scientific reports

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Expectation fulfillment is associated with good outcomes and patient satisfaction after knee arthroplasty: a prospective study in a multi-ethnic Asian population

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We aimed to evaluate the relationship between patient expectations and outcomes after knee arthroplasty (KA) in an Asian population in Singapore. We recruited consecutive patients with severe knee osteoarthritis (KOA) scheduled for KA. Pre-operatively, patients provided socio-demographic data and completed the Hospital for Special Surgery Knee Replacement Expectations Survey (HSS-KRES) for baseline pre-operative expectations and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for baseline pain and function. Telephone interviews were conducted at 6- and 12-months post-operatively to collect the WOMAC, satisfaction with KA, and the extent to which pre-operative expectations had been fulfilled. We included 1136 patients (mean age 65.9 years, 69.9% female), of which 1103 and 1089 completed the telephone interviews at 6- and 12-months post-KA respectively. In the multivariable models, expectation fulfilment was consistently associated with improvements in WOMAC pain and function at 6- and 12-months post-operatively, but not the baseline expectations. In the sensitivity analyses, expectation fulfilment was also found to be significantly associated with the achievement of minimal clinically important difference (MCID) for WOMAC pain and function at both 6- and 12-months. Expectation fulfilment was associated with patient satisfaction in the adjustment models at both 6- and 12-months after KA. The fulfilment of expectations, rather than pre-operative expectations, is associated with improvements in WOMAC pain, function and overall satisfaction at 6- and 12-months after KA.

Keywords Knee arthroplasty, Patient expectations, Fulfilment of expectations, Patient-reported outcomes, Satisfaction

Knee osteoarthritis (KOA) accounts for the majority of the total OA disease burden[1] and is highly prevalent, affecting up to 30% of the older population[2]. Amidst trends of population aging and rising obesity rates, it is an important healthcare issue, having consistently ranked among the top causes of years lived with disability globally and in Asia[1]. The impact of KOA on the individual is extensive, ranging from chronic pain, functional impairment and social isolation, to an increase in all-cause mortality owing to its interplay with underlying comorbidities. To date, there is no approved efficacious or safe treatment option for KOA that can reverse the disease process. Knee arthroplasty (KA) is an effective surgical intervention for KOA if conservative treatment has failed[3]. However, around 20–30% of patients experience suboptimal outcomes after KA, including chronic pain, functional limitations and dissatisfaction[4].

In recent years, there has been growing interest in understanding the impact of patient expectations on outcomes after KA. As patient-centric care and shared decision making become linchpins in today's practice

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of medicine, the importance of understanding patient expectations becomes increasingly recognized[5]. Patient expectations towards treatment is a complex construct that encompasses beliefs or cognitions regarding health outcomes following a therapeutic intervention[6]. They are shaped by a plethora of factors including an individual's personal experiences and that of those within their social circle. Across various clinical disciplines and contexts[7,8], there is emerging evidence that positive expectations play a central role in influencing treatment outcomes. Expectancy theory has also posited that the difference between the actual and expected outcome, for which the fulfillment of expectations is a function of, is a dominant determinant of patient satisfaction[9], an important patient-centered metric of quality of care. Multi-faceted as they may be, patient expectations are dynamic and malleable, and the patient encounter represents an important timepoint in the patient journey where clinicians may be instrumental in influencing these expectations[6]. Being cognizant of the interplay between patient expectations and post-operative outcomes will enable clinicians to better manage, align and close the expectation gap between patient and clinicians, empower the shared decision-making process, and improve post-operative outcomes.

In the setting of KA, several studies conducted in Western populations have found that the fulfilment of pre-operative expectations correlates with post-operative satisfaction and improvements in patient-reported outcomes, while some have demonstrated a positive association between baseline expectations and post-KA outcomes[10–15]. However, there is a paucity of such studies evaluating the relationship between patients' expectations and post-operative outcomes in the Asian context. Patient expectations regarding KA have been known to vary across different socio-cultural and geographical contexts[16]. Moreover, phenotypic heterogeneity exists across ethnic groups that accounts for differences in the severity of KOA disease manifestation and post-operative outcomes[17]. Among patients with osteoarthritis, ethnicity have been shown to influence the degree of pain independent of socioeconomic status[18], and specific domains of health were different across ethnic groups within the same country[19]. Compared with their Western counterparts, the functional demands of Asian patients are generally greater as high flexion activities such as squatting, kneeling and cross-legged sitting are cardinal components of daily living for some ethnic groups[20]. In addition, it is also well established that Asian patients have distinctly different anatomical and anthropometric characteristics that may influence post-operative outcomes[20]. In this study, we aimed to explore the relationship between patient expectations and post-KA outcomes in the domains of pain, function and patient satisfaction within a multi-ethnic Asian population in Singapore. We postulate that higher baseline expectations is associated with poorer outcomes whilst expectation fulfilment is associated with better post-KA outcomes.

Methods

Study population

Between May 2017 and May 2019, we recruited consecutive patients with severe KOA scheduled for KA (total knee arthroplasty [TKA] or uni-compartmental knee arthroplasty [UKA]) in Singapore General Hospital during their pre-operative assessment visit, 1–2 weeks before KA. We excluded patients who had cognitive impairment, and those who were listed for revision KA or KA indicated for a diagnosis other than KOA. Participants completed a paper copy of a pre-operative questionnaire during their pre-operative assessment visit. Follow-up questionnaires at 6- and 12-months after surgery were completed over the telephone with a trained interviewer. The study protocol was read and approved by the SingHealth Centralized Institutional Review Board (CIRB Ref: 2016/3168) and conforms to the provisions of the Declaration of Helsinki. Informed written consent was obtained from all participants.

Data collection

We collected socio-demographic information including age, sex, ethnicity and highest education level. Body height and weight were measured at recruitment. Surgical information collected include the type of KA (TKA or UKA) and laterality (unilateral versus bilateral).

All patient-reported outcomes at recruitment were self-completed on paper by patients in either English or Chinese language as per their preference. We assessed patients' baseline KOA symptoms and functional impairment using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), with reference to the index knee which was designated as the side planned for KA or the dominant side in cases of bilateral KA. The WOMAC is a disease specific, tri-dimensional PRO that comprises a battery of 24 questions designed to assess the 3 core dimensions of pain (5 questions), function (17 questions) and stiffness (2 questions)[21]. Each question is answered on a 5-point Likert scale from 0 to 4 (0: none; 4: extreme) and aggregated to a WOMAC pain score (0–20), function score (0–68), stiffness score (0–8) and total WOMAC score (0–96), with a higher score indicating more severe symptoms. The WOMAC was developed to detect clinically important changes in overall health status following therapeutic interventions, and has been validated for Asian patients with KOA in Singapore[22]. To accurately reflect a meaningful change of scores with arithmetic property, we converted the ordinal WOMAC scores to interval scales using a transformation table developed through Rasch model analysis (Supplementary table 1)[23]. The score range of 0–20 for pain, 0–68 for function, 0–8 for stiffness and 0–96 for overall WOMAC remains unchanged in interval scale, with a higher score reflecting greater impairment.

We assessed the number of co-morbidities with the Functional Comorbidity Index (FCI)[24]. The FCI includes questions on the presence or absence of 17 comorbid conditions in addition to arthritis and is summated to a total score (0–18). We evaluated anxiety and depression using the Hospital Anxiety and Depression Scale (HADS)[25], and social support through the Lubben Social Network Scale (LSNS)[26].

Routine weight-bearing anterior–posterior radiographs of the index knee were taken as part of standard care. The radiographic severity of KOA in the medial and lateral tibio-femoral compartments of the index knee was assessed using the Kellgren and Lawrence (KL) classification system[27] by a designated radiologist (SBW) who was blinded to the patients' clinical profile. A random sample of 70 radiographs were read twice 2–4 weeks

apart and the intra-class correlation coefficient (ICC) of the KL grading was 0.75 (95% confidence interval, CI: 0.60–0.84).

Pre-operative expectations

We assessed patients' pre-operative expectations using the Hospital for Special Surgery Knee Replacement Expectations Survey (HSS-KRES)[28]. The HSS-KRES is a validated 19-item patient-derived instrument that evaluates patients' expectations in relation to pain relief, baseline activities, high flexion activities, social activities and psychological well-being. Patients indicated the degree of improvement they expected for each of the domains on a 5-point Likert scale from 0 to 4 (0: I do not have this expectation, or this expectation does not apply to me; 1: a little improvement; 2: a moderate amount of improvement; 3: a lot of improvement; 4: back to normal or complete improvement). Their responses to the 19 items were subsequently summed up and transformed to a 0–100-point scale[28,29], with a higher score reflecting higher overall expectations.

Fulfilment of expectations

We collected post-operative data at 6-months when clinically important improvements and maximal achievable benefits following KA are expected to be achieved[30], and longer term outcomes at 12-months. Patients were contacted and asked to complete questionnaires with a trained interviewer who was blinded to the initial interview over the telephone at 6- and 12-months post-KA. They were asked to rate the extent to which each expectation previously cited on the HSS-KRES was fulfilled, on a scale of 1 to 3 (1 = complete satisfaction, 2 = partial satisfaction, 3 = dissatisfaction)[31]. A previously cited expectation was defined as a domain on the HSS-KRES for which patients expected at least a little improvement. Domains that patients reported as "0: I do not have this expectation, or this expectation does not apply to me" at baseline were not collected at 6- or 12-months. An expectation was defined as completely fulfilled if the participant gave it a "complete satisfaction" rating post-operatively, in relation to the expectation expressed by the participant pre-operatively. We tabulated the fulfilment of expectations by taking the number of expectations fulfilled completely (at 6 months or 12 months) divided by the total number of expectations cited pre-operatively, and converting to a 0–100 point scale[31]. A higher score represents greater fulfilment of expectations.

Pain, function, and satisfaction after KA

At 6- and 12-months post-operatively, the WOMAC and Self-Administered Patient Satisfaction Scale (SAPS) were collected over the telephone.

We derived the change in WOMAC pain and WOMAC function by subtracting the pre-operative scores from the follow-up scores. All WOMAC scores were converted to interval scales prior to calculation of changes[23]. The lower or more negative the value of the change in WOMAC pain or function, the greater the improvement in pain or function respectively.

The SAPS is a 4-item questionnaire that measures patients' overall satisfaction with the outcome of KA[32]. Patients rated their satisfaction with KA for overall outcome, pain relief, ability to perform housework and ability to take part in recreational activities on a 4-point Likert scale (100: very satisfied, 75: somewhat satisfied, 50: somewhat dissatisfied, 25: very dissatisfied). Total scores were calculated by taking the unweighted average of the scores from the individual questions, with a higher score reflecting higher satisfaction.

Statistical analysis

Continuous variables were presented as means and standard deviations unless otherwise stated, while categorical variables were presented as frequencies and percentages. Univariable and multivariable analyses were conducted using the generalized linear model. Univariable analyses were first performed to examine the relationship between the study variables (pre-operative expectations and post-KA fulfilment of expectations) and each of the outcome measures (change in WOMAC pain, change in WOMAC function and overall satisfaction) at 6- and 12-months. We also evaluated variables that have been found to be plausible predictors of post-KA outcomes including age, sex, ethnicity, type of KA, pre-operative pain and function, body mass index (BMI), comorbidities, KL grade, anxiety, depression and social support[17,33–37]. Study variables with $p < 0.1$ association with the KA outcomes in the univariable analysis were entered into the corresponding multivariable model.

To evaluate for clinical relevance, we conducted sensitivity analyses to assess if the variables in test were statistically significantly associated with the achievement of minimal clinically important difference (MCID) for WOMAC pain or function respectively at 6- and 12-months. The MCID represents the smallest magnitude of improvement in WOMAC pain or function that is clinically important and meaningful from the patient's perspective[38]. As there is no consensus cut-off for MCID for WOMAC in knee arthroplasty[38], we adopted an MCID of 20.5 and 24.2 for change in WOMAC pain and function respectively which were derived from a large multi-center cohort study using a patient-derived anchor and Receiver Operating Characteristics curve approach[39].

A subgroup analysis limited to patients who underwent UKA was conducted to evaluate for consistency in the results. Furthermore, to evaluate the effect of ethnicity, we conducted a subgroup analysis limiting to the non-Chinese patients who together represent all the minority ethnic groups, as the number of patients in each of the minority ethnic groups was small.

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA) and a significance level of 0.05 was set as the threshold for statistical significance.

Participant characteristics

We approached 1698 patients, of which 1539 were eligible for the study. 1201 patients consented to the study, reflecting a response rate of 78%. The mean (standard deviation, SD) age of the 338 patients who declined

participation was 67.0 (6.9) years and 261 (77.2%) were female, which were not dissimilar from that of the included participants. Of the 1201 patients who were recruited for the study, 1136 underwent KA. Amongst those who had undergone KA, 1103 and 1089 patients completed the follow-up at 6- and 12-months post-KA respectively (Fig. 1). The baseline characteristics of the study cohort are presented in Table 1. Of the study population, 794 (69.9%) were female and 954 (84.0%) were Chinese. The mean (SD) age was 65.9 (7.0) years, and the mean BMI was 28.3 (4.7) kg/m^2. More than half (58.2%) of the patients had severe KOA on radiography (KL grade 4). The majority (92%) of patients underwent TKA while 8% underwent UKA. Additionally, 94.6% of the patients underwent unilateral KA, while the rest underwent bilateral KA. The baseline demographics of our study cohort were similar to other KA cohorts from Asia[40].

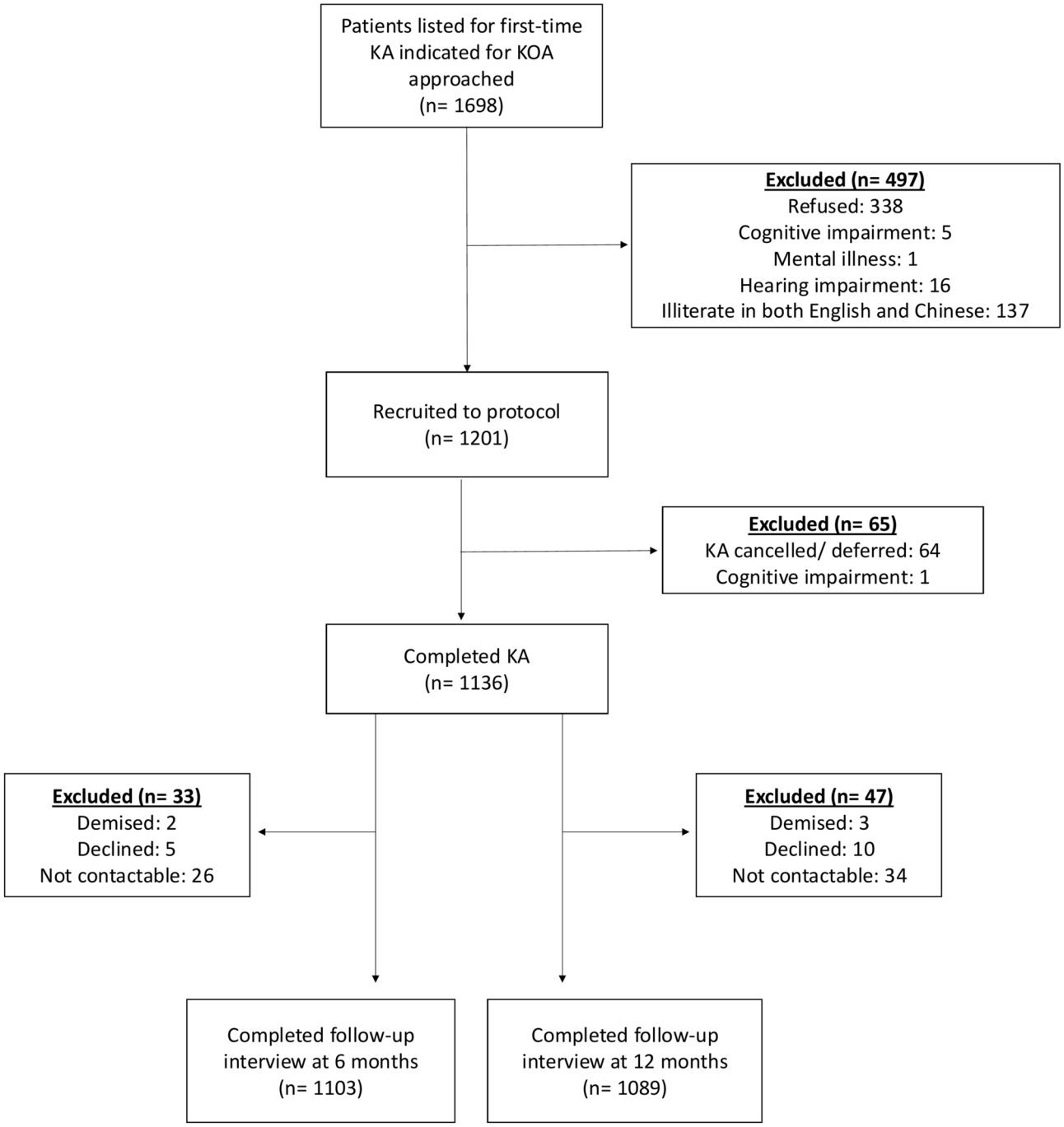

Fig. 1. Flow diagram detailing recruitment process and follow-up.

Baseline characteristics	
Age, years	65.9 (7.0)
Female, n (%)	794 (69.9)
Ethnicity	
Chinese, n (%)	954 (84.0)
Malay, n (%)	84 (7.4)
Indian, n (%)	82 (7.2)
Others, n (%)	16 (1.4)
Type of arthroplasty	
UKA, n (%)	91 (8.0)
TKA, n (%)	1045 (92.0)
Unilateral, n (%)	1075 (94.6)
Bilateral, n (%)	60 (5.3)
Highest education level	
Primary or below, n (%)	464 (40.8)
Secondary or above, n (%)	672 (59.2)
BMI, kg/m^2	28.3 (4.7)
FCI (0–18)	2.2 (1.1)
Radiographic severity of index knee	
KL grade 0–3, n (%)	469 (41.3)
KL grade 4, n (%)	661 (58.2)
HADS-A (0–21)	3.9 (4.1)
HADS-D (0–21)	2.9 (3.1)
LSNS (0–60)	32.5 (9.9)
Baseline WOMAC pain* (0–20)	6.8 (3.3)
Baseline WOMAC function* (0–68)	19.4 (10.6)

Table 1. Baseline characteristics of patients who underwent knee arthroplasty (n = 1136). *Original ordinal scale is shown. All figures are given in mean (SD) unless otherwise specified. Abbreviations: BMI, body mass index; FCI, Functional Comorbidity Index; HADS-A, Hospital Anxiety and Depression Scale-Anxiety; HADS-D, Hospital Anxiety and Depression Scale-Depression; KL, Kellgren and Lawrence; LSNS, Lubben Social Network Scale; TKA, total knee arthroplasty; UKA, uni-compartmental knee arthroplasty; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

Results

Description of measures

The baseline patient expectations, degree of expectation fulfilment post-KA and outcomes at 6- and 12-months post-KA are described in Table 2**.** The mean HSS-KRES score was 73.4, whilst the mean post-KA expectation fulfilment at 6- and 12-months were 64.1 and 71.6 respectively. The largest change in WOMAC pain and WOMAC function can be observed during the first 6 months, with the mean change in WOMAC pain and WOMAC function (in ordinal scale) being -5.4 and -14.1 respectively. The overall satisfaction (SAPS) score at 6- and 12-months post-KA were 89.7 and 92.5 respectively.

Associations with change in WOMAC pain and function

In the uni-variable analyses, HSS-KRES was statistically significantly associated with change in WOMAC pain or function at 6 months. However, statistical significance was lost in the multi-variable analyses. Of note, the association between HSS-KRES and change in WOMAC function at 6 months was trending towards significance in the multi-variable model [ß: −0.03, 95% CI −0.07 to 0.00, $p = 0.069$]. In contrast, post-KA expectation fulfilment was statistically significantly associated with the change in WOMAC pain [ß: −0.06, 95% CI −0.07 to −0.06, $p < 0.001$] and function [ß: −0.32, 95% CI −0.34 to −0.31, $p < 0.001$] at 6 months (Tables 3 and 4). This suggests that higher post-KA expectation fulfilment was associated with greater improvements in both WOMAC pain and function. Similar results were found in the analyses of the change in WOMAC pain and function at 12 months post-operative (Supplementary tables 2 and 3). We tested and refuted significant multicollinearity between HSS-KRES and post-KA expectation fulfilment at 6 months (r = 0.063, Variance Inflation Factor 1.004).

In the sensitivity analyses, post-KA expectation fulfilment was also found to be statistically significantly associated with the achievement of MCID for WOMAC pain [OR: 1.05, 95% CI 1.04 to 1.06, $p < 0.001$ (6 months)] and function [OR: 1.08, 95% CI 1.07 to 1.09, $p < 0.001$ (6 months)] at both 6- and 12-months post-KA (Supplementary tables 5 to 8), supporting that post-KA expectation fulfilment is associated with a clinically relevant change in WOMAC pain and function after arthroplasty.

Consistent results were found in the subgroup analyses for a smaller sample of 83 patients who underwent UKA (Supplementary tables 9 and 10) and 169 non-Chinese patients (Supplementary tables 11 and 12).

	Baseline (n = 1136)	6-months post KA (n = 1103)	12-months post KA (n = 1089)
HSS-KRES (0–100)	73.4 (12.9)	–	–
Fulfilment of expectations (0–100)	–	64.1 (26.3)	71.6 (26.7)
WOMAC pain* (0–20)	6.8 (3.3)	1.4 (2.2)	0.9 (2.1)
Change in WOMAC pain from baseline*	–	− 5.4 (3.4)	− 5.9 (3.5)
WOMAC function* (0–68)	19.4 (10.6)	5.1 (6.5)	3.6 (6.6)
Change in WOMAC function from baseline*	–	− 14.1 (10.5)	− 15.5 (11.0)
Satisfaction with surgery:			
Overall (25–100)	–	87.5 (16.1)	90.7 (15.4)
Pain relief (25–100)	–	90.3 (15.5)	92.7 (14.4)
Ability to perform housework (25–100)	–	90.7 (14.3)	93.6 (13.1)
Ability to perform recreational activities (25–100)	–	90.4 (15.0)	92.9 (14.2)
SAPS (25–100)	–	89.7 (13.7)	92.5 (12.9)

Table 2. Baseline patient expectations, expectation fulfilment and outcomes at 6 months and 12 months post knee arthroplasty. *Original ordinal scale is shown. All figures are given in mean (SD) unless otherwise specified. Abbreviations: HSS-KRES, Hospital for Special Surgery Knee Replacement Expectations Survey; SAPS, Self-Administered Patient Satisfaction Scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

	Univariable			Multivariable	
	ß (95% CI)	R^2	*p*	ß (95% CI)	*p*
Age, years	0.04 (0.02, 0.07)	0.005	0.003	0.01 (− 0.01, 0.03)	0.311
Sex (Female vs Male)	**− 0.84 (− 1.27, − 0.41)**	**0.010**	**< 0.001**	**− 0.51 (− 0.82, − 0.19)**	**0.002**
Ethnicity (Non-Chinese vs Chinese)	− 0.30 (− 0.84, 0.24)	0.001	0.280	–	–
Type of arthroplasty (UKA vs TKA)	− 0.19 (− 0.93, 0.54)	< 0.001	0.610	–	–
Education level (Secondary or above vs Primary or below)	0.18 (− 0.22, 0.58)	0.001	0.388	–	–
BMI, kg/m^2	− 0.07 (− 0.11, − 0.02)	0.009	0.002	0.03 (0.00, 0.07)	0.064
FCI (0–18)	− 0.26 (− 0.44, − 0.08)	0.008	0.005	− 0.14 (− 0.28, 0.00)	0.055
Radiographic severity of index knee (KL grade 4 vs KL grade 0–3)	**− 0.73 (− 1.13, − 0.34)**	**0.013**	**< 0.001**	**− 0.45 (− 0.74, − 0.16)**	**0.002**
HADS-A (0–21)	− 0.12 (− 0.17, − 0.07)	0.019	< 0.001	0.02 (− 0.03, 0.07)	0.400
HADS-D (0–21)	**− 0.17 (− 0.23, − 0.11)**	**0.022**	**< 0.001**	**− 0.07 (− 0.14, 0.00)**	**0.038**
LSNS (0–60)	− 0.03 (− 0.05,− 0.01)	0.005	0.012	− 0.01 (− 0.02, 0.01)	0.333
Baseline WOMAC total (0–96)	**− 0.26 (− 0.29, − 0.24)**	**0.265**	**< 0.001**	**− 0.30 (− 0.33, − 0.28)**	**< 0.001**
HSS-KRES (0–100)	− 0.05 (− 0.06, − 0.03)	0.026	< 0.001	− 0.01 (− 0.02, 0.01)	0.376
Post KA fulfilment of expectations at 6 months (0–100)	**− 0.04 (− 0.05, − 0.04)**	**0.113**	**< 0.001**	**− 0.06 (− 0.07, − 0.06)**	**< 0.001**

Table 3. Factors associated with change in WOMAC pain at 6 months (n = 1060). Bold: variables associated with change in WOMAC pain at 6 months in multivariable analysis. Abbreviations: BMI, body mass index; FCI, Functional Comorbidity Index; HADS-A, Hospital Anxiety and Depression Scale-Anxiety; HADS-D, Hospital Anxiety and Depression Scale-Depression; HSS-KRES, Hospital for Special Surgery Knee Replacement Expectations Survey; KL, Kellgren and Lawrence; LSNS, Lubben Social Network Scale; TKA, total knee arthroplasty; UKA, uni-compartmental knee arthroplasty; vs, versus; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

Associations with satisfaction

There was no association between pre-operative HSS-KRES and SAPS at 6 months post-operative in the univariable analysis (Table 5). In contrast, post-KA expectation fulfilment was positively associated with SAPS at 6 months in the multi-variable model [ß: 0.38, 95% CI: 0.35 to 0.40, $p < 0.001$], suggesting that greater post-KA expectation fulfilment was associated with higher overall satisfaction at 6 months post-KA. Similar results were found in the analysis of overall satisfaction at 12 months post-operative (Supplementary table 4).

Discussion

In this study, we found that baseline patient expectations were not associated with improvements in WOMAC pain, function and overall satisfaction at both 6- and 12-months post-KA after adjustments in the multi-variable analyses. However, higher post-KA expectation fulfilment was associated with greater improvements in WOMAC pain, function and overall satisfaction at both 6- and 12-months post-KA.

	Univariable			Multivariable	
	ß (95% CI)	R^2	*p*	ß (95% CI)	*p*
Age, years	0.07 (−0.04, 0.18)	0.001	0.184	–	–
Sex (Female vs Male)	−1.25 (−2.91, 0.40)	0.001	0.138	–	–
Ethnicity (Non-Chinese vs Chinese)	−1.58 (−3.65, 0.49)	0.002	0.135	–	–
Type of arthroplasty (UKA vs TKA)	−1.20 (−4.03, 1.62)	<0.001	0.404	–	–
Education level (Secondary or above vs Primary or below)	−0.38 (−1.92, 1.17)	<0.001	0.632	–	–
BMI, kg/m^2	−0.29 (−0.46, −0.13)	0.012	<0.001	−0.04 (−0.13, 0.06)	0.441
FCI (0–18)	−0.40 (−1.09, 0.30)	0.001	0.267	–	–
Radiographic severity of index knee (KL grade 4 vs KL grade 0–3)	**−3.06 (−4.59, −1.53)**	**0.017**	**<0.001**	**−1.20 (−2.08, −0.32)**	**0.007**
HADS-A (0–21)	−0.26 (−0.44, −0.08)	0.006	0.006	0.00 (−0.15, 0.15)	0.997
HADS-D (0–21)	−0.27 (−0.52, −0.03)	0.004	0.029	0.03 (−0.18, 0.23)	0.801
LSNS (0–60)	−0.06 (−0.14, 0.01)	0.002	0.105		
Baseline WOMAC total (0–96)	**−0.94 (−1.05, −0.84)**	**0.231**	**<0.001**	**−1.23 (−1.30, −1.15)**	**<0.001**
HSS-KRES (0–100)	−0.18 (−0.24, −0.12)	0.030	<0.001	−0.03 (−0.07, 0.00)	0.069
Post KA fulfilment of expectations at 6 months (0–100)	**−0.26 (−0.28, −0.23)**	**0.286**	**<0.001**	**−0.32 (−0.34, −0.31)**	**<0.001**

Table 4. Factors associated with change in WOMAC function at 6 months (n = 1060). Bold: variables associated with change in WOMAC function at 6 months in multivariable analysis. Abbreviations: BMI, body mass index; FCI, Functional Comorbidity Index; HADS-A, Hospital Anxiety and Depression Scale-Anxiety; HADS-D, Hospital Anxiety and Depression Scale-Depression; HSS-KRES, Hospital for Special Surgery Knee Replacement Expectations Survey; KL, Kellgren and Lawrence; LSNS, Lubben Social Network Scale; TKA, total knee arthroplasty; UKA, uni-compartmental knee arthroplasty; vs, versus; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

	Univariable			Multivariable	
	ß (95% CI)	R^2	*p*	ß (95% CI)	*p*
Age, years	0.20 (0.08, 0.32)	0.012	0.001	0.05 (−0.04, 0.13)	0.300
Sex (Female vs Male)	−1.46 (−3.27, 0.34)	0.003	0.112	–	–
Ethnicity (Non-Chinese vs Chinese)	−2.39 (−4.64, −0.13)	0.004	0.038	−0.14 (−1.76, 1.49)	0.870
Type of arthroplasty (UKA vs TKA)	−1.85 (−4.92, 1.23)	0.002	0.240	–	–
Education level (Secondary or above vs Primary or below)	−0.74 (−2.42, 0.94)	<0.001	0.390	–	–
BMI, kg/m^2	−0.12 (−0.30, 0.06)	0.001	0.178	–	–
FCI (0–18)	−1.56 (−2.32, −0.81)	0.013	<0.001	−0.23 (−0.77, 0.30)	0.394
Radiographic severity of index knee (KL grade 4 vs KL grade 0–3)	2.76 (1.09, 4.43)	0.013	0.001	0.29 (−0.87, 1.45)	0.620
HADS-A (0–21)	−0.49 (−0.68, −0.29)	0.024	<0.001	0.05 (−0.15, 0.25)	0.624
HADS-D (0–21)	−0.84 (−1.10, −0.58)	0.039	<0.001	−0.09 (−0.36, 0.18)	0.497
LSNS (0–60)	**0.13 (0.05, 0.21)**	**0.009**	**0.002**	**0.08 (0.02, 0.14)**	**0.008**
Baseline WOMAC total (0–96)	−0.37 (−0.50, −0.25)	0.032	<0.001	0.00 (−0.10, 0.09)	0.938
HSS-KRES (0–100)	−0.01 (−0.08, 0.06)	<0.001	0.786	–	–
Post KA fulfilment of expectations at 6 months (0–100)	**0.38 (0.36, 0.40)**	**0.537**	**<0.001**	**0.38 (0.35, 0.40)**	**<0.001**

Table 5. Factors associated with Self-Administered Patient Satisfaction Scale (SAPS) at 6 months (n = 1060). Bold: variables associated with SAPS at 6 months in multivariable analysis. Abbreviations: BMI, body mass index; FCI, Functional Comorbidity Index; HADS-A, Hospital Anxiety and Depression Scale-Anxiety; HADS-D, Hospital Anxiety and Depression Scale-Depression; HSS-KRES, Hospital for Special Surgery Knee Replacement Expectations Survey; KL, Kellgren and Lawrence; LSNS, Lubben Social Network Scale; TKA, total knee arthroplasty; UKA, uni-compartmental knee arthroplasty; vs, versus; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

In the current study, the pre-operative expectations of our patients were comparable to that reported in previous studies using the same tool[12,14]. The most commonly cited expectations in this study population were pertaining to pain relief and return of baseline activity. Notably, we found that higher expectations were associated with greater improvements in both pain and function post-KA in the univariable analysis. This observation is congruent with several other studies[13–15]. Although the association of pre-operative expectation and post-operative WOMAC outcomes were lost in the multi-variable analyses, this should not undermine the importance of individualizing discussion for specific expectation before KA. Across a spectrum of clinical contexts[7], there is a growing body of evidence demonstrating the positive influence of patient expectations on

treatment outcomes. One of the postulated mechanisms explaining this phenomenon is the "placebo" effect that patient expectations might have on treatment outcomes. A randomized controlled trial involving patients with degenerative tear of the medial meniscus demonstrated the equivalence of all patient outcomes between placebo surgery and arthroscopic meniscectomy, suggesting the power of the placebo effect from patients' positive expectations to improve regardless of the treatment per se [8]. Another possibility for this association is that patients with greater expectations may have a higher level of motivation and self-efficacy, and may therefore be more proactive in their rehabilitation post-KA[41], which can contribute to optimizing their post-operative pain and function.

Another important finding in the current study is the association of expectation fulfilment with improvements in WOMAC pain and function, as well as overall satisfaction at both 6- and 12-months post-KA. The association between expectation fulfilment and improvements in pain and function post-KA has been shown from other studies[10]. Similarly, expectation fulfilment has stood out consistently in previous studies as a key predictor of overall satisfaction post-KA[11–13]. Patient satisfaction is a complex and multi-faceted concept[6] that has recently been acknowledged as a key measure of the quality of patient-centric care. It reflects patients' affective reaction to, and cognitive evaluation of their healthcare experience and has been widely accepted as a function of the degree of congruence or divergence between the expected and actual outcomes of care[9]. Several studies did not show any correlation between patient expectations and overall satisfaction post-KA[11,13,15]. While higher patient expectations may have a positive influence on post-operative pain and function as described earlier, the lack of an association with overall satisfaction suggests that improvements in patient-reported outcomes may not necessarily translate to expectations being met. Pre-operative expectations could change post-operatively, and may potentially explain why expectation fulfilment is associated with post-operative outcomes rather than baseline expectations[42].

The findings of our study that expectation fulfilment play a more important role than baseline expectations in determining post-operative outcomes were largely concordant with studies conducted in Western socio-cultural contexts. This could possibly be explained by the observations that in both Asian and Western socio-cultural settings, the domains of health-related quality of life (HRQoL) that are regarded as important are mostly similar[19,43]. Importantly, a qualitative study conducted in Singapore has also previously demonstrated that the main domains of pain, physical disability, other symptoms of OA and mental health were important across all three major ethnic groups (Chinese, Malay and Indian)[19], which could have accounted for the similar results seen in the subgroup analyses that included non-Chinese patients only.

The findings from our study also provide insights into how clinical practice may be adapted to drive better KA outcomes. Given the importance of expectation fulfilment, it is essential for clinicians to understand patients' expectations for KA pre-operatively and engage them in a discussion on whether these expectations may be realistically fulfilled from KA. It has been shown that discrepancies in expectations commonly exist between patients and clinicians[44]. This discrepancy is often driven by patients' expectations of higher level activities[44]. Therefore, clinicians should counsel patients about the expected outcomes post-KA[11]. Priorities, values and the acceptance threshold differ from patient to patient. The importance of engaging patients in such a conversation and helping them to re-align their expectations at a realistic level cannot be undermined. In a randomized controlled trial, additional education on realistic outcome expectations pre-operatively has been demonstrated to have a modifying effect on patients' pre-operative expectations, and resulted in higher post-operative expectation fulfilment and satisfaction after KA compared to standard pre-operative counselling[45]. Conversely, the lack of pre-operative education was a reason cited for unmet expectations and poorer outcomes amongst patients who underwent hip replacement[46]. While it is paramount to set realistic expectations amongst those undergoing KA, the link between positive expectations and improvements in pain and function also suggests that it is equally important to identify and build up positive expectations in those with low or even negative expectations for KA, who may be less motivated during the rehabilitation phase[41] and hence may not be able to derive the fullest benefits of KA.

The strength of our study is the prospective study design, large sample size and high follow up rates up to the 12-month time point. To the best of our knowledge, this is the first study examining the relationship between patient expectations and post-KA outcomes in the Asian context. Comprising of a unique ethnic profile of Chinese, Malays, Indians and others, our multi-ethnic cohort in Singapore captures the diversity within Asia. Singapore is a small city state in Asia where Chinese, Malays, Indians and others have lived together for generations since the 1800s[47]. It is a place where the society is relatively homogeneous in education system, job opportunities and access to health care, making it ideal to study health expectations and health outcomes with minimized confounding effects from other disparities. Another strength of this study is that patient expectations was assessed using a validated and reliable instrument, the HSS-KRES. Despite the complexities of patient expectations as a concept, the HSS-KRES is a patient-derived questionnaire specifically developed for the setting of KA, encompassing a comprehensive spectrum of expectations that are important and meaningful to patients[28]. We assessed improvements in pain and function post-KA using the change in WOMAC pain and function measured in interval scale level. The WOMAC is a validated tool that is sensitive in detecting clinically important changes in pain and function following therapeutic interventions[48]. In our study, we further applied conversion algorithms derived from Rasch model analysis to transform the ordinal WOMAC scores into interval-level scores[23]. This WOMAC calibrated in interval scale allowed us to reflect a meaningful magnitude of change in WOMAC scores with arithmetic property and reduce the measurement bias associated with ordinal scale measurement. In addition to assessing post-KA outcomes at 6 months when clinically important improvements are expected, we have shown consistency in the results at a longer follow-up time point (12-month). Sensitivity analyses using achievement of MCID for WOMAC pain and function provided support for the clinical relevance of the results. Finally, we also adjusted for an extensive set of variables that may affect post-KA outcomes, including baseline pain and functional status, social support and psychological well-being which were not included in many of the

previous studies[49]. However, we acknowledge some limitations of our study. As the response rate of the current study is 78%, we were unable to fully account for the characteristics of the 22% who were non-responders, albeit similarities between responders and non-responders in age and sex distribution. There were also patients that we excluded from participating in the study due to low literacy (n = 137), hearing impairment (n = 16) and cognitive impairment (n = 6). Notably however, we had high follow-up rates of 97% and 96% at 6- and 12-months, thereby minimizing the effect of selection bias for KA outcomes. In addition, there has been a lack of a validated method for the assessment of expectation fulfilment to date. We closely adapted the method described by Mancuso et al. in assessing expectation fulfilment for patients undergoing KA[31], which has been utilized in other studies[50]. However, challenges remain in drawing comparisons with studies that used other methods for expectation fulfilment. In the assessment of functional outcomes, we did not collect the post-operative knee range of motion nor utilize performance based scales which could provide a more objective assessment and may have allowed for a more granular analysis. Caution is required for the interpretation of the subgroup analysis limiting to patients who underwent UKA, where the sample size was small, although the results were consistent as those found in the main cohort. Moreover, we did not collect information regarding surgical factors (number of surgeons operating and surgical technique), presence of post-operative complications and participation in post-operative rehabilitation program, which could potentially influence post-KA outcomes and satisfaction.

In conclusion, expectation fulfilment was associated with clinically significant improvements in WOMAC pain, function and satisfaction at both 6- and 12-months post-KA. In addition, we found that it was the fulfilment of expectations, rather than expectations at baseline, that mattered more as a determinant of KA outcomes in an Asian population. Our study underscores the importance of realigning patients' pre-operative expectations at a level that is realistic and achievable to drive better KA outcomes.

Data availability

All data are available upon reasonable request in writing to the corresponding author at katyccc@hotmail.com or gmsleung@nus.edu.sg.

Received: 28 May 2024; Accepted: 20 February 2025
Published online: 30 April 2025

References

1. Vos, T. et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380**(9859), 2163–2196 (2012).
2. Leung, Y. Y. et al. Validation of screening questionnaires for evaluation of knee osteoarthritis prevalence in the general population of Singapore. *Int. J. Rheum. Dis.* **21**(3), 629–638 (2018).
3. Hunter, D. J. & Bierma-Zeinstra, S. Osteoarthritis. *Lancet.* **393**(10182), 1745–1759 (2019).
4. Wylde, V., Dieppe, P., Hewlett, S. & Learmonth, I. D. Total knee replacement: is it really an effective procedure for all?. *Knee* **14**(6), 417–423 (2007).
5. El-Haddad, C., Hegazi, I. & Hu, W. understanding patient expectations of health care: A qualitative study. *J. Patient. Exp.* **7**(6), 1724–1731 (2020).
6. Thompson, A. & Sunol, R. Expectations as determinants of patient satisfaction: Concepts, theory and evidence. *Int. J. Quality Health Care J. Int. Soc. Quality Health Care/ISQua* **7**, 127–141 (1995).
7. Mondloch, M. V., Cole, D. C. & Frank, J. W. Does how you do depend on how you think you'll do? A systematic review of the evidence for a relation between patients' recovery expectations and health outcomes. *Cmaj* **165**(2), 174–179 (2001).
8. Sihvonen, R. et al. Arthroscopic partial meniscectomy versus placebo surgery for a degenerative meniscus tear: a 2-year follow-up of the randomised controlled trial. *Ann. Rheum. Dis.* **77**(2), 188–195 (2018).
9. Lochman, J. E. Factors related to patients' satisfaction with their medical care. *J. Commun. Health.* **9**(2), 91–109 (1983).
10. Espinosa, A. et al. Influence of fulfilment patient expectations in outcomes after total knee arthroplasty. *Rev. Esp. Cir. Ortop. Traumatol. (Engl Ed).* **64**(6), 428–433 (2020).
11. Deakin, A. H., Smith, M. A., Wallace, D. T., Smith, E. J. & Sarungi, M. Fulfilment of preoperative expectations and postoperative patient satisfaction after total knee replacement. A prospective analysis of 200 patients. *Knee* **26**(6), 1403–1412 (2019).
12. Conner-Spady, B. L. et al. Patient expectations and satisfaction 6 and 12 months following total hip and knee replacement. *Qual. Life Res.* **29**(3), 705–719 (2020).
13. Jain, D. et al. Higher patient expectations predict higher patient-reported outcomes, but not satisfaction, in total knee arthroplasty patients: A prospective multicenter study. *J. Arthroplasty.* **32**(9S), S166–S170 (2017).
14. Hafkamp, F. J., de Vries, J., Gosens, T. & den Oudsten, B. L. High pre-operative expectations precede both unfulfilled expectations and clinical improvement after total hip and total knee replacement. *J. Arthroplasty.* **35**(7), 1806–1812 (2020).
15. Mannion, A. F., Kampfen, S., Munzinger, U. & Kramers-de, Q. I. The role of patient expectations in predicting outcome after total knee arthroplasty. *Arthr. Res. Ther.* **11**(5), R139 (2009).
16. Lingard, E. A., Sledge, C. B., Learmonth, I. D. & Kinemax, O. G. Patient expectations regarding total knee arthroplasty: Differences among the United States, United Kingdom, and Australia. *J. Bone Joint Surg. Am.* **88**(6), 1201–1207 (2006).
17. Mangelson, J. J., Noble, P. C., Osadebe, U., Harrington, M. A. & Parsley, B. S. Ethnicity affects the outcome of total knee arthroplasty. *J. Arthroplasty.* **25**(3), e41 (2010).
18. Thumboo, J., Chew, L. H. & Lewin-Koh, S. C. Socioeconomic and psychosocial factors influence pain or physical function in Asian patients with knee or hip osteoarthritis. *Ann. Rheum. Dis.* **61**(11), 1017–1020 (2002).
19. Xie, F. et al. What health domains and items are important to patients with knee osteoarthritis? A focus group study in a multiethnic urban Asian population. *Osteoarthr. Cartilage.* **14**(3), 224–230 (2006).
20. Kim, Y. H., Matsuda, S. & Kim, T. K. Clinical faceoff: Do we need special strategies for Asian patients with TKA?. *Clin. Orthop. Relat. Res.* **474**(5), 1102–1107 (2016).
21. Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J. & Stitt, L. W. Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J. Rheumatol.* **15**(12), 1833–1840 (1988).
22. Thumboo, J., Chew, L. H. & Soh, C. H. Validation of the western ontario and mcmaster university osteoarthritis index in Asians with osteoarthritis in Singapore. *Osteoarthr. Cartilage.* **9**(5), 440–446 (2001).
23. Leung, Y. Y., Thumboo, J., Yeo, S. J., Wylde, V. & Tannant, A. Validation and interval scale transformation of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) in patients undergoing knee arthroplasty, using the Rasch model. *Osteoarthr. Cartil. Open.* **4**(4), 100322 (2022).

24. Groll, D. L., To, T., Bombardier, C. & Wright, J. G. The development of a comorbidity index with physical function as the outcome. *J. Clin. Epidemiol.* **58**(6), 595–602 (2005).
25. Zigmond, A. S. & Snaith, R. P. The hospital anxiety and depression scale. *Acta Psychiatr. Scand.* **67**(6), 361–370 (1983).
26. Lubben, J. E. Assessing social networks among elderly populations. *Family Commun. Health.* **11**(3), 42–52 (1988).
27. Kellgren, J. H. & Lawrence, J. S. Radiological assessment of osteo-arthrosis. *Ann. Rheum. Dis.* **16**(4), 494–502 (1957).
28. Mancuso, C. A. et al. Patients' expectations of knee surgery. *J. Bone. Joint Surg. Am.* **83**(7), 1005–1012 (2001).
29. Mancuso, C. A. et al. Randomized trials to modify patients' preoperative expectations of hip and knee arthroplasties. *Clin. Orthop. Relat. Res.* **466**(2), 424–431 (2008).
30. Nerhus, T. K., Heir, S., Thornes, E., Madsen, J. E. & Ekeland, A. Time-dependent improvement in functional outcome following LCS rotating platform knee replacement. *Acta Orthop.* **81**(6), 727–732 (2010).
31. Mancuso, C. A., Jout, J., Salvati, E. A. & Sculco, T. P. Fulfillment of patients' expectations for total hip arthroplasty. *J. Bone Joint Surg. Am.* **91**(9), 2073–2078 (2009).
32. Mahomed, N., Gandhi, R., Daltroy, L. & Katz, J. N. The self-administered patient satisfaction scale for primary hip and knee arthroplasty. *Arthritis* **2011**, 591253 (2011).
33. Wylde, V. et al. Association of social support with patient-reported outcomes after joint replacement: a systematic review and meta-analysis. *Lancet Rheumatol.* **1**(3), e174–e186 (2019).
34. Dowsey, M. M., Nikpour, M., Dieppe, P. & Choong, P. F. M. Associations between pre-operative radiographic changes and outcomes after total knee joint replacement for osteoarthritis. *Osteoarthr. Cartilage.* **20**(10), 1095–1102 (2012).
35. Elmallah, R. D., Cherian, J. J., Robinson, K., Harwin, S. F. & Mont, M. A. The effect of comorbidities on outcomes following total knee arthroplasty. *J. Knee Surg.* **28**(5), 411–416 (2015).
36. Wilson, H. A. et al. Patient relevant outcomes of unicompartmental versus total knee replacement: Systematic review and meta-analysis. *BMJ.* **364**, l352 (2019).
37. Judge, A. et al. Predictors of outcomes of total knee replacement surgery. *Rheumatology (Oxford).* **51**(10), 1804–1813 (2012).
38. MacKay, C., Clements, N., Wong, R. & Davis, A. M. A systematic review of estimates of the minimal clinically important difference and patient acceptable symptom state of the Western Ontario and McMaster Universities Osteoarthritis Index in patients who underwent total hip and total knee replacement. *Osteoarthr. Cartilage.* **27**(10), 1408–1419 (2019).
39. Escobar, A. et al. Total knee replacement; minimal clinically important differences and responders. *Osteoarthr. Cartilage.* **21**(12), 2006–2012 (2013).
40. Leung, Y. Y. et al. Cigarette smoking and risk of total knee replacement for severe osteoarthritis among Chinese in Singapore–the Singapore Chinese health study. *Osteoarthr. Cartilage.* **22**(6), 764–770 (2014).
41. Judge, A. et al. Pre-operative expectation predicts 12-month post-operative outcome among patients undergoing primary total hip replacement in European orthopaedic centres. *Osteoarthr. Cartilage.* **19**(6), 659–667 (2011).
42. Levinger, P. et al. The discrepancy between patient expectations and actual outcome reduces at the first 6 months following total knee replacement surgery. *Knee Surg. Sports Traumatol. Arthrosc.* **27**(7), 2042–2050 (2019).
43. Xie, F., Li, S. C. & Thumboo, J. Do health-related quality-of-life domains and items in knee and hip osteoarthritis vary in importance across social-cultural contexts? A qualitative systematic literature review. *Semin Arthritis Rheum.* **34**(6), 793–804 (2005).
44. Ghomrawi, H. M. et al. How often are patient and surgeon recovery expectations for total joint arthroplasty aligned? Results of a pilot study. *Hss J.* **7**(3), 229–234 (2011).
45. Tolk, J. J. et al. The influence of expectation modification in knee arthroplasty on satisfaction of patients: A randomized controlled trial. *Bone Joint J.* **103**, 619–626 (2021).
46. Burton, K. E., Wright, V. & Richards, J. Patients' expectations in relation to outcome of total hip replacment surgery. *Ann Rheum Dis.* **38**(5), 471–474 (1979).
47. Turnbull, C. M. *A History of Singapore, 1819–1988* (Oxford University Press, Oxford, 1989).
48. Strand, V. & Kelman, A. Outcome measures in osteoarthritis: Randomized controlled trials. *Curr. Rheumatol. Rep.* **6**(1), 20–30 (2004).
49. Haanstra, T. M. et al. Systematic review: do patient expectations influence treatment outcomes in total knee and total hip arthroplasty?. *Health Qual. Life Outcomes.* **10**, 152 (2012).
50. Lutzner, C., Postler, A., Beyer, F., Kirschner, S. & Lutzner, J. Fulfillment of expectations influence patient satisfaction 5 years after total knee arthroplasty. *Knee Surg. Sports Traumatol. Arthrosc.* **27**(7), 2061–2070 (2019).

Acknowledgements

We thank all patients who participated in the study.

Author contributions

The authors declare the following contributions to the preparation of manuscript: study conception and design (YYL and WZL), acquisition of data (YYL, SJY, HNP, MHT, DT, SBW), data analysis (WZL, YYL, MN), interpretation of data (all authors—WZL, MN, SJY, SBW, VW, MHT, HNP, DT, JT, YYL), drafting of manuscript (YYL and WZL), critical revision of manuscript for important intellectual content (all authors), and final approval of the manuscript (all authors). YYL (katycccc@hotmail.com) takes responsibility for the integrity of the work as a whole.

Funding

This study was supported by the National Medical Research Council of Singapore (NMRC/HSRG/0061/2016 and NMRC/CSA-INV/0022/2017).

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-025-91492-0.

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