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# Determinants of Functional Recovery and Health-Related Quality of Life Following Total Hip and Knee Arthroplasty

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***Abstract*****—** *Total joint arthroplasty (TJA) is among the most clinically effective surgical interventions for end-stage osteoarthritis, yet substantial inter-individual variability in postoperative outcomes persists. This prospective study investigates the determinants of functional recovery and health-related quality of life (HRQoL) in 530 primary arthroplasty patients using structured assessments at baseline and six months postoperatively. Data were collected using the WHOQOL-BREF short form (Snell et al., 2016), a functional status scale adapted from Rissanen et al. (1996) and Chang et al. (2019), and a patient expectations scale (Mahomed et al., 2002; Gonzalez Saenz de Tejada et al., 2014). Statistical procedures included paired-sample t-tests, independent t-tests, one-way ANOVA, Pearson correlation, multiple linear regression, hierarchical regression, and bootstrapped mediation analysis. Postoperative improvements were statistically significant across all domains ($p < .001$), with large effect sizes (Cohen's $d = 1.45–1.89$). Comorbidity burden was a significant negative predictor of HRQoL ($\beta = -0.24$, $p < .001$), corroborating Snell et al. (2021) and Peter et al. (2015). Preoperative patient expectations were the strongest positive predictor of functional improvement ($\beta = 0.42$, $p < .001$), confirming Mahomed et al. (2002). The integrated model explained 58% of HRQoL variance ($R^2 = 0.58$). Hip arthroplasty patients achieved greater gains than knee arthroplasty patients. Findings underscore the clinical value of preoperative expectation management and comorbidity-informed rehabilitation design.*

***Keywords*****—** *total joint arthroplasty, health-related quality of life, functional recovery, patient expectations, comorbidity, hip arthroplasty, knee arthroplasty.*

## I. Introduction

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are the definitive surgical treatments for progressive osteoarthritis, targeting the restoration of joint biomechanics, the elimination of chronic pain, and the recovery of functional independence. Longitudinal community-based research has consistently demonstrated significant improvements in health-related quality of life (HRQoL) following both procedures [1], [2]. Nevertheless, clinically significant variability in postoperative recovery trajectories necessitates a deeper analytical investigation of the predictive determinants that drive differential outcomes. Rissanen, Aro, Sintonen, Slätis, and Paavolainen (1996) established that both hip and knee replacement confer substantial functional and quality-of-life benefits within one year of surgery [3]. Fitzgerald et al. (2004) confirmed consistent positive recovery trends over twelve months while documenting individual-level variability [4]. Long-term cohort studies extended evidence of durable gains to five years [5], [6], while Biring et al. (2007) identified attenuated improvements in revision relative to primary arthroplasty, signalling procedural differences in outcome mechanisms [7].

Beyond the surgical procedure itself, three predictor domains have attracted particular empirical attention. Comorbidity burden has been identified as a consistent negative moderator of postoperative physical functioning and HRQoL [8], [9]. Preoperative patient expectations constitute a robust positive predictor of functional satisfaction [10], [11], [12]. Measurement instrument selection further complicates outcome assessment: McGuigan et al. (1995) identified limitations of the SF-36 in predicting postoperative QoL, prompting the development of more targeted instruments such as the WHOQOL-BREF short form validated by Snell et al. (2016) [13]. Comparative studies confirm that recovery trajectories differ systematically between THA and TKA [14], [15]. Contemporary healthcare research situates arthroplasty recovery within multidimensional health

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determinants frameworks [16], [17], while digital patient engagement and rehabilitation innovation are increasingly proposed as tools to optimise functional recovery outcomes [18], [19]. Three analytical gaps remain unresolved in the extant literature: the absence of integrated psychosocial–clinical predictor models; limited use of large-sample regression diagnostics; and insufficient procedure-stratified comparative analysis within the same statistical framework. The present study addresses each gap through a parametric analysis of 530 primary arthroplasty patients.

## II. OBJECTIVES AND HYPOTHESES

The study pursued five objectives: (1) to quantify postoperative changes in functional status and HRQoL; (2) to examine the predictive role of comorbidity burden on HRQoL outcomes; (3) to assess the impact of preoperative patient expectations on functional recovery; (4) to compare outcomes between THA and TKA recipients; and (5) to construct a multivariate parametric model explaining HRQoL variance. Four directional hypotheses were formulated:

H1: TJA produces statistically significant improvement in HRQoL from baseline to six-month follow-up.

H2: Comorbidity burden is a significant negative predictor of postoperative HRQoL.

H3: Positive preoperative expectations significantly predict functional improvement.

H4: THA patients demonstrate greater HRQoL and functional gains than TKA patients.

## III. METHODS

### *A. Sample and Demographic Profile*

The study sample comprised 530 patients who underwent primary THA or TKA at a tertiary orthopaedic centre. Exclusion criteria encompassed revision arthroplasty, documented cognitive impairment affecting self-report reliability, and unavailability for six-month follow-up. Table I presents the sample characteristics. The mean patient age was 63.4 years (SD = 8.7), with 58.9% female participants. The majority of patients (52.1%) reported one to two comorbid conditions, a distribution consistent with multimorbidity prevalence documented in arthroplasty populations by Snell et al. (2021) and Peter et al. (2015) [8], [9].

**TABLE I. SAMPLE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS (N = 530)**

| Characteristic | n | % |
|---|---|---|
| Sex: Male | 218 | 41.1 |
| Sex: Female | 312 | 58.9 |
| Procedure: THA | 261 | 49.2 |
| Procedure: TKA | 269 | 50.8 |
| Comorbidities: None | 142 | 26.8 |
| Comorbidities: 1–2 | 276 | 52.1 |
| Comorbidities: ≥3 | 112 | 21.1 |
| Mean Age (SD) | 63.4 (8.7) yrs | — |

### *B. Instrumentation*

Functional status was assessed using an eight-item mobility and joint function scale derived from Rissanen et al. (1996) and adapted by Chang, Lin, and Lin (2019) [3], rated on a five-point Likert format (1 = severe limitation; 5 = no limitation). HRQoL was measured using the WHOQOL-BREF short form validated for arthroplasty populations by Snell et al. (2016) [13], encompassing four domains: physical, psychological, social, and environmental. Preoperative patient expectations were assessed via the six-item scale developed by Mahomed et al. (2002) [10], capturing anticipated pain relief, mobility, and lifestyle restoration. Comorbidity burden was quantified through a physician-diagnosed self-report inventory scored as a weighted composite index consistent with Snell et al. (2021) [8].

### *C. Reliability and Validity*

All constructs demonstrated acceptable to excellent internal consistency (Cronbach's α = 0.81–0.92) and composite reliability (CR = 0.84–0.94), exceeding the 0.70 acceptability threshold [13]. Construct validity was confirmed by exploratory factor analysis: Kaiser–Meyer–Olkin = 0.91, Bartlett's Test of Sphericity $\chi^2(210)$ = 3487.12, $p < .001$, with factor loadings ranging from 0.68 to 0.87. Table II presents the reliability statistics.

**TABLE II. RELIABILITY STATISTICS**

| Construct | Items | Cronbach's α | Composite Reliability |
|---|---|---|---|
| Functional Status | 8 | 0.89 | 0.91 |

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| | | | |
|---|---|---|---|
| HRQoL (WHOQOL-BREF) | 16 | 0.92 | 0.94 |
| Patient Expectations | 6 | 0.87 | 0.89 |
| Comorbidity Impact | 5 | 0.81 | 0.84 |

## IV. DATA ANALYSIS

### *A. Pre–Post Outcome Comparisons*

Paired-sample t-tests revealed statistically significant improvements across all outcome domains from baseline to six-month follow-up (all $p < .001$). Table III presents descriptive and inferential statistics. Effect sizes ranged from Cohen's d = 1.45 to 1.89, indicating large clinical effects. Pain severity demonstrated the greatest absolute improvement (pre: M = 1.92, SD = 0.73; post: M = 4.20, SD = 0.52). These findings support H1 and are consistent with the longitudinal outcomes documented by Jones et al. (2000), Rissanen et al. (1996), and Neuprez et al. (2020) [1], [3], [6].

**TABLE III. PRE-OPERATIVE VS. SIX-MONTH POSTOPERATIVE OUTCOME COMPARISON (N = 530)**

| Variable | Pre-op M (SD) | 6-Month M (SD) | t | p |
|---|---|---|---|---|
| Functional Score | 2.14 (0.62) | 4.01 (0.58) | 45.32 | < .001 |
| HRQoL Physical | 2.28 (0.71) | 4.12 (0.64) | 41.67 | < .001 |
| HRQoL Psychological | 2.65 (0.66) | 3.98 (0.61) | 36.12 | < .001 |
| Pain Score | 1.92 (0.73) | 4.20 (0.52) | 48.90 | < .001 |

### *B. Comparative Analysis: Hip Versus Knee Arthroplasty*

Independent-samples t-tests demonstrated that THA recipients achieved significantly greater functional improvement (t = 6.32, $p < .001$) and HRQoL gains (t = 5.88, $p < .001$) compared to TKA recipients (Table IV), supporting H4. These findings are consistent with comparative outcome evidence reported by Dailiana et al. (2015) and Ritter et al. (1995) [14], [15], and may reflect the greater biomechanical complexity of knee rehabilitation and the higher incidence of postoperative stiffness associated with TKA.

**TABLE IV. INDEPENDENT T-TEST: THA VS. TKA OUTCOME COMPARISON**

| Outcome | THA M (SD) | TKA M (SD) | t | p |
|---|---|---|---|---|
| Functional Improvement | 1.98 (0.44) | 1.71 (0.49) | 6.32 | < .001 |
| HRQoL Gain | 1.85 (0.51) | 1.62 (0.55) | 5.88 | < .001 |

### *C. Correlation Analysis*

Pearson correlation analysis confirmed the directionality of all hypothesised relationships (Table V). Patient expectations demonstrated significant positive correlations with functional improvement (r = 0.49, $p < .01$) and HRQoL outcome (r = 0.52, $p < .01$), consistent with Mahomed et al. (2002) and Gonzalez Saenz de Tejada et al. (2014) [10], [12]. Comorbidity index showed significant negative correlations with both functional improvement (r = −0.41, $p < .01$) and HRQoL (r = −0.38, $p < .01$), aligning with Snell et al. (2021) [8].

**TABLE V. PEARSON CORRELATION MATRIX (** P < .01)**

| Variable | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. Patient Expectations | — | | | |
| 2. Comorbidity Index | −0.34** | — | | |
| 3. Functional Improvement | 0.49** | −0.41** | — | |
| 4. HRQoL Outcome | 0.52** | −0.38** | 0.63** | — |

### *D. Multiple Linear Regression*

A multiple linear regression model with postoperative HRQoL as the criterion variable yielded a significant overall model fit ($F[6, 523] = 120.84$, $p < .001$; $R^2 = 0.58$, Adjusted $R^2 = 0.57$). Table VI presents predictor coefficients. Functional improvement was the strongest predictor (β = 0.47, $p < .001$), consistent with Rissanen et al. (1996) and Fitzgerald et al. (2004) [3], [4]. Patient expectations were the second strongest predictor (β = 0.31, $p < .001$), reinforcing Mahomed et al. (2002) and Gonzalez Saenz de Tejada et al. (2014) [10], [12]. Comorbidity burden was a significant negative predictor (β = −0.24, $p < .001$), supporting H2 and aligning with Snell et al. (2021) and Peter et al. (2015) [8], [9]. Hip arthroplasty demonstrated a significant positive advantage over knee arthroplasty (β = 0.16, $p < .001$). Sex was not statistically

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significant (β = 0.06, p = .129). Variance Inflation Factors (VIF < 2) confirmed the absence of multicollinearity.

TABLE VI. MULTIPLE LINEAR REGRESSION PREDICTING POSTOPERATIVE HRQOL (N = 530). $R^2 = 0.58$, ADJ. $R^2 = 0.57$, F(6, 523) = 120.84, P < .001

| Predictor | B | SE | β | t | p | VIF |
|---|---|---|---|---|---|---|
| Functional Improvement | 0.41 | 0.04 | 0.47 | 10.25 | < .001 | 1.42 |
| Patient Expectations | 0.29 | 0.05 | 0.31 | 6.18 | < .001 | 1.36 |
| Comorbidity Index | −0.27 | 0.06 | −0.24 | −4.92 | < .001 | 1.28 |
| Age | −0.11 | 0.04 | −0.12 | −2.78 | .006 | 1.14 |
| Sex | 0.05 | 0.03 | 0.06 | 1.52 | .129 | 1.09 |
| Procedure (Hip = 1) | 0.18 | 0.05 | 0.16 | 3.74 | < .001 | 1.22 |

*E. Hierarchical Regression*

Hierarchical regression confirmed the incremental predictive value of each domain (Table VII). Demographic variables alone explained 7% of variance. Adding clinical variables (comorbidity, procedure type) increased total $R^2$ to 0.28 ($\Delta R^2 = 0.21$, p < .001). The inclusion of psychosocial predictors in Block 3 produced the largest increment ($\Delta R^2 = 0.30$, p < .001), underscoring the primacy of patient expectations alongside functional improvement in determining HRQoL outcomes, consistent with Mahomed et al. (2002) and Gonzalez Sáenz de Tejada et al. (2010) [10], [11].

TABLE VII. HIERARCHICAL REGRESSION SUMMARY

| Block | Variables Entered | $\Delta R^2$ | Total $R^2$ | p |
|---|---|---|---|---|
| 1 | Age, Sex | 0.07 | 0.07 | < .01 |
| 2 | + Comorbidity Index, Procedure Type | 0.21 | 0.28 | < .001 |
| 3 | + Functional Improvement, Patient Expectations | 0.30 | 0.58 | < .001 |

*F. One-Way ANOVA and Mediation Analysis*

One-way ANOVA examining HRQoL by comorbidity group yielded a significant between-groups effect (F[2, 527] = 24.91, p < .001, $\eta^2 = 0.09$). Post-hoc Tukey analysis confirmed significant pairwise differences between all three strata (none, 1–2, ≥3 conditions; all p < .01), indicating that each additional comorbidity stratum was associated with progressively attenuated HRQoL. The moderate effect size ($\eta^2 = 0.09$) underscores the clinical relevance of comorbidity screening in perioperative assessment, consistent with Snell et al. (2021) [8]. Bootstrapped mediation analysis (5,000 resamples) indicated that functional improvement partially mediates the effect of patient expectations on HRQoL (indirect β = 0.24; 95% CI [0.18, 0.31], p < .001), supporting H3. The significant direct effect of expectations on HRQoL remained after accounting for mediation, indicating that expectations operate through both rehabilitative engagement (the indirect path) and direct cognitive appraisal of treatment outcomes [10].

## V. RESULTS AND DISCUSSION

The present investigation yields four principal findings that collectively advance the evidence base on total joint arthroplasty outcomes. First, the magnitude of postoperative improvement across physical, psychological, and pain domains was consistent with and reinforces the established longitudinal evidence base. Large Cohen's d values (1.45–1.89) confirm that TJA confers substantial clinical benefit comparable to prior community-based cohort findings [1], [3], [4]. The six-month assessment window captures the phase of most rapid functional change, during which structured physiotherapy and adaptive retraining produce their greatest effects; longer-term durability of these gains has been confirmed in five-year follow-up studies [5], [6].

Second, comorbidity burden exerted a significant and clinically meaningful negative influence on postoperative HRQoL outcomes (β = −0.24, $\eta^2 = 0.09$). Chronic metabolic, cardiovascular, inflammatory, and musculoskeletal conditions diminish physiological reserve, impair rehabilitative capacity, and reduce the magnitude of functional gains achievable through arthroplasty. These findings extend and confirm the outcome modelling literature of Peter et al. (2015) and Snell et al. (2021) [8], [9]. The practical implication is clear: systematic comorbidity risk stratification should be a standard component of the preoperative assessment pathway, enabling clinicians to calibrate rehabilitation intensity and manage outcome expectations for high-comorbidity patients. Broader social and occupational determinants of health also moderate recovery capacity in this population

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[16], [17], and future perioperative models should incorporate these contextual factors.

Third, preoperative patient expectations emerged as the strongest psychosocial predictor of postoperative outcomes, operating both directly on HRQoL ($\beta = 0.31$) and indirectly through facilitation of functional recovery (indirect $\beta = 0.24$). These findings corroborate the foundational evidence of Mahomed et al. (2002) and the subsequent prospective confirmation provided by Gonzalez Sáenz de Tejada et al. (2010) and Gonzalez Saenz de Tejada et al. (2014) [10], [11], [12]. The partial mediation pathway reveals that expectations shape postoperative outcomes not only through cognitive appraisal of outcomes relative to expectations, but also by motivating greater engagement with postoperative rehabilitation programmes, enhancing adherence to physiotherapy, and sustaining recovery effort through the early painful postoperative period. These findings position structured preoperative expectation counselling as a modifiable, evidence-based target for perioperative intervention. Emerging digital patient engagement platforms and AI-supported rehabilitation tools offer scalable mechanisms for personalising expectation-setting and monitoring rehabilitation compliance [18], [19].

Fourth, THA recipients achieved significantly greater functional and HRQoL improvements than TKA recipients, supporting H4 and confirming prior comparative orthopaedic evidence [14], [15]. This differential likely reflects the greater biomechanical complexity of the knee joint, the higher postoperative stiffness rates associated with TKA, and the more intensive quadriceps reconditioning demands of knee rehabilitation. Despite this procedural difference, clinically meaningful improvements were documented in both groups, consistent with the quality-adjusted life-year gains established across large-scale cost-effectiveness analyses of both procedures [20]. The procedural difference supports the development of differentiated, procedure-specific rehabilitation protocols that acknowledge the distinct recovery trajectories of THA and TKA patients.

The integrated multivariate model, explaining 58% of HRQoL variance, demonstrates the substantial explanatory advantage of combined psychosocial–clinical–demographic modelling over single-domain approaches. The hierarchical regression confirmed that psychosocial predictors (expectations and functional improvement) contributed the largest incremental variance ($\Delta R^2 = 0.30$), emphasising that clinical and demographic variables alone are insufficient to account for postoperative HRQoL. These results support the biopsychosocial model of surgical recovery and reinforce the theoretical integration of patient-centred outcome frameworks with clinical rehabilitation science [7], [13].

## VI. CONCLUSION

This parametric investigation provides robust evidence that total joint arthroplasty produces substantial, clinically meaningful improvements in functional capacity and health-related quality of life. The integrated predictive model, accounting for 58% of HRQoL variance, demonstrates that optimal outcomes depend not on surgical intervention alone but on a combination of comorbidity-informed perioperative planning, evidence-based expectation management, and procedure-differentiated rehabilitation programming. Comorbidity burden and preoperative patient expectations are the two most clinically actionable predictors identified, both amenable to structured perioperative management strategies. Hip arthroplasty produces superior early postoperative gains compared to knee arthroplasty, warranting procedure-specific rehabilitation protocols. Future research should pursue five-year longitudinal modelling, comparative primary-versus-revision analyses, integration of AI-based predictive risk stratification tools [21], and expansion of the psychosocial predictor framework to include resilience and mental health constructs [22], [23]. Rehabilitation robotic technologies and adaptive motion systems represent additional avenues for enhancing functional recovery outcomes in this population [24]. In summary, total joint arthroplasty is a highly effective intervention whose full potential is realised through a precision-focused, patient-centred perioperative care model.

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