourth, the sample came from a single tertiary care center, which may limit generalizability. Finally, there was a time lag between data collection (January to June 2021) and publication. However, surgical techniques for lower extremity fracture fixation have remained relatively consistent over the past decade. Furthermore, the primary modifiable factors examined, such as BMI, mobility, and self-efficacy, are fundamental constructs whose prognostic value remains stable in recent literature (Shan et al., 2024; Zierle-Ghosh & Jan, 2025).

6. Conclusion

HRQoL following lower-extremity surgery was a complex, multidimensional process with divergent trajectories across physical, psychological, and social domains. Elevated BMI remained a persistent barrier to early and intermediate physical HRQoL outcomes, highlighting the need for early risk stratification and targeted perioperative care. Furthermore, the observed dissociation between rapidly improving psychological confidence (self-efficacy) and static overall physical functioning underscored a critical clinical challenge: psychological adaptation did not automatically translate to objective physical restoration. To optimize patient outcomes, clinical care must evolve to provide personalized, phase-specific interventions. This requires healthcare teams to simultaneously monitor both subjective and objective HRQoL indicators, ensuring that patient confidence remains safely calibrated to their actual capabilities while addressing the complex realities of pain management and social reintegration. In addition, future research should shift toward longitudinal designs extending to 3, 6, and 12 months, incorporating a broader set of psychophysiological predictors and disease-specific or objective measures. Ultimately, future randomized controlled trials should test whether preoperative interventions targeting modifiable risk factors (such as weight optimization) and cognitive interventions that enhance self-efficacy translate into measurable improvements in objective HRQoL outcomes.

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Author contribution

All three authors (AS, KJ, and AU) made substantial contributions to the conception and design of the study, data analysis and interpretation, drafting of the manuscript, and critical revision for important content. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of interest

The authors declare that they have no competing interests.

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Declaration of Generative Artificial Intelligence (AI)

During the preparation of this work, the authors used an AI-assisted technology (Gemini) strictly to improve the readability, language, and structural flow of the manuscript. After using this tool, the authors rigorously reviewed and edited the content. The authors take full responsibility and accountability for the accuracy, integrity, and originality of the final publication. The authors did not use AI for data collection, statistical analysis, or drawing clinical conclusions.

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