



## CLINICAL ARTICLE

# Willingness to Have Total Knee Arthroplasty in Rural Areas of Northern China

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## Abstract

**Objective:** To evaluate willingness and its potential predictors to have total knee arthroplasty (TKA) among residents in rural areas of northern China.

**Methods:** Data were collected from two population-based studies on osteoarthritis (OA) in northern China. Residents aged  $\geq 50$  years in randomly selected rural communities were recruited using a cluster survey method. Participants completed a home interview (including social-demographic characteristics, clinical information, 12-Item Short Form Health Surveys [SF-12], and Visual Analog Scale [VAS] of knee pain), a physical examination, and bilateral weight-bearing posteroanterior semi-flexed view of radiographs of knees. Willingness to have TKA was queried by asking: "If you need to undergo total knee arthroplasty as judged by orthopaedic surgeons, are you willing to accept this operation?" Two trained investigators read all radiographs independently and reached an acceptable intra-reader agreement. We fitted univariate and multivariate regressions adjusting for potential confounders to examine predictors of willingness to have TKA stratified by sex.

**Results:** A total of 2172 participants were included. The overall rate of willingness to have TKA was 33.8%. Men were more likely to be willing to have TKA than women with an odds ratio (OR) of 0.73 (95% confidence interval [CI]: 0.60–0.89,  $P = 0.002$ ). A higher household income (OR: 2.34 for men and 1.77 for women, both  $P < 0.001$ ), higher SF-12 Physical Component Summary (PCS) score (OR: 1.02 for both gender,  $P = 0.04$  for men and  $P = 0.01$  for women), and being aware of TKA (OR: 2.55 for men and 2.65 for women, both  $P < 0.001$ ) were associated with a higher willingness to have TKA. Other predictors of higher willingness to have TKA were younger age (OR: 0.66 for 60–70 years,  $P = 0.01$ ; and 0.48 for  $>70$  years,  $P = 0.003$ , respectively) and lower level of physical activity (OR: 0.57 for moderate,  $p = 0.04$ ; and 0.62 for heavy,  $p = 0.04$ , respectively) among men and a higher education (OR: 1.45 for Junior school,  $P = 0.04$ ; and 1.66 for high school and above,  $P = 0.02$ , respectively) and being overweight among women (OR: 1.38,  $P = 0.008$ ), respectively. No significant difference was observed between willingness to have TKA and frequent knee pain, VAS of knee pain and Kellgren and Lawrence grades in both men and women.

**Conclusions:** The willingness to have TKA among rural residents of northern China was relatively low. Younger age, women, educational level, household income, physical function, and awareness of TKA were positively associated with willingness to have TKA.

**Key words:** knee osteoarthritis; Population-based study; Predictors; Total knee arthroplasty; Willingness

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## Introduction

Knee osteoarthritis (OA) is a highly prevalent chronic joint disease and leading cause of disability among the elderly<sup>1</sup>. Severe knee OA causes pain, deformity, and dysfunction, leading to increased cardiovascular events and all-cause mortality and formidable disease burden<sup>2</sup>. Prevention and early treatment such as education, dietary weight management, and structured land-based exercise programs are widely recommended as core methods for patients with knee OA<sup>3</sup>. Failure of conservative therapy, severe pain, loss of function, and immense radiological changes are commonly recommended to perform total knee arthroplasty (TKA)<sup>4,5</sup>. TKA is well-recognized as a cost-effective treatment for end-stage knee OA to alleviate pain, correct deformity, and improve quality of life<sup>6-8</sup>. The number of TKAs has risen in recent years<sup>9</sup>. However, an extensive amount of accommodation to pain and disability is noted in patients with severe OA in order to avoid total joint replacement surgery<sup>10</sup>. Therefore, considering the limited health resources and enormous disease burden, mismatch of willingness to have TKA might be developed.

As for many elective surgeries, how individuals balance the potential benefits and risks of the procedure, together with surgeon's recommendation, have been shown to influence the decision-making process<sup>11</sup>. Decision-making involves "gathering of information on available choices, needs, risks, and benefits and then the systematic weighing or analyzing of alternatives with the aim of achieving the highest gain at the least cost"<sup>10</sup>. As an important factor in decision-making, patient treatment preference is partly attitudinal and has been reported to influence the utilization of various medical procedures and treatments, including joint replacement. There is evidence that willingness to consider joint replacement is the strongest determinant of time to first total joint arthroplasty<sup>12</sup>. Patient preference toward joint replacement may be improved by better understanding and expectations regarding TKA, having lower levels of religiosity, having a surgical discussion with a physician, and having higher trust in physicians and the health care system. In fact, this process is very common in clinical practice with OA patients who are recommended for joint replacement by an orthopaedic surgeon.

Predictors of willingness to have TKA have been previously well-documented. Demographic factors such as sex, race, and age have been shown to influence willingness to have TKA<sup>13,14</sup>. While women have higher prevalence, worse symptoms, and greater disability of OA, they are less willing to undergo TKA compared with men<sup>13,15</sup>. Analogously, African American people may have higher disease burden but reported lower willingness to have TKA<sup>15</sup>. Elderly patients might display less willingness to have TKA due to an undervaluing of the benefit of the operation<sup>10</sup>.

In addition, socioeconomic factors including education attainment and income level have also played a role in

willingness to have TKA. According to Hawker *et al.*<sup>16</sup>, individuals with less education and/or lower income were more likely to have a potential unmet need for TKA. Patients with lower socioeconomic status usually have a preponderance of disease burden and need for TKA but had a lower rate of receiving TKA due to deficient treatment methods and high cost<sup>16</sup>. Moreover, it is shown that marital status has also been predictor of willingness to have TKA, with married individuals more willing to proceed with surgeries<sup>17</sup>. Preference for joint replacement surgery may also be influenced by access to care, beliefs about procedure efficacy, familiarity with the procedure, extent of social support, trust in health care, use of nonsurgical coping and pain management strategies, and expectations about postoperative recovery and potential complications<sup>14,18,19</sup>. Health insurance coverage may also affect demand for joint replacement. Hawker *et al.* studied the residents of Ontario, Canada, where everyone has universal health insurance coverage, and reported under-use of arthroplasty. This underutilization is expected to be worse in countries such as the United States, where health insurance status poses a further barrier to access to health care<sup>13</sup>.

Severity of disease and overall health condition have also been assessed as predictors of patient willingness to have TKA. Patient willingness to have TKA was once expected to augment with OA disease severity on the foundation of cost-effectiveness of the surgery. Pain severity is the independent most important related factor in the decision to perform knee arthroplasty. Simultaneously, patients with lower self-reported ability to function and less knee extension were more likely to undergo the surgery. However, Hawker *et al.*<sup>20</sup> and Suarez-Almazor *et al.*<sup>21</sup> both found that willingness to have TKA was not significantly correlated with disease severity. Socioeconomic factors might be potential confounders during the decision-making process<sup>17</sup>.

Demographic and socioeconomic factors affecting the willingness of receiving TKA may vary across countries and health care systems. In spite of studies on predictors of willingness to have TKA<sup>13,14,16,17,22</sup>, there is a paucity of such studies among Chinese residents. On the contrary, the number of OA patients along with the need for TKA in China have increased substantially mainly due to population aging and the epidemic of obesity<sup>1,23,24</sup>. Previous studies have shown that the burden of knee OA is greater in rural populations in China<sup>24,25</sup>. Estimating the prevalence of willingness to have TKA, especially in rural or less-developed areas where residents often have limited resources for accessing healthcare or social support<sup>26</sup>, is important for policymakers and clinicians to better recognize and target the mismatch of disease burden and surgical intervention. Additionally, assessment of these predictors of willingness to have TKA may provide clinicians a better understanding of patient decision-making while taking TKA into consideration as elective treatment, and inform planning for future orthopaedic resources.

Using data from two population-based studies on OA in China, the purpose of this study was: (i) to assess the prevalence of willingness to have TKA in rural areas of northern China; and (ii) to examine the significant demographic, socioeconomic, and clinical predictors of willingness to have TKA.

## Participants and Methods

### Sampling Methods

The Wuchuan Osteoarthritis Study and Shunyi Osteoarthritis Study are two population-based studies on knee OA, and both were approved by the Ethics Committee of Peking University People's Hospital (No. 2012-040 for Wuchuan Osteoarthritis Study and 2018PHB166-01 for Shunyi Osteoarthritis Study). The details of these two studies have been published previously<sup>27,28</sup>. Residents aged  $\geq 50$  years and living in Wuchuan County of Inner Mongolia and Shunyi Town of Beijing were included in the two studies; individuals with rheumatoid arthritis, ankylosing spondylitis, cerebrovascular disease, or a history of lower extremity surgery were excluded from further participation. Briefly, we recruited participants using door-to-door enumeration in randomly selected rural communities. Recruitment continued until all residents who were willing to participate were included. Each resident who participated in the survey had signed the informed consent document.

### Demographics of Participants

Participants were queried on socio-demographic characteristics including age, sex, education, household income, whether they were currently working, level of physical activity, and awareness of TKA.

Age was categorized into three groups ( $< 60$  years, 60–70 years, and  $> 70$  years). The educational level was divided into primary school, junior school, and high school and above. Household income was classified into  $> 10,000$  yuan and  $\leq 10,000$  yuan per year. Overweight was defined as a body mass index (BMI) higher than  $25 \text{ kg/m}^2$ . Level of physical activity was categorized into sedentary or light, moderate, and heavy. Awareness of TKA was queried and classified as yes or no.

### Clinical Assessment

All participants had clinical assessment such as history of knee injury, 12-Item Short Form Health Surveys (SF-12, from which the physical component summary [PCS] scores and mental component summary [MCS] scores were calculated), frequent knee pain, and Visual Analog Scale (VAS) of knee pain.

### History of Knee Injury

History of knee injury was identified if participants answered "Yes" to the question "Have you ever had a knee injury that affected walking for at least one week?"

### Health-Related Quality of Life

The SF-12<sup>29,30</sup> is one of the most commonly used health-related quality of life questionnaires in community-based health surveys and outcome assessment of physical and mental illnesses because of its brevity and psychometric performance. Responses to questions allow the calculation of PCS and MCS scores, and the higher the score, the better the health status of participants.

### Frequent Knee Pain and Severity of Knee Pain

Frequent knee pain was identified if participants answered "Yes" to the question "Did knee pain occur on most days in the past month?" During the query, we emphasized that the pain should last at least 1 month, then the answer could be recognized as positive<sup>31</sup>. The VAS score system, a most commonly used questionnaire, is used to measure the severity of knee pain. The VAS is a continuous scale comprised of a horizontal or vertical line, usually 10 cm in length. The intensity of pain experienced by the patient on the scale is most commonly anchored by "no pain" (score of 0) and "unbearable pain" (score of 10)<sup>32</sup>.

### Radiographic Assessment

Participants had bilateral weight-bearing posteroanterior semi-flexed view of radiographs of knees. Two trained investigators (both independent and blinded to the data) read randomly selected films until both readers reached an acceptable intra-reader agreement with a kappa over 0.8<sup>33</sup>. Specifically, for each batch of radiographs ( $n = 50$ ), five previous read films were fed back to test the inter-reader reliability. Each knee was assessed for the presence of osteophytes, joint space narrowing, sclerosis, and cysts to evaluate the Kellgren and Lawrence (KL) grades (grade 0, none; grade 1, possible osteophyte; grade 2, definite osteophytes but no joint space narrowing; grades 3, moderate osteophytes, definite joint space narrowing; grade 4, multiple osteophytes, definite joint space narrowing with deformity and sclerosis)<sup>34</sup>.

### Willingness to Have TKA

Willingness to have TKA was queried by asking "If you need to undergo total knee arthroplasty as judged by orthopaedic surgeons, are you willing to accept this operation?" with optional answers of "Yes" or "No". The proportion of patients with positive willingness was regarded as the primary outcome.

### Statistical Analysis

Logistic regression was conducted to identify the association of sex with the willingness to have TKA adjusting for age, education, household income, being overweight, and history of knee injury. Sex-stratified univariate regressions and multivariate regressions adjusting for potential confounders were performed to examine the predictors of willingness to have TKA. Odds ratio (OR) and 95% confidence interval (CI) and the corresponding  $P$  value were reported for each of the predictors. A  $P$  value  $< 0.05$  was considered to be significant. All

statistical analyses were performed using Stata/SE 15.1 (StataCorp, Texas, USA).

## Results

### Characteristics of Participants

A total of 2172 participants were included in the analyses. As shown in Table 1, approximately 61.6% ( $n = 1338$ ) were women and the majority received education from primary or junior school. Most of the participants had household income higher than 10,000 yuan per year (52.6%), were overweight (57.2%), did not have history of knee injury (87.9%), had “heavy” level of physical activity (57.1%), were still working (51.9%), did not have frequent knee pain (57.9%), and were not aware of TKA (63.4%). About one-third of the

participants had a KL grade  $\geq 2$  in at least one knee. The mean (SD) of VAS was 2.1 (2.7). The mean (SD) PCS and MCS score were 41.6 (8.4) and 45.8 (9.1), respectively.

### Univariate Analysis of Willingness

The overall willingness rate to have TKA was 33.8%, with a higher willingness among men (37.0%) than women (31.8%) (Table 2). In the univariate regression, younger age, higher education attainment, higher household income, lower level of physical activity, higher PCS scores, and being aware of TKA were associated with a higher willingness to have TKA among both men and women. Women being overweight, without frequent knee pain, having lower KL grades, lower VAS score of knee pain, and higher MCS score, and men who were currently working were more likely to be willing to

**TABLE 1** Characteristics of participants

	Male ( $n = 834$ )	Female ( $n = 1338$ )	Total ( $n = 2172$ )
Age (%)			
< 60	41.4	57.3	51.2
60–70	42.2	32.7	36.3
> 70	16.4	10.0	12.5
Education (%)			
Primary school	31.9	47.6	41.6
Junior school	55.6	44.0	48.5
High school and above	12.5	8.4	9.9
Household income (> 10,000 yuan) (%)			
No	53.2	52.2	52.6
Yes	46.8	47.8	47.4
Overweight (BMI > 25 kg/m <sup>2</sup> ) (%)			
No	70.3	49.0	57.2
Yes	29.7	51.0	42.8
History of knee injury (%)			
No	89.8	86.8	87.9
Yes	10.2	13.2	12.1
Level of physical activity (%)			
Sedentary or light	14.0	22.8	19.4
Moderate	17.3	27.4	23.5
Heavy	68.7	49.9	57.1
Currently working (%)			
No	39.7	53.4	48.1
Yes	60.3	46.6	51.9
Frequent knee pain (%)			
No	63.1	54.7	57.9
Yes	36.9	45.3	42.1
Kellgren and Lawrence grade (%)			
0	54.4	33.6	41.6
1	21.2	22.7	22.1
2	11.0	23.4	18.7
3–4	13.3	20.3	17.6
VAS of knee pain (mean $\pm$ SD)	1.8 $\pm$ 2.5	2.3 $\pm$ 2.8	2.1 $\pm$ 2.7
PCS (mean $\pm$ SD)	42.3 $\pm$ 8.3	41.2 $\pm$ 8.4	41.6 $\pm$ 8.4
MCS (mean $\pm$ SD)	46.9 $\pm$ 8.7	45.1 $\pm$ 9.3	45.8 $\pm$ 9.1
Awareness of TKR (%)			
No	66.4	61.6	63.4
Yes	33.6	38.4	36.6
Site (%)			
Wuchuan	61.4	47.0	52.5
Shunyi	38.6	53.0	47.5

Abbreviations: MCS: SF-12 Mental Component Summary; PCS: SF-12 Physical Component Summary; TKA: Total knee arthroplasty; VAS: Visual Analog Scale.

TABLE 2 Univariate regression of predictors of willingness to have total knee arthroplasty

	Male				Female			
	Unwilling (%)	Willing (%)	OR (95% CI)	P value	Unwilling (%)	Willing (%)	OR (95% CI)	P value
Total	525 (63.0)	309 (37.0)	1.00 (Reference)	–	912 (68.2)	426 (31.8)	0.79 (0.66, 0.95)	0.01
Age				< 0.001				< 0.001
< 60	187 (35.6)	158 (51.1)	1.00 (Reference)		492 (54.0)	275 (64.6)	1.00 (Reference)	
60–70	234 (44.6)	118 (38.2)	0.60 (0.44, 0.81)		316 (34.6)	121 (28.4)	0.69 (0.53, 0.89)	
> 70	104 (19.8)	33 (10.7)	0.38 (0.24, 0.59)		104 (11.4)	30 (7.0)	0.52 (0.33, 0.80)	
Education				0.04				< 0.001
Primary school	184 (35.0)	82 (26.5)	1.00 (Reference)		478 (52.4)	159 (37.3)	1.00 (Reference)	
Junior school	277 (52.8)	187 (60.5)	1.51 (1.10, 2.08)		369 (40.5)	220 (51.6)	1.79 (1.40, 2.29)	
High school and above	64 (12.2)	40 (12.9)	1.40 (0.87, 2.25)		65 (7.1)	47 (11.0)	2.17 (1.43, 3.29)	
Household income (> 10,000 yuan)				< 0.001				< 0.001
No	326 (62.1)	118 (38.2)	1.00 (Reference)		529 (58.0)	169 (39.7)	1.00 (Reference)	
Yes	199 (37.9)	191 (61.8)	2.65 (1.98, 3.54)		383 (42.0)	257 (60.3)	2.10 (1.66, 2.65)	
Overweight (BMI >25 kg/m <sup>2</sup> )				0.2				< 0.001
No	377 (71.8)	209 (67.6)	1.00 (Reference)		481 (52.7)	175 (41.1)	1.00 (Reference)	
Yes	148 (28.2)	100 (32.4)	1.22 (0.90, 1.65)		431 (47.3)	251 (58.9)	1.60 (1.29, 2.02)	
History of knee injury				0.9				0.1
No	472 (89.9)	277 (89.6)	1.00 (Reference)		782 (85.7)	379 (89.0)	1.00 (Reference)	
Yes	53 (10.1)	32 (10.4)	1.03 (0.65, 1.63)		130 (14.3)	47 (11.0)	0.75 (0.52, 1.06)	
Level of physical activity				0.02				0.02
Sedentary or light	61 (11.6)	56 (18.1)	1.00 (Reference)		206 (22.6)	99 (23.2)	1.00 (Reference)	
Moderate	93 (17.7)	51 (16.5)	0.60 (0.36, 0.98)		222 (24.3)	144 (33.8)	1.35 (0.98, 1.86)	
Heavy	371 (70.7)	202 (65.4)	0.59 (0.40, 0.88)		484 (50.1)	183 (43.0)	0.79 (0.59, 1.05)	
Currently working				0.001				0.3
No	232 (44.2)	99 (32.0)	1.00 (Reference)		495 (52.3)	219 (51.4)	1.00 (Reference)	
Yes	293 (55.8)	210 (68.0)	1.68 (1.25, 2.25)		417 (45.7)	207 (48.6)	1.12 (0.89, 1.41)	
Frequent knee pain				0.2				0.002
No	323 (61.5)	203 (65.7)	1.00 (Reference)		472 (51.8)	260 (61.0)	1.00 (Reference)	
Yes	202 (38.5)	106 (34.3)	0.83 (0.62, 1.12)		440 (48.2)	166 (39.0)	0.68 (0.54, 0.86)	
Kellgren and Lawrence grade				0.3				0.02
0	281 (53.5)	173 (56.0)	1.00 (Reference)		284 (31.1)	166 (39.0)	1.00 (Reference)	
1	109 (20.8)	68 (22.0)	1.01 (0.71, 1.45)		208 (22.8)	95 (22.3)	0.78 (0.57, 1.06)	
2	62 (11.8)	30 (9.7)	0.78 (0.49, 1.26)		234 (25.7)	79 (18.5)	0.58 (0.42, 0.79)	
3–4	73 (13.9)	38 (12.3)	0.85 (0.55, 1.31)		186 (20.4)	86 (20.2)	0.79 (0.57, 1.09)	
VAS of knee pain	–	–	0.96 (0.91, 1.02)	0.2	–	–	0.94 (0.90, 0.98)	0.003
PCS	–	–	1.04 (1.01, 1.06)	< 0.001	–	–	1.04 (1.02, 1.05)	< 0.001
MCS	–	–	1.00 (0.98, 1.02)	0.9	–	–	1.02 (1.01, 1.03)	0.005
Awareness of TKA				0.001				0.001
No	389 (74.1)	165 (53.4)	1.00 (Reference)		639 (70.1)	185 (43.4)	1.00 (Reference)	
Yes	136 (25.9)	144 (46.6)	2.50 (1.85, 3.36)		273 (29.9)	241 (56.6)	3.05 (2.40, 3.87)	
Site				0.02				< 0.001
Wuchuan	338 (64.4)	174 (56.3)	1.00 (Reference)		474 (52.0)	155 (36.4)	1.00 (Reference)	
Shunyi	187 (35.6)	135 (43.7)	1.40 (1.05, 1.87)		438 (48.0)	271 (63.6)	1.89 (1.49, 2.40)	

Abbreviations: MCS: SF-12 Mental Component Summary; PCS: SF-12 Physical Component Summary; TKA: Total knee arthroplasty; VAS: Visual Analog Scale.

have TKA (Table 2). Participants from Shunyi had a higher willingness to have TKA than those from Wuchuan.

### Multivariate Analysis of Willingness

After adjusting for potential confounders, results of multivariate regressions had changed significantly. As shown in Table 3, the adjusted OR of willingness to have TKA was 27% lower in women than in men (95% CI 0.60–0.89,  $P = 0.002$ ). A higher household income (OR: 2.34 for men and 1.77 for women, both  $P < 0.001$ ), higher SF-12 Physical Component Summary (PCS) score (OR: 1.02 for both gender,  $P = 0.04$  for men and  $P = 0.01$  for women), and being aware of TKA (OR: 2.55 for men and 2.65 for women, both  $P < 0.001$ ) were associated with a higher willingness to have

TKA. Other predictors of higher willingness to have TKA were younger age (OR: 0.66 for 60–70 years,  $P = 0.01$ ; and 0.48 for > 70 years,  $P = 0.003$ , respectively) and lower level of physical activity (OR: 0.57 for moderate,  $P = 0.04$ ; and 0.62 for heavy,  $P = 0.04$ , respectively) among men and a higher education (OR: 1.45 for junior school,  $P = 0.04$ ; and 1.66 for high school and above,  $P = 0.02$ , respectively) and being overweight (OR: 1.38,  $P = 0.008$ ) among women, respectively. No significant difference was found between willingness to have TKA and history of knee injury, currently working, frequent knee pain, KL grades, VAS of knee pain, SF-12 MCS scores in both men and women. There was no significant difference in the willingness to have TKA between participants from Shunyi and Wuchuan.

TABLE 3 Multivariate regression of predictors of willingness to have total knee arthroplasty

	Male		Female	
	OR (95% CI)	P value	OR (95% CI)	P value
Total <sup>a</sup>	1.00 (Reference)	–	0.73 (0.60, 0.89)	0.002
Age <sup>a</sup>				
< 60	1.00 (Reference)		1.00 (Reference)	
60–70	0.66 (0.48, 0.91)	0.01	0.79 (0.60, 1.03)	0.08
> 70	0.48 (0.30, 0.78)	0.003	0.69 (0.44, 1.08)	0.1
Education <sup>a</sup>				
Primary school	1.00 (Reference)		1.00 (Reference)	
Junior school	1.06 (0.75, 1.51)	0.7	1.45 (1.13, 1.89)	0.004
High school and above	0.90 (0.53, 1.49)	0.7	1.66 (1.08, 2.57)	0.02
Household income (> 10,000 yuan) <sup>a</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	2.34 (1.72, 3.18)	< 0.001	1.77 (1.39, 2.26)	< 0.001
Overweight (BMI > 25 kg/m <sup>2</sup> ) <sup>a</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.05 (0.76, 1.44)	0.8	1.38 (1.09, 1.76)	0.008
History of knee injury <sup>a</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.10 (0.68, 1.79)	0.7	0.73 (0.51, 1.05)	0.09
Level of physical activity <sup>b</sup>				
Sedentary or light	1.00 (Reference)		1.00 (Reference)	
Moderate	0.57 (0.34, 0.98)	0.04	1.37 (0.98, 1.91)	0.07
Heavy	0.62 (0.39, 0.99)	0.04	1.11 (0.77, 1.60)	0.6
Currently working <sup>b</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.43 (0.99, 2.05)	0.05	1.12 (0.84, 1.48)	0.4
Frequent knee pain <sup>b</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	0.91 (0.39, 2.12)	0.8	0.92 (0.50, 1.69)	0.8
Kellgren and Lawrence grade <sup>b</sup>				
0	1.00 (Reference)		1.00 (Reference)	
1	1.18 (0.81, 1.72)	0.4	0.77 (0.56, 1.06)	0.1
2	0.92 (0.55, 1.54)	0.8	0.62 (0.44, 0.87)	0.006
3–4	1.33 (0.80, 2.21)	0.3	0.96 (0.66, 1.38)	0.8
VAS of knee pain <sup>b</sup>	1.02 (0.87, 1.21)	0.8	1.04 (0.93, 1.17)	0.5
PCS <sup>b</sup>	1.02 (1.00, 1.04)	0.04	1.02 (1.00, 1.04)	0.01
MCS <sup>b</sup>	0.99 (0.97, 1.01)	0.1	1.01 (0.99, 1.02)	0.3
Awareness of TKA <sup>b</sup>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	2.55 (1.81, 3.60)	< 0.001	2.65 (2.02, 3.49)	< 0.001
Site <sup>c</sup>				
Wuchuan	1.00 (Reference)		1.00 (Reference)	
Shunyi	0.86 (0.47, 1.57)	0.6	1.42 (0.82, 2.47)	0.2

Abbreviations: MCS: SF-12 Mental Component Summary; PCS: SF-12 Physical Component Summary; TKR: Total knee arthroplasty; VAS: Visual Analog Scale.; <sup>a</sup> Adjusted for age, education, household income, being overweight, and history of knee injury.; <sup>b</sup> Adjusted for age, education, household income, being overweight, history of knee injury, level of physical activity, current working status, frequent knee pain, Kellgren and Lawrence grade, and VAS of knee pain.; <sup>c</sup> Adjusted for age, education, household income, being overweight, history of knee injury, level of physical activity, current working status, frequent knee pain, Kellgren and Lawrence grade, VAS of knee pain, and awareness of TKA.

## Discussion

Using data collected from the Wuchuan Osteoarthritis Study and Shunyi Osteoarthritis Study, we found that the willingness to have TKA was relatively low, especially in women residents and those without awareness of TKA. There were remarkable variations in the willingness to have TKA according to social demographic and clinical characteristics. However, it was notable that no significant difference was found between willingness to have TKA and frequent knee pain, VAS of knee pain, and KL grades.

## Willingness and Predictors

The willingness to have TKA in rural northern China was relatively low. Bendich *et al.*<sup>35</sup> reported that 75.8% of 4796 Osteoarthritis Initiative (OAI) patients with symptomatic or high risk of knee OA were willing to have TKA.

The predictors of willingness to have TKA varied between men and women, and it might be related to patients' expectations of functionality. Although gender had no effect on primary TKA in Canada<sup>12</sup> or in the United States<sup>36,37</sup>, our study showed that men participants had higher

willingness (OR 0.73 for women) to have TKA. Borkhoff *et al.*<sup>38</sup> indicated that doctors might provide less medical information and less encouragement to participate in the surgery of TKA to women compared to men. Toye *et al.*<sup>39</sup> also stressed the importance to consider gender differences that may influence the decision for TKA, for women might be more likely to have heard about negative examples of TKA from friends and be less likely to discuss treatment preferences with their doctors.

Among people age over 60 years, the willingness appears to decline with increasing age in our study, especially in men. How this impacted the willingness might depend on whether they have opportunities of retirement or availability of formal care by family members<sup>18</sup>. According to Hanchate *et al.*<sup>22</sup>, TKA was appreciated more by people with paid work than others, after considering social demographic characteristics, health insurance type, education, and health status. Further studies are warranted to examine the relationship between retirement and willingness to have TKA. If so, a gender difference between age and the willingness to have TKA might result due to different employment statuses in rural northern China, according to the data from China Statistical Yearbook<sup>23</sup>.

While elderly men usually emphasized their effects on leisure activities, women viewed unmet functional needs associated with walking, shopping, and doing housework limitations<sup>39</sup>. That might be the reason why men with lower level of physical activity were willing to have TKA. And as for women, it seemed to be those with a higher level of physical activity, though it was not statistically significant.

As expected, the willingness to have TKA was higher for people with higher household income, having awareness of TKA. People living in families with higher household income have relatively more opportunities to cover those expenses which were not covered by health insurance in rural China. This finding could explain the age deficits as described above. Having awareness of the uncertainty of risks, benefits, and the implant survivorship of TKA, both men and women were expected to balance their choices before making a decision, as some believed that if they were either required or would benefit from the surgery, their surgeons would advise them to go ahead with the surgery<sup>40</sup>.

TKA is recognized as a cost-effective treatment for reducing pain and restoring the function and mobility of patients with severe arthritis<sup>1,8</sup>. However, Vina *et al.*<sup>17</sup> found that compared to participants without pain, severe knee pain was paradoxically associated with less willingness to undergo TKA. This was somehow confirmed by our findings in these two randomly selected rural areas. In our study, almost half of the participants (42.1%) had frequent knee pain, and approximately 36.3% of their KL grades were  $\geq 2$ , assuming a significant disease burden. Nevertheless, no significant differences were found between willingness to have TKA and frequent knee pain, VAS of knee pain, and KL grades. These two contradictory situations together form a mismatch or unmet need between patients and surgeons<sup>19,41</sup>. There was

also no significant difference in the willingness to have TKA between participants from Shunyi and Wuchuan after adjusting potential confounders. The differences of social demographic and clinical characteristics might contribute to this phenomenon.

In clinical practice the decision to have TKA depends on a shared decision-making process regarding the surgery<sup>42</sup>. The willingness to have TKA plays an important role in this process<sup>12</sup>. It was found in clinical practice and many studies that even patients with severe OA (including arthritis symptoms, dysfunction, and imaging findings, i.e. high KL grades) who were good candidates for TKA have no or less willingness to consider surgery<sup>19,20</sup>, resulting in mismatch of disease burden and surgical intervention<sup>20</sup>. Studies have shown that demographic factors (such as sex and race)<sup>13,14</sup>, socioeconomic factors (such as education attainment, marital status, and income level)<sup>16,17</sup>, and severity of symptoms<sup>43</sup> affect their willingness to have TKA. Further interventions should be taken to better supplement this mismatch.

In particular, more education on OA and TKA implementation to the public, especially in rural areas in China, should be developed regarding the low awareness of TKA (33.8%) in our study, though the willingness to accept joint surgery might take account of a large number of complex issues, including psychological and socioeconomic characteristics. Decision aids to deliver information on knee OA and joint replacement to patients with moderate or severe knee OA had been confirmed to be valid to increase the willingness to consider TKA<sup>44,45</sup>. The risks and benefits of treatment options including lifestyle changes, weight control, exercises, medications, injections, and surgeries should be outlined in the education programs. Clinical indications of each treatment option, probable duration of surgeries, the need and time of rehabilitation, and costs and efforts should be also covered.

#### **Limitations of the Study**

Our study had limitations. First, the sample size of our study is not large enough. This might be the reason that no significant differences were found between some variates and the willingness to have TKA. Second, we did not assess the influence of insurance status on residents' willingness to have TKA, which is known to have impact on it<sup>17,22</sup>. Third, we are incapable of distinguishing between those who are simply unwilling to have TKA from those who are strained due to their financial situation.

#### **Conclusion**

In conclusion, the willingness to have TKA among rural residents of northern China was relatively low. Younger age, being a woman, educational level, household income, physical function, and awareness of TKA were positively associated with willingness to have TKA. Education on OA and TKA implementation to the public, to better deal with the mismatch between OA burden and health resources, is warranted.

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