Patient-reported Quality of Life Before and After Total Knee Arthroplasty: A Prospective Multicentre Cohort Study

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Abstract

Background: To identify patients' self-reported health-related quality of life (HRQoL) before and after total knee arthroplasty (TKA) and determine factors contributing to any heterogeneity in HRQoL.

Methods: This prospective multicentre study included 404 patients with knee osteoarthritis who underwent TKA between 1 April and 30 December 2019 and in whom HRQoL was assessed preoperatively and at 7 days and 1, 3, and 6 months postoperatively. Sociodemographic characteristics were assessed using a general information questionnaire; disability, using the Knee Injury and Osteoarthritis Outcome Score; pain, using the visual analogue scale (VAS) score; and HRQoL, using the European Quality of Life Five Dimension Five Level (EQ-5D-5L) score. Potential heterogeneity and factors influencing longitudinal changes in HRQoL were analysed using a growth mixture model.

Results: The mean EQ-5D-5L score improved from 0.69 preoperatively to 0.90 at 6 months postoperatively. Two types of longitudinal heterogeneity were identified: (1) a group of patients with a small and slow improvement in HRQoL and (2) a group of patients who showed marked and rapid improvement in HRQoL. The main characteristics of the latter group were a monthly family income >2000 yuan, exercising for approximately 30 min daily, and better knee function at baseline. Baseline knee function and change in knee function were significantly associated with the percentage change in HRQoL.

Conclusions: HRQoL improved considerably after TKA. However, there was some heterogeneity in the changes in HRQoL depending on certain patient characteristics. Targeted interventions should focus on these differences to optimise the outcomes of TKA.

Background

Osteoarthritis is a common chronic musculoskeletal disease that affects nearly 400 million people worldwide and imposes a heavy socioeconomic burden on individuals and health care systems in many countries (1–3). Knee osteoarthritis (KOA) is present in 86.8% of osteoarthritis cases and is the main cause of knee pain (2–4). It is characterised by osteophyte formation and destruction of the articular cartilage of the knee. Patients with KOA often have reduced self-care ability and even disability due to joint pain, stiffness, and limited activity, which has an increasingly severe impact on their quality of life and leads to a wide range of social problems over time (3).

The prevalence of KOA in the Chinese population over 40 years of age is reported to be 17.0%, affecting 12.3% of men and 22.2% of women, and both these figures are higher than the world average values (5). Furthermore, the prevalence of younger patients with KOA is increasing, and it is projected that the proportion of the population over the age of 45 years with a diagnosis of KOA will increase from 13.8–15.7% by 2032 (6, 7). This degenerative disease adversely affects the health-related quality of life (HRQoL) of middle-aged and older patients and represents a substantial burden of disease in China.

Total knee arthroplasty (TKA) is the most effective treatment for end-stage KOA (8–11) and has been performed for more than 40 years (12, 13). Previous studies have shown that 80–85% of patients with KOA have good outcomes after TKA (14–16). However, several studies have reported that not all patients are satisfied with the outcome after surgery, with 15–20% of patients reporting ongoing pain, poor joint function, postoperative infection, or complications, including a need for revision surgery (17).

Previous studies of TKA have focused primarily on the clinical effectiveness of the surgery and on risk factors (18, 19), costs versus benefits of surgery (20), or the safety and efficacy of postoperative rehabilitation (21). Although some studies have investigated the HRQoL of patients after TKA (22, 23), the factors affecting this change are not clear.

Therefore, we conducted this cohort study in Guangzhou, the largest city in southern China, to assess the self-reported HRQoL trajectories of patients with KOA before and after TKA and to identify the factors contributing to any differences in these trajectories.

Methods

Study design and participants

This prospective observational study enrolled patients who underwent TKA at four tertiary hospitals in four districts in Guangzhou, China, between 1 April 2019 and 30 December 2019. The following inclusion criteria were applied: 1) diagnosis of KOA based on the 2018 clinical guidelines for the diagnosis of osteoarthritis in China (24); 2) first TKA procedure; 3) willingness and ability to complete questionnaires; and 4) completion of at least three of five follow-up questionnaires. Patients with a psychiatric disorder, those with another serious disease, and those who were not independently self-caring were excluded. Questionnaires were distributed to patients by the investigators and medical students in the same year of training at the five assessment points. In total, 404 of 520 patients with KOA screened at baseline met the study inclusion criteria and attended at least three follow-up visits. The screening process and follow-up of patients throughout the study are shown in Fig. 1.

This study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for the reporting of observational studies.

General information questionnaire

Sociodemographic characteristics were obtained from a questionnaire adapted from the General Information Questionnaire developed by the International Consortium for Health Outcomes Measurement for KOA. Information collected included sex, age, marital status, education level, weight, height, monthly family income, basic health insurance, smoking status, alcohol consumption, frequency of physical activity, history of KOA, and history of knee surgery. Body mass index (BMI, in kg/m^2) was calculated for each patient. Using the BMI cut-off values reported for the Chinese population, patients were classified as follows: underweight (< 18.5), normal weight (18.5–23.9), overweight (24.0–27.9), and obese (≥ 28).

Knee Injury and Osteoarthritis Outcome Score

The Knee Injury and Osteoarthritis Outcome Score (KOOS-PS) is a short version of the original KOOS. It is a self-administered instrument that measures the outcomes of impairment, disability, and handicap after knee injury and comprises seven dimensions, each of which is scored from 0 to 4 for the degree of difficulty (0, none; 1, slight; 2, moderate; 3, very; and 4, extreme). The original total score ranges from 0 to 28, with a higher score indicating better joint function (25). The KOOS-PS standard score is obtained by converting the score formula specified by the scale and ranges from 0 to 100 (13).

Visual analogue pain scale score

Patients' subjective perception of pain was estimated using the visual analogue scale (VAS) score, which is widely used and determined by measuring the distance on a 10-cm line between the “no pain” anchor and the mark made by the patient. Patients use a vertical line to mark their current level of knee pain. Scores range from 0 to 10, and a higher score indicates greater pain intensity.

European Quality of Life Five Dimension Five Level scale

The European Quality of Life Five Dimension Five Level (EQ-5D-5L) scale is a standardised instrument developed by the EuroQol group to measure health status and is widely used internationally (26, 27). It comprises five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), each of which is rated on a 5-point scale (none, not difficult; slight, a little difficult; moderate, some difficulty; severe, very difficult; or extreme, impossible). The scores obtained were converted into a total score using the Chinese scoring system and ranged from − 0.391 to 1.000, with higher scores representing a better health status.

Reliability

Internal consistency was measured using the Cronbach's alpha coefficient. An alpha value between 0.70 and 0.95 was considered to indicate acceptable reliability. The Cronbach's coefficients for the five measurements of the KOOS-PS scale and five measurements of the EQ-5D-5L scale are listed in Table 1.

Table 1
Reliability of KOOS-PS and EQ-5D-5L scores at five time points from before surgery to 6 months after surgery

Variable	Before surgery	7 days after TKA	1 month after TKA	3 months after TKA	6 months after TKA
KOOS-PS score					
Cronbach's alpha	0.85	0.83	0.81	0.81	0.80
EQ-5D-5L score	0.77	0.78	0.72	0.79	0.79
Cronbach's alpha					
EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; TKA, total knee arthroplasty					

Statistical analyses

Continuous variables are summarised as the mean and standard deviation, and categorical variables are shown as the frequency (percentage). Categorical variables were compared using Pearson's test, and continuous variables were compared using the Student's *t*-test or Wilcoxon test. Statistical significance was set at a p-value of < 0.05. The Spearman's correlation coefficient was used to describe the correlation between the KOOS-PS and EQ-5D-5L scores at each time point. An unconditional growth mixture model (GMM) with free estimates of factor loadings was fitted to the EQ-5D-5L, KOOS-PS, and knee pain scores. A conditional GMM was fitted to the EQ-5D-5L score; the intercept and slope terms for the KOOS-PS were then used as covariables to fit the conditional GMM for the EQ-5D-5L score. The categorical latent variables of the EQ-5D-5L were used as the grouping variables. Univariable and multivariable logistic regression models were used to explore the factors associated with the EQ-5D-5L score. The multivariable logistic regression model was established by including variables with a p-value < 0.1. Monthly family income, exercise, KOOS-PS_I (the intercept term of KOOS-PS), KOOS-PS_S (the slope term of KOOS-PS), and VAS_C were independent variables, and EQ-5D-5L_C was the dependent variable. VAS_C and EQ-5D-5L_C represent categorical latent variables. R 3.6.2 was used for data cleaning, statistical description, and regression analysis, and Mplus 8.3 software was used for the GMM analysis.

Results

Patient characteristics

The patient characteristics are presented in Table 2. Of the 404 study participants, 313 (77.48%) were female, 395 (97.77%) were over the age of 40 years, 360 (89.11%) were married, and 221 (55.22%) had not been educated beyond the elementary school level. Monthly family income was < 2000 Yuan for 198 (49.75%), 2000–4000 Yuan for 106 (26.63%), and > 4000 Yuan for 94 (23.62%) patients. One hundred and forty-one patients (34.90%) did not perform daily exercise, 106 (26.24%) exercised for approximately 30 min daily, and 157 (38.86%) exercised for > 30 minutes daily. A total of 289 (71.53%) patients were overweight or obese.

Table 2
Patient demographic and clinical characteristics (n = 404)

Variable	Classification	n (%)
Location	Hospital A	116 (28.71)
	Hospital B	71 (17.57)
	Hospital C	197 (48.76)
	Hospital D	20 (4.95)
Sex	Male	91 (22.53)
	Female	313 (77.48)
Age, years	< 59	90 (22.28)
	60–74	242 (59.90)
	> 74	72 (17.82)
Marital status	Unmarried	8 (1.98)
	Married	360 (89.11)
	Divorced	1 (0.25)
	Widowed	35 (8.66)
Education	Elementary school or below	221 (55.11)
	Junior high school	91 (22.69)
	Junior college or high school	49 (12.22)
	College/bachelor or above	40 (9.98)
Smoker	No	378 (93.56)
	Yes	26 (6.44)
Alcohol consumption	No	385 (95.30)
	Yes	19 (4.70)
Monthly family income (Yuan)	> 2000	198 (49.75)
	2000–4000	106 (26.63)
	≥ 4000	94 (23.62)
Medical insurance	No	32 (7.92)
	Yes	372 (92.08)
Duration of illness, years	< 5	174 (43.07)

Variable	Classification	n (%)
	6–15	174 (43.07)
	> 15	56 (13.86)
Expected duration of recovery, months	< 1	350 (86.63)
	≥ 1	54 (13.37)
Hospital stay, days	< 5	27 (6.72)
	6–8	118 (29.35)
	9–11	119 (29.60)
	> 12	138 (34.33)
Daily exercise, minutes	None	141 (34.90)
	Approximately 30	106 (26.24)
	> 30	157 (38.86)
Body mass index	< 18.5	5 (1.24)
	18.5–24	110 (27.23)
	24–28	164 (40.59)
	> 28	125 (30.94)

Changes in EQ-5D-5L and KOOS-PS across five waves

Table 3 shows the changes in HRQoL and knee function over time, as assessed by the EQ-5D-5L and KOOS-PS scores. In comparison with preoperative values, HRQoL and knee function scores were lower on postoperative day 7 but were significantly improved by 6 months after surgery. There was a significant correlation between the KOOS-PS sore and EQ-5D-5L score preoperatively, at 7 days, and at 1, 3, and 6 months postoperatively, with Spearman correlation coefficients of 0.568, 0.654, 0.579, 0.525, and 0.538 ($p < 0.001$), respectively.

Table 3
EQ-5D-5L and KOOS-PS scores at five time points from before to 6 months after surgery

Variable	Before TKA	7 days after TKA	1 month after TKA	3 months after TKA	6 months after TKA
KOOS-PS					
	65.774 (15.02)	59.627 (13.03)	67.046 (12.46)	72.925 (11.47)	76.984 (10.82)
EQ-5D-5L					
	0.686 (0.23)	0.625 (0.26)	0.768 (0.21)	0.858 (0.17)	0.895 (0.14)
EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; SD, standard deviation; TKA, total knee arthroplasty					

Selection of the best GMM

EQ-5D-5L scores did not show a linear or quadratic growth trajectory over time (Supplementary Figs. 1 and 2, Additional files 1); therefore, an unconditional GMM was used to identify the growth trajectory of EQ-5D-5L scores and its heterogeneity. The same method was used to explore the growth trajectory and heterogeneity of the KOOS-PS and pain-VAS scores. The model fitting results (Supplementary Tables 1–4, Additional files 1) showed that the best classifications for EQ-5D-5L, KOOS-PS, and VAS pain scores were 3-class, 1-class (latent growth curve modelling), and 2-class, respectively. We further examined the fitted linear-free-estimate GMM (2-class, 3-class, and 4-class) and found that the KOOS-PS_I and KOOS-PS_S simultaneously had a significant effect on the categorical latent variables as well as the continuous intercept term (EQ-5D-5L_I) and slope term (EQ-5D-5L_S) for the EQ-5D-5L (28–30). Therefore, the 2-class GMM was deemed to be the best fitting model for representing the HRQoL trajectories over a period of five waves. The individual growth trajectories of these two classes are shown in Supplementary Figs. 3 and 4 (Additional files1). The average trajectory of the 2-class GMM-C is shown in Fig. 2. Patients in whom the average HRQoL trajectory (EQ-5D-5L) improved markedly and rapidly after TKA were classified as the “rising” group, and those in whom the increase in the HRQoL trajectory was slower and less marked were classified as the “stable” group.

Parameter estimates of HRQoL in 2-class GMM

Supplementary Table 5 (Additional file1) presents the parameter estimates for the selected 2-class GMM of the EQ-5D-5L scores. In the stable group ($n = 45$), the baseline EQ-5D-5L scores (EQ-5D-5L_I) was positively associated with the baseline KOOS-PS scores (KOOS-PSI) (beta = 0.021, $p < 0.001$), suggesting that HRQoL was positively associated with the KOOS-PSI preoperatively. However, the baseline KOOS-PS scores were not significantly associated with changes in the EQ-5D-5L scores ($p = 0.518$). The results of the heterogeneity analysis in the stable group also showed that there were differences in the baseline HRQoL scores among individuals (residual mean, -0.446, $p = 0.044$; and residual variance, -0.023, p =

0.014), although there were no significant differences in the change in HRQoL among individuals ($p = 0.569$ and $p = 0.742$). The intercept was not correlated with the slope ($p = 0.972$).

In the rising group (n = 359) (Table 4), the baseline EQ-5D-5L (EQ-5D-5L_I) score (ß = 0.030, $p < 0.001$) was positively associated with baseline KOOS-PS score. However, the baseline KOOS-PS score was negatively associated with the rate of change in the EQ-5D-5L (EQ-5D-5L_S; -0.015, $p < 0.0001$). The residual differences in the initial HRQoL scores among individuals were statistically significant ($p < 0.001$), as was the rate of change ($p < 0.001$). Furthermore, the residuals of the intercept and slope terms were correlated ($p = 0.232$).

Table 4
Comparison of sociodemographic characteristics between the stable and rising groups

Variable	Classification	Rising group (n = 359)	Stable group (n = 45)	p-value
Location, n (%)	Hospital A	102 (87.93)	14 (12.07)	0.167
	Hospital B	66 (92.96)	5 (7.04)	
	Hospital C	176 (89.34)	21 (10.66)	
	Hospital D	15 (75)	5 (25)	
Sex, n (%)	Male	82 (90.11)	9 (9.89)	0.667
	Female	277 (88.50)	36 (11.50)	
Age, years, n (%)	< 59	81 (90)	9 (10)	0.703
	60–74	216 (89.26)	26 (10.74)	
	> 74	62 (86.11)	10 (13.89)	
Marital status, n (%)	Unmarried	37 (84.09)	7 (15.91)	0.287
	Married	322 (89.44)	38 (10.56)	
Education, n (%)	Elementary school or below	189 (85.52)	32 (14.48)	0.118
	Junior high school	85 (93.41)	6 (6.59)	
	Junior college or high school	45 (91.84)	4 (8.16)	
	College/bachelor or above	38 (95)	2 (5)	
Smoker	No	295 (93.65)	83 (93.26)	0.894
	Yes	20 (6.35)	6 (6.74)	
Alcohol consumption	No	299 (94.92)	86 (96.63)	0.501
	Yes	16 (5.08)	3 (3.37)	
Income, Yuan, n (%)	< 2000	163 (82.32)	35 (17.68)	< 0.001
	2000–4000	98 (92.45)	8 (7.55)	

Note: KOOS-PS_I and KOOS-PS_S, the intercept term and slope term of KOOS-PS; The group with 89 observations tended to be stable over time, hence, was named as the “stable” group. The group with 315 observations showed a decreasing trend over time, hence, was named the “rising” group. EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; OJD, Other Joint Diseases; SD, standard deviation.

Variable	Classification	Rising group (n = 359)	Stable group (n = 45)	p-value
	> 4000	93 (98.94)	1 (1.06)	
Medical insurance, n (%)	No	331 (88.98)	41 (11.02)	0.799
	Yes	28 (87.5)	4 (12.5)	
Duration of illness, years, n (%)	< 5	151 (86.78)	23 (13.22)	0.134
	6–15	154 (88.51)	20 (11.49)	
	> 15	54 (96.43)	2 (3.57)	
Expected duration of recovery, months, n (%)	< 1	311 (88.86)	39 (11.14)	0.995
	≥ 1	48 (88.89)	6 (11.11)	
TKA, n (%)	No	323 (88.49)	42 (11.51)	0.472
	Yes	36 (92.31)	3 (7.69)	
OJD, n (%)	No	323 (88.493)	42 (11.51)	0.472
	Yes	36 (92.31)	3 (7.69)	
Trauma, n (%)	No	290 (88.96)	36 (11.04)	0.901
	Yes	69 (88.46)	9 (11.54)	
Hospital stay, days, n (%)	< 5	25 (92.59)	2 (7.41)	0.844
	6–8	105 (88.98)	13 (11.02)	
	9–11	107 (89.92)	12 (10.08)	
	> 12	120 (86.96)	18 (13.04)	
Daily exercise, minutes, n (%)	None	118 (83.69)	23 (16.31)	0.040
	Approximately 30	99 (93.40)	7 (6.60)	
	> 30	142 (90.45)	15 (9.55)	
Body mass index, n (%)	< 18.5	3 (60)	2 (40)	0.159
	18.5–24	100 (90.91)	10 (9.09)	
	24–28	143 (87.20)	21 (12.81)	

Note: KOOS-PS_I and KOOS-PS_S, the intercept term and slope term of KOOS-PS; The group with 89 observations tended to be stable over time, hence, was named as the “stable” group. The group with 315 observations showed a decreasing trend over time, hence, was named the “rising” group. EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; OJD, Other Joint Diseases; SD, standard deviation.

Variable	Classification	Rising group (n = 359)	Stable group (n = 45)	p-value
	> 28	113 (90.4)	12 (9.6)	
KOOS-PS_I		60.150 (4.09)	56.156 (7.94)	0.002
KOOS-PS_S		7.685 (2.06)	5.674 (1.92)	< 0.001
VAS_C	Decreasing group	297 (94.29)	18 (5.71)	< 0.001
	Stable group	62 (69.66)	27 (30.34)	

Note: KOOS-PS_I and KOOS-PS_S, the intercept term and slope term of KOOS-PS; The group with 89 observations tended to be stable over time, hence, was named as the “stable” group. The group with 315 observations showed a decreasing trend over time, hence, was named the “rising” group. EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; OJD, Other Joint Diseases; SD, standard deviation.

Latent HRQoL variables as risk factors

In univariable logistic regression analysis, the KOOS-PS knee function score, monthly family income, amount of daily exercise, and VAS_C were associated with being in the rising EQ-5D-5L group (Table 5). In the multivariable logistic regression model, KOOS-PS, family monthly income, daily exercise, and VAS_C were associated with increased odds of being in the rising group for EQ-5D-5L. Compared with patients with a monthly family income < 2000 yuan, the odds of being in the rising group was higher in patients with a monthly family income of 2000–4000 yuan (odds ratio [OR] 6.19, 95% confidence interval [CI] 2.16–21.57) and in those with a monthly family income of > 4000 yuan (OR 19.73, 95% CI 3.77–366.69). The odds of being in the rising group were higher in patients who exercised for approximately 30 min daily than in those who did not (OR 2.95, 95% CI 1.06–9.02). However, when daily exercise was performed for more than 30 min, the odds were not significant (OR 1.62, 95% CI 0.66–4.02), using patients who did not exercise as reference. For patients with a decreasing VAS pain score, the odds of being in the rising group were higher than in those with a stable VAS pain score (OR 6.09, 95% CI 2.72–14.07). Moreover, we found that the odds of being in the rising group increased with higher KOOS-PS scores (Table 5).

Table 5
Logistic regression with EQ-5D-5L_C as the dependent variable

Variable	Univariable OR (95% CI)	p value	Multivariable* OR (95% CI)	p-value
KOOS-PS_I, per SD	2.01 (1.506–2.754)	< 0.001	2.26 (1.517–3.519)	< 0.001
KOOS-PS_S, per SD	3.26 (2.201–5.014)	< 0.001	2.60 (1.656–4.311)	< 0.001
Income, Yuan				
< 2000	Reference		Reference	
2000–4000	2.63 (1.228–6.308)	0.019	6.19 (2.155–21.567)	0.002
≥ 4000	19.97 (4.206–357.716)	0.003	19.73 (3.767–366.688)	0.005
Daily exercise, minutes				
None	Reference		Reference	
Approximately 30	2.76 (1.189–7.194)	0.025	2.95 (1.061–9.022)	0.045
> 30	1.85 (0.929–3.764)	0.084	1.62 (0.664–4.024)	0.292
VAS pain score				
Stable group	Reference		Reference	
Decreasing group	7.19 (3.758–14.055)	< 0.001	6.09 (2.715–14.074)	< 0.001

*Adjusted for KOOS-PS_ I, KOOS-PS _S, family monthly income, exercise, VAS_C. CI, confidence interval; EQ-5D-5L, European Quality of Life Five Dimension Five Level; KOOS-PS, Knee Injury and Osteoarthritis Outcome Score; OR, odds ratio; SD, standard deviation; VAS, visual analogue scale

Discussion

This study aimed to identify any population heterogeneity in factors influencing changes in the HRQoL of patients with KOA that might be used to develop individualised treatment strategies.

We found that patients showed improvement in knee function and HRQoL after TKA, which is consistent with the findings of Zhang et al. (31) and Neuprez et al. (32). The trajectory for EQ-5D-5L indicated that patients experienced a cycle of change in knee function and HRQoL after TKA. HRQoL would be expected to deteriorate for a short period immediately after TKA due to postoperative bed rest, limited knee function, and wound pain. Osteotomy, unicompartmental knee arthroplasty, TKA, and arthroscopic surgery can all improve functional scores in patients with KOA; however, follow-up studies indicate that TKA is better than the other interventions in relieving knee pain and improving knee function in the long term (33). HRQoL is not only an indicator of physical fitness but also a reflection of psychological and socioeconomic status. Therefore, mental well-being may be almost as important as physical discomfort and activity restriction in determining self-reported outcomes and HRQoL after TKA (34, 35). High preoperative expectations are associated with clinical improvement, including pain reduction (36). Maintaining a stable emotional state and a positive attitude toward short-term discomfort are important in patients undergoing TKA. Additionally, patients should follow medical advice strictly and cooperate with examinations, treatment, and rehabilitation exercises. Doctors and rehabilitation therapists should strengthen preoperative communication and psychological counselling for these patients. Appropriate guidance and care are essential to gain the full trust of patients with KOA and boost their confidence, which is essential to the success of treatment (24).

In this study, the results of 2-class GMM indicate that the higher the baseline knee function score, the more rapid the improvement in knee function and HRQoL after surgery. This finding suggests that patients with better knee function at baseline would derive the most benefit from surgery, which is consistent with the findings of Fortin et al. (37). Age-related neuromotor changes lead to skeletal muscle weakness and reduced power. Muscle strength and power have been reported to decrease by at least 24% in TKA recipients compared with those in controls (38). However, more demanding rehabilitation protocols may help to overcome these deficits. Postoperative rehabilitation following TKA would make a substantial contribution to patient outcomes, including a shorter hospital stay and fewer complications. Early rehabilitation, telerehabilitation, outpatient therapy, and high intensity and high velocity exercise may be beneficial to reduce pain intensity and joint stiffness (38). Therefore, joint rehabilitation training and functional exercises should be initiated under medical supervision as soon as possible in these patients. An improved focus on patient rehabilitation after discharge, including home-based exercise and dietary guidance, may also be needed to maximise the benefits of surgery.

In this study, patients with a monthly family income of < 2000 yuan had less improvement in postoperative knee function and HRQoL than their more affluent counterparts, and this difference was observed over a long period of time. Most patients were over the age of 50 years and those with a monthly family income of < 2000 yuan were mostly agricultural or migrant workers. These individuals generally have less health knowledge, are of lower socioeconomic status, and have relatively poor self-management skills (39). For financial reasons, they are less likely to protect their knees when performing daily activities and are more likely to opt for less expensive drugs, medical consumables, and therapies. Furthermore, they often return to work prematurely without adequate rest and rehabilitation after surgery.

Patients in this study who exercised for approximately 30 min daily had a better outcome than those who did not exercise. An appropriate amount of regular exercise both protects and improves knee function in patients with KOA and accelerates postoperative recovery. However, care must be taken to avoid excessive exercise, which can damage the reconstructed knee.

Pain was also identified to affect the outcome of TKA, which is consistent with previous reports (40, 41). Pain severely affects both mobility and mental well-being in patients with KOA. Therefore, adequate perioperative pain management is important in these patients. A study found that some patients with KOA and mild pain do not ask for pain relief soon enough and miss the opportunity for intervention in the early stage of inflammation (41), which led to worsening of the disease. Pain should be controlled effectively in the early stages of KOA, with consideration of interventions such as physical therapy to avoid progression of acute pain to uncontrollable chronic pain. As soon as KOA is diagnosed, doctors and family members should cooperate to standardise pain management and encourage the patient to undertake exercise as appropriate to help preserve their joint function.

This study had some potential limitations. First, data for 67 patients could not be collected at all five time points; these missing results may have resulted in reporting bias. Second, the size of the stable group in the 2-class GMM was small, meaning that the effects of certain patient factors, such as age, sex, and BMI, might not be well reflected. Third, the effects of TKA were not analysed according to the implantation method used. Therefore, future studies should investigate the impact of the implantation method and rehabilitation protocol used on postoperative HRQoL in patients who undergo TKA.

Conclusions

This study found that TKA can achieve significant improvement in HRQoL and knee function in patients with KOA. TKA should be recommended for patients with end-stage KOA and for those who do not respond to pharmacological therapy. The study also revealed potential heterogeneity in the trajectory of HRQoL after TKA in patients with KOA. Experts should keep this heterogeneity in mind when developing targeted health guidelines for promotion of knee health in the general population and improvement of HRQoL in patients with KOA. The association between physical activity, postoperative rehabilitation, and HRQoL should be investigated in these patients to optimise treatment protocols and develop preventive strategies.

Abbreviations

EQ-5D-5L, European Quality of Life Five Dimension Five Level; GMM, growth mixture model; HRQoL, health-related quality of life; KOA, knee osteoarthritis; KOOS-PS, The Knee Injury and Osteoarthritis Outcome Score; TKA, total knee arthroplasty; VAS, visual analogue scale

Declarations

Ethics approval and consent to participate

This study was conducted in line with the Declaration of Helsinki and was approved by the Ethics Committee of the Third Affiliated Hospital of Southern Medical University (approval number 2018-IORG-10-1). Informed consent was obtained from all study participants.

Consent for publication

Each patient included in this study received written information and no patient objected to this study.

Availability of data and materials

Data are available to request.

Competing interests

The authors declare that they have no competing interests.

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Role of funding source

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' contributions

All authors contributed to the conception and design of the study, or acquisition of data, or analysis and interpretation of data; drafting the article or revising it critically for important intellectual content and approved the final manuscript for publication. JC (erin2009@smu.edu.cn) takes responsibility for the integrity of the work as a whole, from inception to finished article.

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Figures

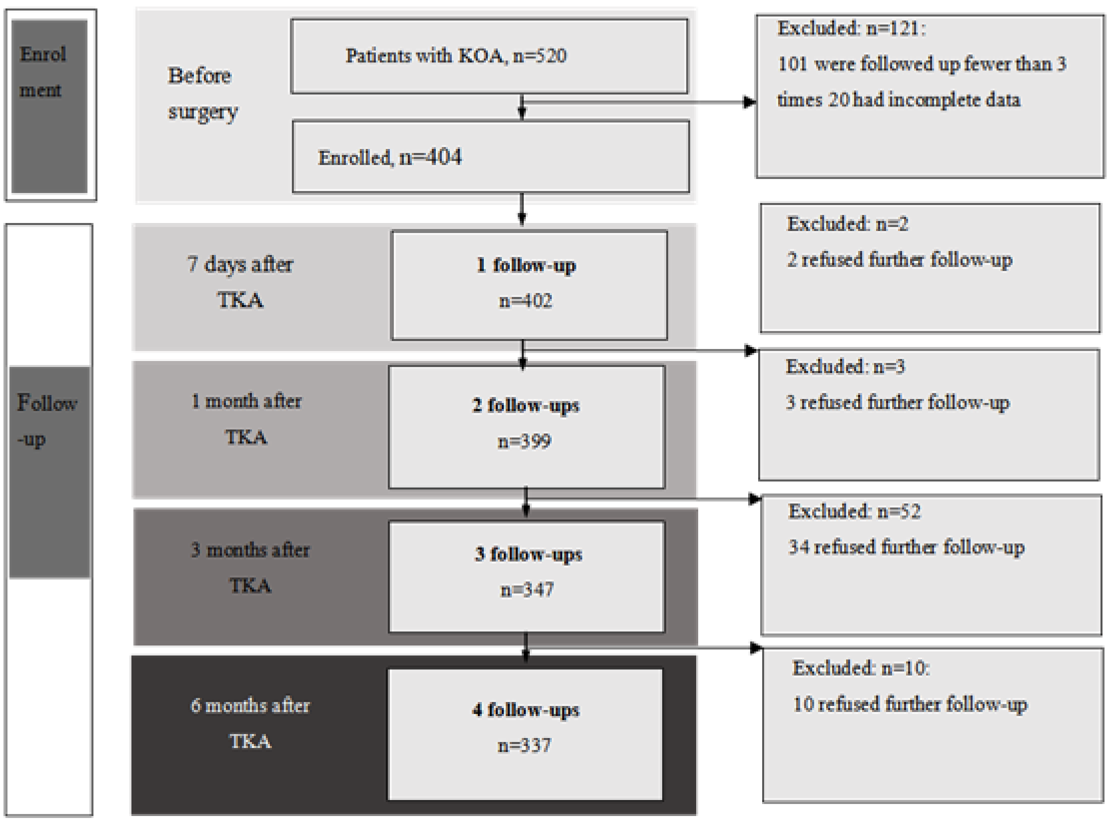

Figure 1

Flow chart showing the study screening and enrolment process. KOA, knee osteoarthritis; TKA, total knee arthroplasty

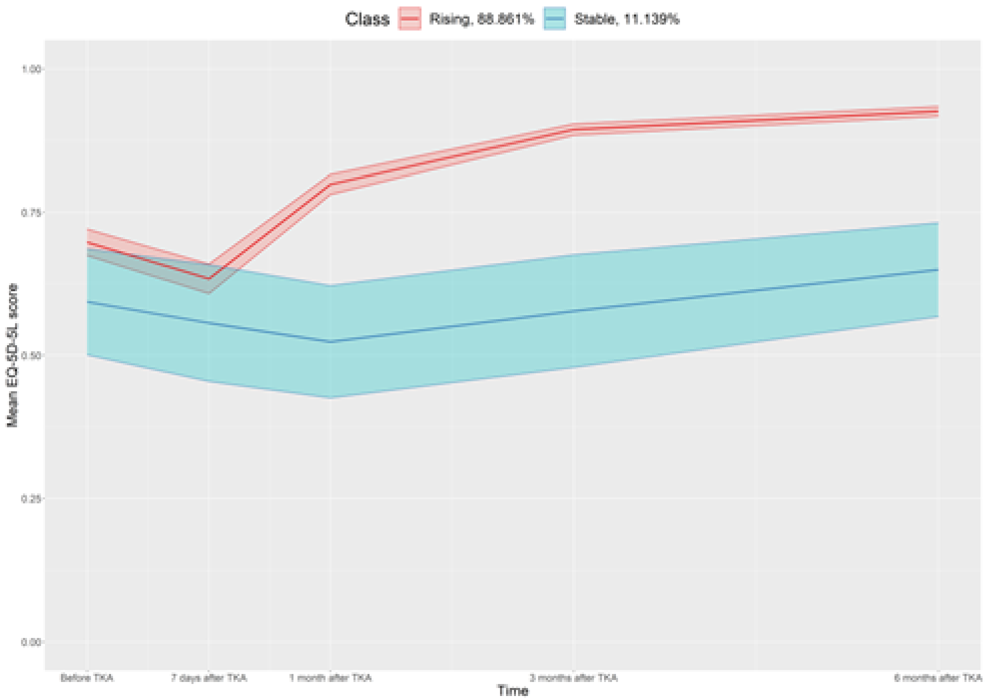

Figure 2

Average health-related quality of life trajectory based on the EQ-5D-5L score in a 2-class growth mixture model. EQ-5D-5L, European Quality of Life Five Dimension Five Level; TKA, total knee arthroplasty

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