

## ORIGINAL ARTICLE

# Preoperative Factors Affecting Patient-reported Outcome Measures for Total Knee Arthroplasty

Yuya Mawarikado, RPT, MSc <sup>a, b</sup> Yusuke Inagaki, MD, PhD <sup>a</sup> Tadashi Fujii, MD, PhD <sup>c</sup>  
Hidetaka Imagita, RPT, PhD <sup>d</sup> Takahiko Fukumoto, RPT, MSc <sup>e</sup> Takanari Kubo, RPT, MSc <sup>f</sup>  
Mimo Shirahase, RPT, MSc <sup>g</sup> Akira Kido, MD, PhD <sup>h</sup> and Yasuhito Tanaka, MD, PhD <sup>a</sup>

**Objectives:** The aim of this study was to investigate the preoperative factors affecting health-related quality of life (HRQOL) at 3 and 12 months after total knee arthroplasty (TKA). **Methods:** In total, 156 patients who underwent unilateral TKA for knee osteoarthritis were included in the study. The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used as a measure of HRQOL before surgery and 3 and 12 months post-TKA. The Modified Gait Efficacy Scale (mGES) score, tibiofemoral angle, rest pain, walking pain, knee joint range of motion, knee joint extensor strength, and walking speed were recorded preoperatively. Pearson's correlation coefficient and the correlation ratio were used to calculate the correlation between KOOS and preoperative factors at 3 and 12 months post-TKA. Multiple regression analysis was performed using the stepwise method with the five postoperative KOOS subscales as dependent variables and the other preoperative factors as independent variables. **Results:** Preoperative mGES scores were significantly correlated with KOOS Activities of Daily Living, Sport/Rec, and QOL subscores at 3 months post-TKA and with all five KOOS subscales at 12 months post-TKA. Multiple regression analysis identified mGES as an influencing factor for all KOOS subscales except Pain at 3 months post-TKA and all KOOS subscales except Symptoms at 12 months post-TKA. **Conclusions:** Preoperative walking self-efficacy influenced HRQOL at 3 and 12 months post-TKA. Psychological factors such as self-efficacy should be considered when predicting postoperative outcomes.

**Key Words:** modified gait efficacy scale; health-related quality of life; self-efficacy

## INTRODUCTION

Total knee arthroplasty (TKA) decreases pain and improves function in most patients with severe knee osteoarthritis (OA).<sup>1,2</sup> Postoperative physiotherapy (PT) aims to improve physical function and activities of daily living (ADL), enhance health-related quality of life (HRQOL),<sup>3-7</sup> and prolong

healthy life expectancy. Therefore, it is important to evaluate HRQOL as an outcome measure for patients undergoing TKA. In recent years, patient views and satisfaction have become a major focus in post-TKA HRQOL assessments.<sup>8</sup> Self-reported questionnaires can show whether patient expectations are fulfilled after TKA.<sup>9</sup> The Knee Injury and Osteoarthritis Outcomes Score (KOOS) is a well-validated

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<sup>a</sup> Graduate School of Medicine, Musculoskeletal Reconstructive Surgery, Nara Medical University, Nara, Japan

<sup>b</sup> Department of Rehabilitation, Kashiba Asahigaoka Hospital

<sup>c</sup> Department of Orthopedic Surgery, Kashiba Asahigaoka Hospital

<sup>d</sup> Graduate School of Health Sciences, Saitama Prefectural University

<sup>e</sup> Graduate School of Health Sciences, Kio University

<sup>f</sup> Department of Rehabilitation, Osaka Kawasaki Rehabilitation University

<sup>g</sup> Department of Rehabilitation, Kishiwada Rehabilitation Hospital

<sup>h</sup> Department of Rehabilitation Medicine, Nara Medical University

Correspondence: Yuya Mawarikado, RPT, MSc, Graduate School of Medicine, Musculoskeletal Reconstructive Surgery, Nara Medical University, 840 Shijocho, Kashihara-shi, Nara 639-0265, Japan; E-mail: [K115877@naramed-u.ac.jp](mailto:K115877@naramed-u.ac.jp)

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post-TKA HRQOL assessment method.<sup>10</sup> In addition to evaluating pain, symptoms, and quality of life (QOL), KOOS can elucidate a broader range of patient-relevant functional abilities using subscales that include leisure activities as well as ADL.

TKA improves HRQOL in patients with knee OA.<sup>7,11</sup> Specifically, physical function<sup>12,13</sup> and pain<sup>12–14</sup> improve significantly at 8–12 weeks post-TKA versus pre-TKA. Significant improvement and stable results have been reported at 12 months post-TKA.<sup>15,16</sup> Assessments of physical function and pain are often performed. In addition to preoperative physical function and pain, several sociodemographic and clinical variables, such as pre-intervention QOL scores, psychological factors, obesity, and social support, may influence post-TKA outcomes.<sup>6,7,11,17</sup> Among them, psychological factors have recently attracted attention: these factors are reportedly predictors of satisfaction, pain, and physical function<sup>18</sup> and are associated with post-TKA HRQOL outcomes.<sup>19</sup>

Self-efficacy, the degree of confidence in how well one can perform an act to produce a result, is promoted by manipulating measurable self-efficacy.<sup>20</sup> The psychological factors of self-efficacy may affect postoperative HRQOL, but few relevant reports are available. The modified Gait Efficacy Scale (mGES), the evaluation index of confidence in whether walking can be performed safely, can assess self-efficacy. The mGES is a questionnaire-based self-efficacy assessment using a Likert scale that assesses older adults' perceptions of their confidence walking under difficult circumstances. The preoperative mGES score affects a patient's post-TKA physical activity level.<sup>21</sup> Conventional physical therapy in post-TKA rehabilitation is mainly evaluated using physical factors, but psychological factors must also be assessed. The preoperative mGES score is also associated with the number of days needed to gain walking independence post-TKA.<sup>22</sup> Consequently, the mGES score may be an important predictor of post-TKA HRQOL improvements.

Although mGES scores may affect HRQOL assessments at 3 and 12 months post-TKA, few studies have analyzed these relationships. The aim of the present study was to identify the preoperative factors, including the mGES score, that affect HRQOL at 3 and 12 months post-TKA. We hypothesized that the preoperative mGES score would influence the five KOOS subscales at 3 and 12 months post-TKA.

## MATERIALS AND METHODS

### Participants

This retrospective study included a 1-year follow-up peri-

od. A total of 255 patients who underwent unilateral TKA at a single hospital in Japan between November 2019 and April 2021 were screened for enrollment. The inclusion criteria were diagnosis of knee OA, ambulatory ability or use of a T-cane at the time of the preoperative evaluation, undergoing a first TKA, the possibility of 12 months of postoperative follow-up, and the ability to undergo a KOOS evaluation. The exclusion criteria were having undergone TKA for idiopathic osteonecrosis or rheumatoid arthritis, having undergone revision TKA, or the diagnosis of psychiatric disorders including dementia. A total of 89 participants failed to meet the study criteria, and 10 patients for whom data were missing were excluded. Consequently, 156 participants (121 woman, 35 men; mean age: 74.1±7.3 years; mean body mass index: 26.6±4.1 kg/m<sup>2</sup>) were included in the study.

This study was approved by our hospital's research ethics committee (2019051–003). Details of the study protocol and the aim of the study were explained to all participants, and written informed consent was obtained from all participants before study inclusion.

### Rehabilitation

During hospitalization, participants received 40–60 min of PT 6 days a week for approximately 2 weeks. The PT components included: (1) range of motion (ROM) training of the knee joint, including 10–15 min of active and passive movements; (2) quadriceps muscle training, including during the first postoperative week, patella setting with three to four sets of ten repetitions, and after the first postoperative week, straight leg raises with three to four sets of ten repetitions; (3) icing, including cooling the affected area with an ice bag for approximately 30 min after training; (4) gait practice, including practicing walking with a walker or T-cane under physical therapist supervision for approximately 10 min; (5) stair practice, including after mastering T-cane gait, climbing 10–15 steps under supervision while grasping the handrail; and (6) practicing ADL, i.e., after mastering T-cane gait, practicing getting up from the floor, doing chores, changing clothes, and squatting.

Outpatient physical therapy was performed at weekly intervals until 3 months post-TKA. The components included: (1) ROM training of the knee joint, including approximately 10–15 min of active and passive movements; (2) quadriceps muscle training consisting of knee joint extension with three to four sets of ten repetitions with weights ranging from 0–2 kg; (3) gait practice, including supervised walking around the hospital grounds for 5–10 min; (4) stair practice, including the supervised climbing of 30–45 steps while

grasping the handrail; and (5) ADL practice, consisting of asking the patients about their difficulty with ADLs and implementing practice accordingly.

## Data Acquisition

The patients' demographic and radiographic data and implant type were recorded. Demographic data included age, body mass index, and sex. Radiographic data included the Kallgren–Lawrence (KL) grades and femorotibial angles. Three implant types were employed for TKA: posterior stabilized, cruciate retaining, and cruciate substituting. KOOS, which was used to assess HRQOL, was evaluated pre-TKA and 3 and 12 months post-TKA. KOOS was used to assess HRQOL. The mGES total and physical function scores were assessed preoperatively. Physical function measurements, including rest pain, walking pain, ROM of knee flexion and extension, isometric knee extension strength (IKES), and walking speed, were performed for all participants by ten randomly assigned physical therapists.

The KOOS is a reliable and valid assessment tool<sup>23</sup> that consists of 42 factors separated into five subscales: pain (9 factors), symptoms (7 factors), ADL function (17 factors), sport and recreation function (5 factors), and quality of life (4 factors). Each of the five subscale scores was calculated as the sum of the included factors. The scores were converted to a 0–100 scale, with 0 representing extreme knee problems and 100 representing no knee problems, as is common for orthopedic scales.<sup>24,25</sup> A Likert scale was used; all factors had five possible answer options ranging from 0 (no problems) to 4 (extreme problems), and scores between 0 and 100 represent the percentage of the total possible score achieved. In addition to analysis and interpretation of the five subscales separately, an aggregate score was calculated.

## Outcome Measures

Self-efficacy was measured using the Japanese version of the mGES, which assesses older adults' perception of their level of confidence walking in challenging circumstances. The mGES is a reliable and validated questionnaire-based assessment of self-efficacy that uses a Likert scale.<sup>26</sup> The factors include walking on a level surface and grass, stepping over an obstacle, stepping up and down a curb, ascending and descending stairs (with and without a handrail), and walking for a long distance. The factors are scored individually on a 10-point Likert scale, with 1 denoting no confidence and 10 representing complete confidence for a total score range of 10–100, with 100 representing complete confidence in all tasks.

Pain levels were estimated using a visual analog scale ranging from 0 (no pain) to 100 (worst imaginable pain).<sup>27</sup> Knee joint ROM in flexion and extension was measured according to the measurement method specified by the Japanese Society of Rehabilitation Medicine. A goniometer was used to measure knee joint ROM during flexion and extension on the operative side during passive motion. The measurement was performed once by a physiotherapist.

IKES was measured using a handheld dynamometer ( $\mu$ -tas F1; ANIMA, Tokyo, Japan) with the participants in a seated position with the knee in 90° of flexion.<sup>28</sup> The participants were instructed to gradually increase the intensity of knee extension against the dynamometer for approximately 2 s, avoid explosive contractions, and maintain their maximal force output for approximately 3 s. The average of two measurements was divided by the body weight (kgf/kg).

Each participant's walking speed was measured using a digital stopwatch on a 16-m walking path designed with a 10-m measurement section bordered on either side by 3-m acceleration and deceleration zones. At the start of the measurement, the participants were verbally instructed to "walk ordinarily," and their walking time was recorded. Walking type was either unaided or using a T-cane. Walking speed (m/s) was calculated as the average based on the two walking times.

## Statistical Analyses

Data are presented as mean  $\pm$  standard deviation (SD) or 95% confidence interval (CI). The KL grading system was used, and the implant type was described for each grade. For all analyses, the significance level was set at 5%. All statistical analyses were performed using SPSS for Windows version 26.0 (SPSS, Chicago, IL, USA). The paired *t*-test was performed to compare the five preoperative KOOS subscale scores with those at 3 or 12 months post-TKA. The correlations between the five KOOS subscale scores at 3 and 12 months post-TKA and the preoperative factors were calculated using the correlation coefficient. Moreover, the Shapiro–Wilk test was conducted to determine whether the data followed a normal distribution. The five KOOS subscale scores at 3 and 12 months post-TKA and sex and implant type were used to calculate correlation ratios. To identify the factors that affect the five KOOS subscales at 3 and 12 months post-TKA, multiple regression analysis was performed using a stepwise method with the five KOOS subscale scores as the dependent variable and other preoperative factors as independent variables.

**Table 1.** Participants' descriptive characteristics (n=156)

Age, years	74.1 (7.3)
Sex, male/female	35/121
BMI, kg/m <sup>2</sup>	26.6 (4.1)
K-L grade, n	II:6, III:27, IV:123
FTA, degrees	183.9 (8.1)
Implant type, n	PS: 100 CR: 29 CS: 27
Rest pain, mm	14.0 (21.1)
Walking pain, mm	45.8 (26.5)
ROM of extension, degrees	-7.0 (7.7)
ROM of flexion, degrees	127.9 (13.7)
IKES, kgf/kg	0.2 (0.1)
Walking speed, m/s	1.2 (0.4)
mGES, points	45.7 (20.5)

Data are expressed as mean (standard deviation).

BMI, body mass index; CR, cruciate retaining; CS, cruciate substituting; FTA, femorotibial angle; IKES, isometric knee extension strength; K-L grade, Kellgren-Lawrence grade; mGES, modified Gait Efficacy Scale; PS, posterior stabilized; ROM, range of motion.

## RESULTS

The participants' descriptive pre-TKA characteristics are given in **Table 1**. KOOS scores at different time points are shown in **Table 2** as means  $\pm$  SDs. The five KOOS subscale scores at 3 and 12 months post-TKA all differed significantly from the preoperative scores.

Correlation coefficients between the five KOOS subscale scores at 3 and 12 months post-TKA and preoperative factors are shown in **Table 3**. The Shapiro-Wilk test was used to analyze whether the data distributions were normal, and all variables complied. Consequently, Pearson's correlation coefficient could be used. The mGES scores were significantly correlated with the KOOS ADL, Sport/Rec, and QOL subscores at 3 months post-TKA and with all five KOOS sub-

scale scores at 12 months post-TKA. Age was significantly correlated with the KOOS ADL subscale score at 3 and 12 months post-TKA. Rest pain was significantly correlated with the KOOS Pain subscale score at 12 months post-TKA, whereas Walking pain was significantly correlated with KOOS Pain and Symptoms subscale scores at 12 months post-TKA.

The correlation ratios for sex and implant type are also shown in **Table 3**. Sex was significantly correlated with KOOS Pain, Symptoms, and ADL subscale scores at 3 months post-TKA and with Pain and Symptoms at 12 months post-TKA. Implant type was significantly correlated with Pain and Symptoms at 3 months post-TKA and with Symptoms and QOL at 12 months post-TKA.

The results of multiple regression analysis of the factors affecting the five KOOS subscales at 3 and 12 months post-TKA are described in **Tables 4 and 5**, respectively. Factors affecting KOOS Pain at 3 months post-TKA were identified as IKES. Factors affecting the postoperative KOOS Symptoms at 3 months were identified as IKES and mGES. mGES was identified as a factor affecting KOOS ADL, Sport/Rec, and QOL at 3 months post-TKA. At 12 months post-TKA, mGES and rest pain were identified as factors affecting KOOS Pain. Sex and Walking pain were identified as factors affecting the KOOS Symptoms at 12 months post-TKA. Sex and mGES were identified as factors affecting KOOS ADL at 12 months, whereas mGES alone was identified as the factor affecting KOOS Sport/Rec and QOL at 12 months post-TKA.

## DISCUSSION

We identified associations between preoperative mGES scores and three KOOS subscales at 3 months post-TKA and all five KOOS subscales at 12 months post-TKA. Moreover, mGES was a factor influencing all subscales other than KOOS Pain at 3 months post-TKA and all subscales other

**Table 2.** KOOS scores at three different time points (n=156)

KOOS	Preoperative		3-month follow up		12-month follow up	
	Mean (SD)	Mean (SD)	Difference from preoperative P-value (95% CI)	Mean (SD)	Difference from preoperative P-value (95% CI)	
Pain, %	52.4 (19.3)	77.2 (14.8)	<0.001 (-28.5, -21.1)	85.0 (13.8)	<0.001 (-20.9, -14.8)	
Symptoms, %	62.7 (16.1)	69.8 (14.8)	<0.001 (-10.3, -3.9)	80.6 (13.8)	<0.001 (-35.9, -29.3)	
ADL, %	60.2 (17.9)	80.1 (13.2)	<0.001 (-22.7, -17.1)	83.8 (12.9)	<0.001 (-26.6, -20.8)	
Sport/Rec, %	24.7 (23.7)	38.7 (30.1)	<0.001 (-19.0, -9.0)	43.4 (30.8)	<0.001 (-23.9, -13.6)	
QOL, %	30.8 (20.4)	57.6 (21.1)	<0.001 (-30.8, -22.7)	62.3 (23.0)	<0.001 (-35.2, -27.2)	

ADL, activities of daily living; CI, confidence interval; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life.

**Table 3.** Correlation coefficients and correlation ratios between postoperative KOOS scores and preoperative factors (n=156)

Preoperative factor	KOOS score at 3 months post-TKA					KOOS score at 12 months post-TKA				
	Pain	Symptoms	ADL	Sport/Rec	QOL	Pain	Symptoms	ADL	Sport/Rec	QOL
Age	0.02	0.14	-0.21**	0.08	-0.06	0.07	0.07	-0.18*	-0.12	-0.01
Sex	0.15 #	0.17 #	0.11 #	0.01	0.06	0.13 #	0.12 #	0.08	0.06	0.01
BMI	0.01	-0.06	-0.05	-0.11	-0.03	0.07	0.11	0.09	0.09	0.04
FTA	0.07	0.05	-0.07	0.04	0.05	0.10	0.06	0.04	0.09	0.07
Implant type	0.16 #	0.18 #	0.01	0.02	0.03	0.01	0.18 #	0.01	0.01	0.12 #
Rest pain	-0.06	0.14	0.02	0.10	0.05	-0.21**	-0.08	-0.12	0.03	-0.09
Walking pain	-0.06	-0.01	-0.04	0.04	0.04	-0.31**	-0.22*	-0.10	-0.12	-0.11
ROM of extension	0.07	-0.15	-0.01	0.03	0.09	0.06	-0.06	-0.05	0.08	-0.03
ROM of flexion	0.05	0.02	0.09	0.03	0.10	0.01	-0.08	0.01	0.14	0.01
IKES	0.21**	-0.13	0.01	0.03	-0.05	0.01	0.01	0.05	0.03	0.01
Walking speed	0.15	0.07	-0.05	-0.10	-0.04	0.02	0.19	-0.11	-0.15	-0.10
mGES	0.12	0.15	0.43**	0.19*	0.30**	0.26**	0.16**	0.40**	0.26**	0.43**

\*P&lt;0.05, \*\*P&lt;0.01.

#Significant correlation noted by the correlation ratio.

**Table 4.** Multiple regression analysis of the five KOOS subscales at 3 months post-TKA

Dependent variable	Independent variable	Unstandardized coefficient	95% CI for B (lower limit, upper limit)	Standardized coefficient	P-value	VIF	R <sup>2</sup>
		B		$\beta$			
Pain	IKES	0.39	0.159, 0.523	0.281	0.001	1.000	0.10
Symptoms	IKES	-28.96	-49.896, -8.025	0.217	0.007	1.059	0.12
	mGES	0.12	0.008, 0.233	0.167	0.035	1.038	
ADL	mGES	0.27	0.181, 0.366	0.426	0.001	1.000	0.18
Sport/Rec	mGES	0.28	0.055, 0.514	0.193	0.016	1.000	0.04
QOL	mGES	0.31	0.153, 0.466	0.301	0.001	1.000	0.09

VIF, variance inflation factor.

than KOOS Symptoms at 12 months post-TKA. This is the first study to report the relationship between KOOS scores and mGES. Therefore, the study hypothesis that mGES would affect the five KOOS subscales at 3 and 12 months post-TKA was mostly supported.

Analysis of the five KOOS subscales showed significant improvements 3 and 12 months post-TKA versus the preoperative values. Total joint arthroplasty reportedly improves HRQOL after surgery.<sup>7,29)</sup> We observed that the preoperative KOOS scores in our study were similar to<sup>30,31)</sup> or better than<sup>32)</sup> those reported in previous studies. In studies with worse preoperative KOOS scores, the patients were younger (mean age, approximately 60 years) at the time of TKA. The observed differences may be explained by differences in lifestyle and physical activities associated with age and anxiety about the future. In a large prospective cohort study,<sup>32)</sup> the KOOS scores at 12 months post-TKA were similar to the re-

sults of the current study. However, in that study, the KOOS scores at 24 months post-TKA remained unchanged from those at 12 months post-TKA. KOOS scores at 24 months post-TKA reported by Lyman et al. were similar to those in our study. If an HRQOL assessment of TKA is feasible up to 12 months post-TKA, it should be performed because it helps to illustrate the financial and emotional advantages of TKA.

A single correlation analysis showed that the five-subscale KOOS scores at 12 months post-TKA were significantly correlated with the preoperative mGES scores. Additionally, the KOOS ADL, Sport/Rec, and QOL subscores at 3 months post-TKA were significantly correlated with the preoperative mGES. Van den et al.<sup>19)</sup> reported that self-efficacy was associated with HRQOL at 6 months post-TKA and after total hip arthroplasty. Preoperative psychological health is also a significant predictor of post-TKA satisfaction, pain, and function.<sup>18)</sup> Baseline mental health factors may affect

**Table 5.** Multiple regression analysis of the five KOOS subscales at 12 months post-TKA

Dependent variable	Independent variable	Unstandardized coefficient	95% CI for B (lower limit, upper limit)	Standardized coefficient	P value	VIF	R <sup>2</sup>
		B		$\beta$			
Pain	mGES	0.18	0.074, 0.277	0.261	0.001	1.005	0.18
	Rest pain	-0.13	-0.230, -0.034	-0.203	0.009	1.003	
Symptoms	Sex	-6.48	-11.366, -1.599	-0.197	0.001	1.072	0.19
	Walking pain	-0.14	-0.238, -0.051	-0.222	0.007	1.004	
ADL	Sex	-5.37	-9.818, -0.922	-0.174	0.018	1.005	0.20
	mGES	0.26	0.169, 0.350	-0.174	0.001	1.005	
Sport/Rec	mGES	0.39	0.161, 0.623	0.261	0.001	1.000	0.07
QOL	mGES	0.48	0.317, 0.641	0.426	0.001	1.000	0.18

patient satisfaction, long-term pain perceptions, and motivation to return to the desired level of function. We believe that patients who were confident about their gait despite preoperative knee pain retain their mental stability and motivation to perform ADL postoperatively. Furthermore, because a previous study reported that self-efficacy can be enhanced through educational guidance and successful experiences,<sup>33)</sup> the impact of patient education on confidence in gait in patients with knee OA should be examined.

The preoperative mGES score was identified as an influencing factor of all KOOS subscales except Symptoms at 12 months post-TKA. Giesinger et al. reported a strong relationship between psychological status and parameters such as pain, stiffness, and function on the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) pain scale.<sup>34)</sup> However, Lindner et al.<sup>35)</sup> reported that regression analyses with all WOMAC scales as dependent variables revealed that psychosocial parameters were significant predictors for total hip arthroplasty. In contrast, among TKA patients, with one exception, psychosocial variables did not play a role in predicting disease-specific outcomes. Desmeules et al.<sup>36)</sup> found that psychological distress (anxiety and depression) influenced Short Form-36 physical functioning but not WOMAC pain and function. Although the relationship between psychological factors and HRQOL scores after TKA has not been established, mGES was associated with KOOS subscale scores. This is because mGES is a self-efficacy assessment specific to walking. Self-efficacy acts as a predictor of physical activity.<sup>37)</sup> We speculate that preoperative walking confidence will affect postoperative walking and other activities. Many patients undergo TKA because knee pain reduces their walking ability. Even under such circumstances, patients with high preoperative walking confidence are more likely than those with low confidence

to be motivated to perform postoperative physical therapy exercises and ADL. Consequently, we believe that higher preoperative mGES scores contributed to improved HRQOL at 12 months post-TKA.

This study investigated the preoperative factors associated with patient HRQOL after TKA. The results showed that HRQOL at 3 and 12 months post-TKA was correlated with preoperative walking self-efficacy. The preoperative evaluation assessed physical function such as ROM, lower limb muscle strength, and pain. We propose that the psychological factors of self-efficacy be considered when predicting postoperative outcomes. Consensus is lacking about whether educational interventions for patients undergoing TKA can improve their self-efficacy.<sup>30,31)</sup> Consequently, because gait confidence may affect postoperative HRQOL, it is necessary to consider interventions that incorporate education that will increase patient walking confidence. Knee surgeons should also be aware of the patient's preoperative walking confidence during the surgical consultation and evaluation to help predict postoperative QOL improvements.

This study has some limitations. First, we included only patients who underwent TKA, and the proportion of female participants was high. A larger number of subjects and other diseases must be assessed to examine whether our results are applicable to a wider range of orthopedic surgeries. Second, walking status (unaided or with a cane), age, the presence of complications, and the activity and living environment pre-TKA versus post-TKA were not standardized. We believe that these factors are associated with physical function and walking confidence. The inclusion and exclusion criteria of future studies should be more strictly defined. Third, significant correlations were found between three KOOS subscales at 3 months and five KOOS subscales at 12 months post-TKA and the preoperative mGES score. However, because the

correlations were weak to moderate, further analyses are necessary. Finally, this study did not include intraoperative factors related to TKA such as the surgical approach, fixation technique, tourniquet use, surgical time, and postoperative pain management. In examining postoperative results from preoperative factors, the influence of intraoperative factors should be included in the analysis.

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### CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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