Disease burden of and expectations from surgery in patients prior to total knee arthroplasty

Jacobs, Hannes; Seeber, Gesine H.; Lazovic, Djordje; Maus, Uwe; Hoffmann, Falk

Published in:
Knee

DOI:
10.1016/j.knee.2023.01.020

Publication date:
2023

The Knee 41 (2023) 257–265

Contents lists available at ScienceDirect

The Knee

journal homepage:

Disease burden of and expectations from surgery in patients prior to total knee arthroplasty: Results of the prospective FInGK study

Hannes Jacobs [a,*], Gesine H. Seeber [b,d], Djordje Lazovic [b], Uwe Maus [c], Falk Hoffmann [a]

[a] Department of Health Services Research, Carl von Ossietzky University Oldenburg, Oldenburg, Germany
[b] University Hospital for Orthopaedics and Trauma Surgery Pius-Hospital, Medical Campus University of Oldenburg, Oldenburg, Germany
[c] Department of Orthopaedics & Trauma Surgery, University Hospital Düsseldorf, Germany
[d] Department of Orthopedics, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

ARTICLE INFO

Article history:
Received 31 August 2022
Revised 30 December 2022
Accepted 26 January 2023

Keywords:
Osteoarthritis
Disease burden
Total knee arthroplasty
Knee
Expectations
Conservative Management

ABSTRACT

Background: Disease burden in patients prior to total knee arthroplasty (TKA) varies widely between studies and countries. We aimed to characterize individuals undergoing TKA and examine their expectations from the surgery, focusing on variations in disease burden.
Methods: Consecutive patients undergoing primary TKA in a German university hospital were recruited. A questionnaire including information on disease burden, preoperative expectations from surgery, health care utilization, demography, and socioeconomics was collected one day prior to surgery and linked to data from medical records. Patients were categorized into disease burden quartiles using the Western Ontario and McMaster Universities Osteoarthritis Index' (WOMAC) total score. Subsequently, study population's characteristics and expectations from surgery were analyzed stratified by disease burden.
Results: A total of 196 patients were included (41 % male; mean age: 68.2 years). The median WOMAC was 52.0 (IQR: 41.0–58.0). Patients in Q1 were more often males (Q1: 63 % vs Q4: 29 %) and had a shorter duration of complaints with the impaired knee. They were also less restricted in social participation, reported less often signs of depression, and were less often treated with physiotherapy (Q1: 27 % vs Q4: 54 %). Furthermore, expectations from surgery were highest in patients with a low disease burden.
Conclusion: We found large variations in disease burden with a considerable number of patients undergoing TKA whose functional capacity is still maintained and for which guideline-recommended conservative treatment options are not fully exhausted. Further research on this subgroup as well as establishing an international consensus on specific thresholds for TKA indication are needed.

1. Introduction

Osteoarthritis (OA) is one of developed countries' ten most disabling diseases [1]. It is characterized by the degeneration of cartilage and surrounding joint structures and often leads to pain, reduced function, and, consequently, diminished quality

* Corresponding author at: Department of Health Services Research, Carl von Ossietzky University Oldenburg, Ammerländer Heerstr. 114-118, 26129 Oldenburg, Germany.
E-mail address: Hannes.Jacobs@uol.de (H. Jacobs).

https://doi.org/10.1016/j.knee.2023.01.020
0968-0160/

of life (QoL) [2]. As a large weight-bearing joint, the knee is most commonly affected [3]. Management of knee OA traditionally involves a combination of non-pharmacological and pharmacological interventions [4,5]. However, for individuals with end-stage knee OA no longer responding to non-surgical interventions, total knee arthroplasty (TKA) is recommended [6].

TKA is one of the most frequently performed procedures worldwide, and its number has increased rapidly over the past decades. In OECD countries, the age-adjusted average TKA rate has more than doubled between 2009 and 2019 [7]. Simultaneously, these rates also display high levels of variations. Generally, they are highest – with more than 200 surgeries per 100.000 inhabitants – in Switzerland, Finland, Austria, the USA, Australia, Belgium, and Germany. On the contrary, countries like Norway, Poland, Israel, and Ireland have TKA rates $\leq$ 100/100.000, which is below the OECD average (137/100.000) of 2019 [7].

Variations in TKA rates may occur for many reasons, including differences in OA prevalence, differences in surgeons' expectations and treatment preferences, and restricted access to the procedure [8]. Although there are some national approaches on the criteria for conducting TKA like the New Zealand Priority Criteria Project [9], there is no internationally accepted consensus on the exact indication or optimal timing for TKA [10]. Besides, it has been shown that patients from diverse countries have different expectations from TKA [11]. These are influenced by multiple factors such as demographic characteristics [12], patient information/education [13], as well as clinical features [11] and, therefore, may – in combination with the preoperative disease burden [12,14] - also play a role in country-specific TKA variation.

Studies on disease burden before TKA show a wide range of pain-, stiffness-, and functional levels of the affected knee between countries [15–18]. Generally, studies report a more significant preoperative disease burden in women [16,19,20]. Papaskostidou et al. further observed an association between obese individuals and higher disease burden, whereas age and socioeconomic status (SES) were not associated [20]. In contrast, other authors reported age differences [16] and significantly worse preoperative pain and function in lower-income versus higher-income patients [21]. Simultaneously, TKA growth rates show trends of varying degrees. While most OECD countries show a remarkable increase, others show above average or unchanged growth rates [7]. Time trends in the characteristics of patients undergoing TKA also show that comorbidities like obesity and depression increased in the last three decades. In contrast, data on sex remained unchanged and on age are inconsistent [22–25]. In Germany, data on the characterization of patients undergoing TKA are scarce. It is known from official statistics registries that the proportion of males increased from 2005 to 2019 from 31 % to 39 % [26]. Additionally, Stürmer et al. provided information on disease burden [27]. However, the underlying data are 25 years old, and TKA rates have greatly increased in the meantime [7]. Moreover, data on the factors associated with disease burden is lacking for Germany, and international data are inconsistent.

Therefore, this study aims to characterize patients undergoing TKA in Germany regarding disease burden and expectations from surgery. In addition, we particularly aim to characterize those individuals with a lower disease burden and identify associated factors.

2. Material and Methods

2.1. Study design and study population

The present study was part of the FInGK project, a prospective cohort of patients undergoing unilateral primary or revision TKA. Participants were consecutively recruited in a German university hospital between December 2019 and May 2021. The following inclusion criteria had to be fulfilled: age $\geq$ 18 years, projected life expectancy > 12 months, and sufficient cognitive ability and German language skills to give informed consent and to complete the questionnaires. Ultimately, 241 of 283 eligible patients consented to participate in the study (response 85 %). We excluded patients with revision TKA (n = 37) (Supplementary material 1). Details on recruitment, differences between responders and non-responders, and the sample size calculation are described elsewhere [28].

2.2. Data collection

Data were collected pre-operatively (usually at admission one day before surgery) and 2 and 12 months after surgery (via a postal survey). For this cross-sectional study, analyses combined data from patient self-reported baseline questionnaires and clinical data obtained from hospital records.

2.2.1. Survey data

The baseline questionnaire included information on (1) disease burden of the impaired knee, (2) expectations from surgery, (3) utilization of health services, (4) sociodemographic characteristics, and information on (5) QoL, depressive symptoms, and restrictions on social participation.

The German version of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used to evaluate the disease burden of the impaired knee [29]. The WOMAC consists of 24 self-administrated questions in three subscales and considers the components pain (5 items), stiffness (2 items), and function (17 items). Each question is scored on a 5-point Likert scale (none, mild, moderate, severe, and extreme). The total (0–96) and the three subscales' scores were summed up with higher scores indicating more pain or disability. As recommended [30] and for cross-study comparisons,

the WOMAC total score was also reported normalized (range 0–100, 100 representing the worst outcome). In that context, duration of knee complaints, duration from the decision to operate to surgery, and fear of surgery were assessed. Furthermore, current use of analgesics and physiotherapy (PT) utilization for the impaired knee joint in the year before surgery was evaluated.

Health-related QoL was assessed by the EQ-5D visual analogue scale (EQ-5D-VAS) [31]. It is scored from 0 (“worst imaginable health state”) to 100 (“best imaginable health state”) and has good reliability and validity in knee OA patients [32]. The WHO Well-Being Index (WHO-5) measures psychological well-being and shows favorable properties for detecting major depression [33]. Scores were transformed (range 0–100) and categorized into “moderate-to-severe” (0–28), “mild” (29–50), and “no” (>50) depressive symptoms as validated and used in previous studies [34,35]. To measure restrictions on social participation, the IMET index was used [36]. Based on ICF criteria [37], it determines in 9 items the subjective impairment of chronically ill people in their everyday lives and can be evaluated as a total score (0–90; high values indicate high participation restrictions). The tool has proven to be valid and reliable for application in chronically ill patients [38]. Patients were also asked whether they were living alone in their household.

Patient expectations from surgery regarding pain relief, activities of daily living (ADL), and physical activities were assessed using the preoperative German New Knee Society Score (GNKSS) [39]. Each question was scored on a 5-point Likert scale. For analyses, categories 0 (“none”), 1 (“a little”), and 2 (“somewhat”) were eventually combined and presented as one single category named “none/low”. Category 3 (“moderate”) stayed unchanged. Category 4 “a lot” was renamed as “high”.

According to the International Standard Classification of Education (ISCED) [40,41], we divided the level of education as low, middle, or high. In the German school system, a low, medium, and high educational level corresponds to nine years of schooling or leaving school without having graduated (ISCED level 0–2B), ten years of schooling (level 2A), and 12 or 13 years of schooling (level 3A), respectively.

2.2.2. Data from medical records

Data from hospital medical records included subjects’ age and sex. Body mass index (BMI) was obtained from height and weight as determined one day before surgery. Missing values (n = 4) were completed via patient self-report. Primary and secondary diagnoses were retrieved based on the International Classification of Diseases, 10th Revision, German Modification (ICD-10-GM), and comorbidities were categorized by the Elixhauser comorbidity index. This index was developed for studies using administrative hospitalization databases and includes 31 severe comorbidities [42].

2.3. Statistical analyses

As in previous studies [43], patients were categorized into quartiles using the WOMAC total score. Individuals with missing data for total WOMAC score were excluded. Study population characteristics and expectations from surgery for pain relief, ADL, and physical activities were analyzed descriptively (percentages, mean, standard deviation [SD]) and stratified by WOMAC total score quartiles (Q1-Q4).

Backwards multivariable logistic regression analysis was used to determine factors associated with having a lower disease burden (being categorized in Q1 of the WOMAC total score) prior to surgery. We adjusted for main demographic (sex, age, living status), disease-related (social participation restrictions, number of comorbidities, presence of depressive symptoms, current use of analgesics, PT utilization, duration of complaints), socioeconomic (level of education), and surgery-related (fear of surgery, expectations from surgery about pain relief, ADL, and physical activities) characteristics. A significance level of 0.05 was required for a variable to stay in the model. Age and level of education were always included in the model. Adjusted odds ratios (OR) were calculated with a 95 % confidence interval (CI). Non-overlapping 95 % CIs were considered statistically significant.

Data analyses were performed with SAS (Version 9.4, SAS Institute, Cary, NC, USA).

3. Results

3.1. Baseline characteristics of the study population

For a total of 196 of 204 patients undergoing primary TKA, the WOMAC was available, of whom 41 % were male, and the mean age was 68.2 years (Table 1). Mean EQ-5D-VAS and IMET scores were 54.7 and 38.6, respectively. According to the WHO-5, more than one-third had moderate to severe depressive symptoms. Nearly half of the participants had a low educational level, and approximately-two-thirds were categorized in the BMI group $\geq$ 30 kg/m^2 (mean BMI: 32.7 kg/m^2). In addition, 35 % had $\geq$ 3 comorbidities. Regarding treatment options, 72 % were currently using analgesics, and 40 % had used PT within the year before surgery. Vast fear of surgery was reported by 39 % of the study population. The mean duration of complaints with the impaired knee was 8.3 years.

Overall, the mean WOMAC total score was 50.4 (median: 52.0; IQR: 41.0–58.0) (Table 1). Compared to participants in Q2-Q4, those in Q1 were more often males (Q1: 63 % vs Q4: 29 %) and had a shorter period of complaints. They were also less restricted in social participation (15 % above the median score vs 38 %, 65 %, and 80 % in Q2-Q4, respectively), were less likely to be obese, and reported less often signs of depression. Furthermore, they had fewer comorbidities and were less often treated with analgesics or PT. Patients grouped in Q1 had similar education levels and similar proportions of fear of surgery as

Table 1
Characteristics of the study population in %; stratified by total WOMAC-score quartiles.

Characteristics	WOMAC total score				
	Q1 (score < 41.0); (n = 48; 24.5 %)	Q2 (score ≥ 41.0 - <52.0); (n = 49; 25.0 %)	Q3 (score ≥ 52.0 - <58.0); (n = 47; 24.0 %)	Q4 (score ≥ 58.0); (n = 52; 26.5 %)	Total (n = 196; 100.0 %)
WOMAC total, 0–96, mean (SD) (n = 196)	32.2 (7.0)	46.7 (3.2)	54.3 (1.7)	67.2 (7.8)	50.4 (14.0)
WOMAC total*, 0–100, mean (SD) (n = 196)	33.5 (7.3)	48.6 (3.3)	56.6 (1.8)	70.0 (8.1)	52.5 (14.5)
WOMAC pain, 0–20, mean (SD) (n = 196)	7.0 (2.0)	9.6 (1.8)	11.3 (1.5)	14.0 (2.3)	10.5 (3.2)
WOMAC stiffness, 0–8, mean (SD) (n = 196)	3.2 (1.5)	4.4 (1.2)	5.1 (1.0)	5.5 (1.5)	4.6 (1.6)
WOMAC function, 0–68, mean (SD) (n = 196)	22.0 (5.4)	32.7 (2.9)	37.9 (2.1)	47.7 (6.1)	35.3 (10.3)
EQ-5D scale, 0–100, mean (SD) (n = 192)	70.2 (16.3)	59.0 (15.4)	48.7 (21.9)	42.6 (20.4)	54.7 (21.4)
Sex, male (n = 196)	62.5	46.9	27.7	28.9	41.3
Age in years, mean (SD) (n = 196)	69.8 (8.4)	65.7 (9.6)	67.8 (10.4)	69.5 (10.2)	68.2 (9.8)
18–64 years	20.8	46.9	42.6	32.7	35.7
65–74 years	45.8	34.7	31.9	25.0	34.2
75 + years	33.3	18.4	25.5	42.3	30.1
Social participation restrictions (IMET total), 0–90, mean (SD) (n = 191)	26.3 (12.7)	32.8 (12.7)	41.7 (13.8)	53.0 (17.9)	38.6 (17.6)
Above median (score > 38.3)	14.6	38.3	65.2	80.0	49.7
Level of education (n = 193)					
low	47.8	47.9	42.6	48.1	46.6
middle	28.3	27.1	44.7	34.6	33.7
high	23.9	25.0	12.8	17.3	19.7
Living alone, yes (n = 191)	19.2	12.5	23.9	32.0	22.0
BMI, mean (SD) (n = 196)	30.4 (4.4)	33.1 (5.8)	33.2 (6.2)	34.1 (7.3)	32.7 (6.1)
<25	4.2	8.2	8.5	11.5	8.2
25-<30	50.0	22.5	23.4	13.5	27.0
≥30	45.8	63.4	68.1	75.0	64.8
Elixhauser comorbidity index score (n = 196)					
0	12.5	12.2	12.8	5.8	10.7
1–2	72.9	57.1	48.9	38.5	54.1
≥3	14.6	30.6	38.3	55.8	35.2
Depressive symptoms (WHO-5), 0–100, mean (SD) (n = 191)	60.7 (22.3)	46.8 (22.3)	35.8 (20.2)	29.1 (19.5)	42.8 (24.2)
no (>50)	70.8	42.2	23.9	19.2	38.7
mild (29–50)	18.8	31.1	28.3	21.2	24.6
moderate-to-severe (≤28)	10.4	26.7	47.8	59.6	36.7
Current use of analgesics, yes (n = 191)	46.8	74.5	76.6	88.0	71.7
Use of physiotherapy prior to surgery (n = 194)	27.1	40.4	38.3	53.9	40.2
Duration of complaints in years, mean (SD) (n = 186)	8.0 (8.5)	9.4 (7.8)	7.6 (8.2)	8.1 (9.8)	8.3 (8.6)
<3 years	25.0	20.8	31.8	26.0	25.8
3-<6 years	40.9	25.0	29.6	32.0	31.7
≥6 years	34.1	54.2	38.6	42.0	42.5
Duration from decision to operate to surgery in years, mean (SD) (n = 193)	2.6 (8.6)	1.7 (3.0)	1.9 (5.0)	1.4 (1.7)	1.9 (5.2)
<1 year	43.5	47.9	36.2	46.2	43.5
≥1-<2 years	39.1	31.3	46.8	25.0	35.2
≥2 years	17.4	20.8	17.0	28.9	21.2
Fear of surgery (n = 186)					
no or little	70.2	68.2	57.8	48.0	60.8
big	29.8	31.8	42.2	52.0	39.3

*=normalized (0–100 scale); SD = standard deviation; IMET = limitation of social participation; BMI = body mass index in kg/m^2; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; WHO5 = WHO-Five Well-being index.

patients in Q2 but more often had a high level of education and less fear of surgery compared to those individuals in Q3 or Q4. There were none or just small differences between the quartiles regarding age.

3.2. Expectations from surgery

Overall, 84 % of the study population had high expectations for pain relief. However, the proportion of patients with high expectations concerning ADLs and physical activities was smaller at 65 % and 51 %, respectively (Figure 1 and Supplementary material 2).

Stratified by WOMAC total score quartiles, expectations from surgery were highest in patients categorized in Q1 in all three expectations categories. In this group, for instance, 92 % reported high expectations regarding pain relief before surgery versus only 77 % and 81 % of the patients in Q3 and Q4, respectively.

3.3. Factors associated with having a lower disease burden prior to TKA

Univariable and multivariable (backwards) logistic regression on factors associated with being categorized into WOMAC total score Q1 is shown in Table 2. Univariable logistic regression models showed that sex, social participation restrictions, depressive symptoms, BMI, PT utilization, and duration of complaints with the impaired knee were associated with having a lower disease burden. In contrast, age and level of education were not. Backwards multivariable logistic regression revealed that male sex (OR: 4.38; 95 % CI: 1.44–13.36), fewer restrictions on social participation, absence of depressive symptoms, a lower BMI, having not used PT within the year before surgery (OR: 4.08; 95 % CI: 1.23–13.54) and a shorter duration of complaints with the impaired knee were factors associated with having a lower disease burden. Here, we additionally entered age and education level in the final model (although the significance levels were ≥ 0.05) since they are meaningful parameters. However, both factors were not associated with having a lower disease burden while controlling for the other variables.

4. Discussion

Overall, in patients undergoing TKA in Germany, we found a considerable variation in disease burden and that expectations from surgery were highest in those reporting a lower disease burden. Moreover, male sex, less social participation restrictions, absence of depressive symptoms, a lower BMI, having not used PT within the year before surgery, and a shorter duration of complaints with the impaired knee were associated with a lower disease burden.

4.1. Expectations from surgery and duration of complaints

Patients' expectations from surgery in this study were reasonably high, especially regarding pain. The vast majority (84 %) of patients expected considerable pain relief confirming different authors' findings [44,45], where 85 % and 75 % of patients

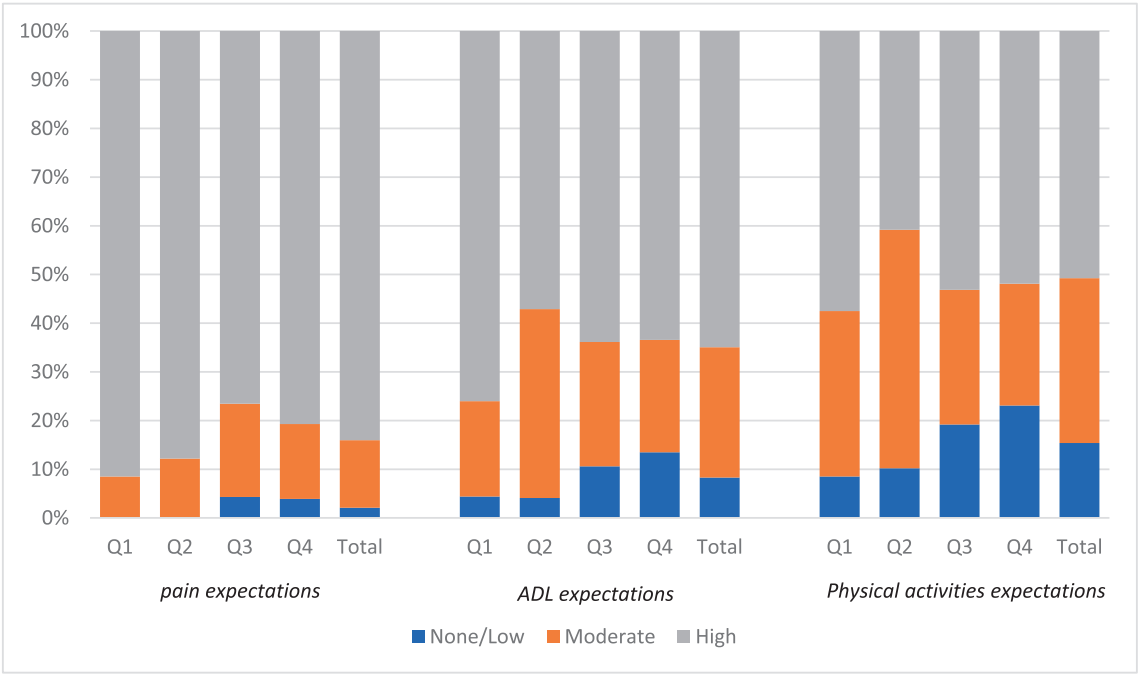

Figure 1. Expectations from surgery for pain relief, activities of daily life (ADL), and physical activities from total knee arthroplasty depending on WOMAC total score quartiles.

Table 2
Factors associated with being in Q1 of total WOMAC-score; results from univariable and backwards multivariable logistic regression analyses (with backwards selection).

Characteristics	reference	OR (95 % CI) Univariable analysis	Multivariable analysis
Sex, male	female	3.43 (1.61–7.30)	4.38 (1.44–13.36)
Age	per 1 year	1.03 (0.99–1.07)	1.00 (0.94–1.06)
Level of education			
Middle	low	0.82 (0.35–1.92)	1.51 (0.42–5.39)
high	low	1.16 (0.46–2.93)	1.81 (0.46–7.18)
Social participation restrictions (IMET total score)	per 1 unit	0.92 (0.89–0.95)	0.93 (0.90–0.97)
BMI	per 1 unit	0.89 (0.83–0.96)	0.88 (0.78–0.99)
Depressive symptoms (WHO-5)			
No	moderate to severe	15.65 (4.42–55.38)	11.02 (2.32–52.31)
mild	moderate to severe	3.80 (0.92–15.66)	1.89 (0.35–10.05)
No use of physiotherapy prior to surgery	yes	2.24 (1.00–5.00)	4.08 (1.23–13.54)
Duration of complaints in years			
<3 years	≥6 years	1.90 (0.74–4.89)	11.17 (2.19–56.99)
3-<6 years	≥6 years	2.13 (0.89–5.07)	7.16 (1.79–28.61)

IMET = limitation of social participation; BMI = body mass index in kg/m^2; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; WHO5 = WHO-Five Well-being index; forced-in variables: age and level of education.

expected being pain-free following TKA, respectively. Previous research also reported that expectations do not appear to be influenced by preoperative knee pain or patient-reported function scores [12,14,45–47]. However, although our results were not statistically significant, we observed the highest expectations in patients with a comparable low disease burden measured by total WOMAC score. Furthermore, we found an association between being in total WOMAC score Q1 and having a shorter duration of complaints with the impaired knee. Generally, unrealistic pain or walking outcome expectations are powerful predictors of willingness to undergo TKA [48,49], and in addition, patients often overestimate the potential improvement after TKA [44,45]. It seems possible that this overestimation is especially true for those with comparable low disease burden and short duration of complaints because those patients have lower postoperative satisfaction scores [50,51]. As an explanation, Dunbar et al. suggest that patients with a comparatively short duration of complaints base their TKA expectations on their relatively high pre-disease function [50]. These findings highlight the importance of preoperative expectations management. On the one hand, patients with unrealistic high expectations might discuss their individual goals, the extent of improvement, and timelines that can realistically be achieved with their surgeon. Consequently, they might be more satisfied with the surgery. On the other hand, patients could rethink their willingness to undergo surgery but instead first max out recommended conservative OA treatment.

4.2. Variations of patients undergoing TKA

We observed sparse conservative OA management before surgery, especially in those with a low disease burden. For example, while 75 %-88 % of patients categorized in Q2-Q4 were currently using analgesics, only 47 % of those classified in Q1 did so. The same was seen for PT, which corresponds to findings that PT utilization is associated with a higher disease burden in patients with knee OA [28,52]. However, this also means that nearly-three fourth in the Q1 subgroup (and still 46 % for those in Q4) underwent TKA without receiving PT in the last year, which seems to clearly violate relevant guidelines recommending at least six months of conservative management, including PT, for patients with symptomatic knee OA before surgery [53].

There were also large sex differences regarding disease burden in patients prior to TKA. 71 % of patients categorized with the highest disease burden were women (compared to 37.5 % in Q1). That finding is in line with studies observing that women generally report more significant pain and worse function of the impaired knee prior to TKA than men [16,20]. It seems possible that women often delay opting for TKA because they are more fearful of the surgery and, thus, prefer to suffer OA pain rather than have surgery [54,55], leading to potential unmet needs among women [56]. On the contrary, evidence suggests that men are more likely to be referred to an orthopedic surgeon by their general practitioner and, if referred, are more likely than women to be offered surgery [57,58]. In addition, men seem more receptive to receiving invasive treatment and choose surgery earlier in the disease [5,55]. Furthermore, men also less often prefer holistic approaches [58] and/or conservative treatment such as PT or analgesics [52,59–62].

Depression is a common comorbidity in pain [34] and OA patients [63,64]. We found an association between a higher total WOMAC score and depressive symptoms confirming previous studies [65]. These findings indicate that depression may be associated with increased knee pain intensity and is further associated with functional limitation in patients with knee OA, emphasizing the need for recognition and appropriate treatment [63].

4.3. Variation of disease burden

Our findings show a considerable variation of disease burden in patients prior to TKA. When compared to earlier data from Germany [27], our results are similar regarding the median total WOMAC score and its IQR, suggesting that national

variations remained unchanged in the last 25 years. However, compared to international research, the results are inconsistent. Alongside similar disease burden levels in Belgium [66], Greece [20], and France [67], the current study's findings suggest a lower burden of disease in German patients versus patients in the United Kingdom [17,68–70], Finland [71], Sweden [17], Spain [8] and Canada [72]. Nevertheless, we observed higher total pain, stiffness, or dysfunction scores compared to findings from the United States [73], the Netherlands [74], Australia [15], and the United Kingdom [16]. Several reasons for these differences have been postulated, including variations in waiting times for surgery [75], rationing of surgery due to limited resources, cultural differences, and disparities in access to surgery according to SES, sex, or ethnicity [56,76,77].

4.4. Strengths and limitations

A major strength of the present study was the great variation of disease burden in patients prior to TKA and, consequently, the possibility to characterize individuals with low and high disease burden, respectively. Furthermore, our high response of 85 % and only eight individuals excluded from analyses due to insufficient WOMAC data reduced the risk of selection bias.

Some limitations must be considered. First, due to the COVID-19 pandemic, recruitment had to be paused between 17 March and 13 May 2020 (recruitment stop 1) and between 18 December 2020 and 31 January 2021 (recruitment stop 2) because all elective surgeries were postponed. Therefore, we had to extend our scheduled recruitment period, which was initially planned for 12 months. Second and even more importantly, the COVID-19 pandemic and its related measures might have influenced the disease burden prior to TKA. Therefore, we performed sensitivity analyses by stratifying by time periods and observed that the disease burden was slightly lower before recruitment stop 1 (mean total WOMAC score 47.6) compared to patients following lockdown 1 (mean total WOMAC score 51.8) and lockdown 2 (mean total WOMAC score 50.7), which might be due to postponed surgeries resulting in expanded waiting times. However, differences were marginal and remained at the same level when stratifying by WOMAC quartiles, suggesting that the differences were not clinically meaningful. Third, our study was limited to only one university hospital, thus limiting the generalizability. Nevertheless, the hospital's catchment area is large (only 31 % of study participants resided in the city of the hospital) and covers urban as well as rural regions.

5. Conclusions

To conclude, there is considerable heterogeneity - in Germany and internationally - regarding disease burden amongst patients undergoing TKA. In addition to patients with high levels of disease burden, a considerable number of patients whose functional capacity is still maintained received a TKA. In the current study, those are primarily normal-weight males without depressive symptoms and fewer restrictions in social participation, who did not use PT within the year before TKA, and have a high expectation for surgery. Future research is clearly needed and should provide more information on this subgroup especially on their expectation management and why guideline-recommended conservative OA management options are not fully exhausted before TKA. Furthermore, an international consensus regarding specific thresholds for TKA indication should be established.

Ethics approval

The medical ethics committee of the University of Oldenburg approved this study (#2019–064). All participants gave written informed consent prior to enrolment.

Funding

This work was supported by intramural funding from the School of Medicine and Health Sciences of the Carl von Ossietzky University Oldenburg (FP 2018–026).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors would like to thank the participating patients who took the time to complete the survey.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.knee.2023.01.020.

References

[1] Glyn-Jones S, Palmer A, Agricola R, Price A, Vincent T, Weinans H, et al. Osteoarthritis. Lancet (London, England) 2015;386:376–87. doi: https://doi.org/10.1016/S0140-6736(14)60802-3.

[2] Storheim K, Zwart J-A. Musculoskeletal disorders and the Global Burden of Disease study. Ann Rheum Dis 2014;73:949–50. doi: https://doi.org/10.1136/annrheumdis-2014-205327.

[3] Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: Estimates from the Global Burden of Disease 2010 study. Ann Rheum Dis 2014.

[4] Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthr Cartil 2019.

[5] Fernandes L, Hagen KB, Bijlsma JWJ, Andreassen O, Christensen P, Conaghan PG, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Ann Rheum Dis 2013;72:1125–35. doi: https://doi.org/10.1136/annrheumdis-2012-202745.

[6] Bedard NA, Dowdle SB, Anthony CA, DeMik DE, McHugh MA, Bozic KJ, et al. The AAHKS Clinical Research Award: What Are the Costs of Knee Osteoarthritis in the Year Prior to Total Knee Arthroplasty? J Arthroplasty. 2017;32:S8-S10.e1. doi:10.1016/j.arth.2017.01.011.

[7] OECD. Health at a Glance 2019: OECD Indicators, OECD Publishing 2019. https://www.oecd-ilibrary.org/docserver/ae3016b9-en.pdf?expires=1649316248&id=id&accname=guest&checksum=F5CF4FBA3E6FC575C33A56030FDC2936. Accessed 7 Apr 2022.

[8] Cobos R, Latorre A, Aizpuru F, Guenaga JI, Sarasqueta C, Escobar A, et al. Variability of indication criteria in knee and hip replacement: an observational study. BMC Musculoskelet Disord 2010:11. doi: https://doi.org/10.1186/1471-2474-11-249.

[9] Hadorn DC, Holmes AC. The New Zealand priority criteria project. Part 1: Overview. BMJ 1997;314(7074):131–4. doi: https://doi.org/10.1136/BMJ.314.7074.131.

[10] Lützner J, Schmitt J, Lange T, Kopkow C, Rataj E, Günther K. Knietotalendoprothese: Wann ist der Ersatz angebracht? Dtsch Arztebl. 2016;113:A 1983-5.

[11] Lingard EA, Sledge CB, Learmonth ID. Patient expectations regarding total knee arthroplasty: differences among the United States, United Kingdom, and Australia. J Bone Joint Surg Am 2006;88:1201–7. doi: https://doi.org/10.2106/JBJS.E.00147.

[12] Hepinstall MS, Rutledge JR, Bornstein LJ, Mazumdar M, Westrich GH. Factors That Impact Expectations Before Total Knee Arthroplasty. J Arthroplasty 2011;26:870–6.

[13] Tilbury C, Haanstra TM, Leichtenberg CS, Verdegaal SHM, Ostelo RW, de Vet HCW, et al. Unfulfilled Expectations After Total Hip and Knee Arthroplasty Surgery: There Is a Need for Better Preoperative Patient Information and Education. J Arthroplasty 2016;31:2139–45.

[14] Jain D, Nguyen LCL, Bendich I, Nguyen LL, Lewis CG, Huddleston JI, et al. Higher Patient Expectations Predict Higher Patient-Reported Outcomes, But Not Satisfaction, in Total Knee Arthroplasty Patients: A Prospective Multicenter Study. J Arthroplasty 2017;32:S166–70. doi: https://doi.org/10.1016/J.ARTH.2017.01.008.

[15] Dowsey MM, Robertsson O, Sundberg M, Lohmander LS, Choong PFM, W-Dahl A. Variations in pain and function before and after total knee arthroplasty: a comparison between Swedish and Australian cohorts. Osteoarthr Cartil 2017;25:885–91. doi: https://doi.org/10.1016/J.JOCA.2016.12.018.

[16] Lingard EA, Katz JN, Wright EA, Sledge CB. Predicting the outcome of total knee arthroplasty. J Bone Jt Surg - Ser A 2004;86:2179–86.

[17] Ackerman IN, Dieppe PA, March LM, Roos EM, Nilsdotter AK, Brown GC, et al. Variation in age and physical status prior to total knee and hip replacement surgery: a comparison of centers in Australia and Europe. Arthritis Rheum 2009;61:166–73. doi: https://doi.org/10.1002/ART.24215.

[18] Franklin PD, Miozzari H, Christofilopoulos P, Hoffmeyer P, Ayers DC, Lübbeke A. Important patient characteristics differ prior to total knee arthroplasty and total hip arthroplasty between Switzerland and the United States. BMC Musculoskelet Disord 2017;18:14.

[19] Dalury DF, Mason JB, Murphy JA, Adams MJ. Analysis of the outcome in male and female patients using a unisex total knee replacement system. J Bone Jt Surg - Ser B 2009;91:357–60.

[20] Papakostidou I, Dailiana ZH, Papapolychroniou T, Liaropoulos L, Zintzaras E, Karachalios TS, et al. Factors affecting the quality of life after total knee arthroplasties: a prospective study. BMC Musculoskelet Disord 2012:13. doi: https://doi.org/10.1186/1471-2474-13-116.

[21] Davis ET, Lingard EA, Schemitsch EH, Waddell JP. Effects of socioeconomic status on patients' outcome after total knee arthroplasty. Int J Qual Heal care J Int Soc Qual Heal Care 2008;20:40–6. doi: https://doi.org/10.1093/INTQHC/MZM059.

[22] Singh JA, Lewallen DG. Time trends in the characteristics of patients undergoing primary total knee arthroplasty. Arthritis Care Res (Hoboken) 2014;66:897–906. doi: https://doi.org/10.1002/ACR.22233.

[23] Ekhtiari S, Sefton AK, Wood TJ, Petruccelli DT, Winemaker MJ, de Beer JD. The Changing Characteristics of Arthroplasty Patients: A Retrospective Cohort Study. J Arthroplasty 2021;36:2418–23. doi: https://doi.org/10.1016/J.ARTH.2021.02.051.

[24] Oh C, Slover JD, Bosco JA, Iorio R, Gold HT. Time Trends in Characteristics of Patients Undergoing Primary Total Hip and Knee Arthroplasty in California, 2007–2010. J Arthroplasty 2018;33:2376–80. doi: https://doi.org/10.1016/J.ARTH.2018.02.079.

[25] Pabinger C, Lothaller H, Geissler A. Utilization rates of knee-arthroplasty in OECD countries. Osteoarthr Cartil 2015;23:1664–73. doi: https://doi.org/10.1016/J.JOCA.2015.05.008.

[26] Häufigste Operationen in Krankenhäusern. https://www.gbe-bund.de/gbe/!pkg_olap_tables.prc_set_dim_values. Accessed 12 Apr 2022.

[27] Stürmer T, Günther KP, Brenner H. Obesity, overweight and patterns of osteoarthritis: the Ulm Osteoarthritis Study. J Clin Epidemiol 2000;53:307–13. doi: https://doi.org/10.1016/S0895-4356(99)00162-6.

[28] Jacobs H, Hoffmann F, Lazovic D, Maus U, Seeber GH. Use of Physiotherapy Prior to Total Knee Arthroplasty-Results of the Prospective FInGK Study. Healthc (Basel, Switzerland). 2022;10:407. doi:10.3390/HEALTHCARE10020407.

[29] Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. 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 1988;15:1833–40.

[30] Singh J, Sloan JA, Johanson NA. Challenges with health-related quality of life assessment in arthroplasty patients: Problems and solutions. J Am Acad Orthop Surg 2010;18:72–82.

[31] Rabin R, De Charro F. EQ-5D: A measure of health status from the EuroQol Group. In: Annals of Medicine. Royal Society of Medicine Press Ltd; 2001. p. 337–43. doi: https://doi.org/10.3109/07853890109002087.

[32] Conner-Spady BL, Marshall DA, Bohm E, Dunbar MJ, Loucks L, Ammar •, et al. Reliability and validity of the EQ-5D-5L compared to the EQ-5D-3L in patients with osteoarthritis referred for hip and knee replacement. Qual Life Res. doi:10.1007/s11136-014-0910-6.

[33] Topp CW, Østergaard SD, Søndergaard S, Bech P. The WHO-5 Well-Being Index: A Systematic Review of the Literature. Psychother Psychosom 2015;84:167–76. doi: https://doi.org/10.1159/000376585.

[34] Redeker I, Hoffmann F, Callhoff J, Haibel H, Sieper J, Zink A, et al. Determinants of psychological well-being in axial spondyloarthritis: An analysis based on linked claims and patient-reported survey data. Ann Rheum Dis 2018.

[35] Boonstra AM, Preuper HRS, Balk GA, Stewart RE. Cut-off points for mild, moderate, and severe pain on the visual analogue scale for pain in patients with chronic musculoskeletal pain. Pain 2014.

[36] Deck R, Mittag O, Hüppe A, Muche-Borowski CRH. IMET–Index zurMessung von Einschränkungen der Teilhabe [IMET–index for the measurement of restrictions on participation]. Diagnostische Verfahren der Rehabil 2008:372–4.

[37] Deutsches Institut für Medizinische Dokumentation und Information (DIMDI). International Classification of Functioning, Disability and Health (ICF). Internationale Klassifikation der Funktionsfähigkeit, Behinderung und Gesundheit–ICF [international classification of functioning, disability andhealth–ICF]. 2005. https://www.who.int/classifications/international-classification-of-functioning-disability-and-health. Accessed 10 Mar 2022.

[38] Deck R. Veränderungen von Teilhabestörungen nach Reha [Changes inparticipation disorders after rehab]. Prax Klin Verhal Rehabil 2008,:229–36.

[39] Kayaalp ME, Keller T, Fitz W, Scuderi GR, Becker R. Translation and Validation of the German New Knee Society Scoring System. Clin Orthop Relat Res 2019;477:383. doi: https://doi.org/10.1097/CORR.0000000000000555.
[40] UNESCO. International standard classification of education ISCED 1997. Paris; 1997. www.uis.unesco.org. Accessed 6 Jul 2021.
[41] UNESCO. International Standard Classification of Education ISCED 2011. Paris; 2011. http://www.uis.unesco.org. Accessed 6 Jul 2021.
[42] Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care. 1998;36:8–27. http://www.ncbi.nlm.nih.gov/pubmed/9431328. Accessed 18 Jun 2019.
[43] Escobar A, Riddle DL. Concordance between important change and acceptable symptom state following knee arthroplasty: the role of baseline scores. Osteoarthr Cartil 2014;22:1107–10.
[44] Mannion AF, Kämpfen S, Munzinger U, Kramers-de QI. The role of patient expectations in predicting outcome after total knee arthroplasty. Arthritis Res Ther 2009:11. doi: https://doi.org/10.1186/AR2811.
[45] Brigham Multipurpose RB, Mahomed NN, Liang MH, Cook EF, Daltroy LH, Fortin PR, et al. The Importance of Patient Expectations in Predicting Functional Outcomes After Total Joint Arthroplasty. 2002. www.jrheum.org. Accessed 13 Apr 2022.
[46] J. Smith E, Soon VL, Boyd A, McAllister J, Deakin AH, Sarungi M. What Do Scottish Patients Expect of Their Total Knee Arthroplasty? J Arthroplasty. 2016;31:786–92. doi:10.1016/J.ARTH.2015.10.021.
[47] Riddle DL, Golladay GJ, Hayes A, Ghomrawi HMK. Poor expectations of knee replacement benefit are associated with modifiable psychological factors and influence the decision to have surgery: A cross-sectional and longitudinal study of a community-based sample. Knee 2017;24:354–61. doi: https://doi.org/10.1016/J.KNEE.2016.11.009.
[48] Allen KD, Golightly YM, Callahan LF, Helmick CG, Ibrahim SA, Kwoh CK, et al. Race and sex differences in willingness to undergo total joint replacement: the Johnston County Osteoarthritis Project. Arthritis Care Res (Hoboken) 2014;66:1193–202. doi: https://doi.org/10.1002/ACR.22295.
[49] Hawker GA, Guan J, Croxford R, Coyte PC, Glazier RH, Harvey BJ, et al. A prospective population-based study of the predictors of undergoing total joint arthroplasty. Arthritis Rheum 2006;54:3212–20.
[50] Dunbar MJ, Richardson G, Robertsson O, Dunbar M J, Richardson G, Robertsson O. Management factorials in total knee replacement I can't get no satisfaction after my total knee replacement RHYMES AND REASONS. Bone Jt J. 2013;95:148–52.
[51] Robertsson O, Dunbar M, Pehrsson T, Knutson K, Lidgren L. Patient satisfaction after knee arthroplasty: a report on 27,372 knees operated on between 1981 and 1995 in Sweden. Acta Orthop Scand 2000;71:262–7. doi: https://doi.org/10.1080/000164700317411852.
[52] Iversen MD, Schwartz TA, von Heideken J, Callahan LF, Golightly YM, Goode A, et al. Sociodemographic and Clinical Correlates of Physical Therapy Utilization in Adults With Symptomatic Knee Osteoarthritis. Phys Ther 2018;98:670–8. doi: https://doi.org/10.1093/ptj/pzy052.
[53] Zhang W, Nuki G, Moskowitz RW, Abramson S, Altman RD, Arden NK, et al. OARSI recommendations for the management of hip and knee osteoarthritis. Osteoarthr Cartil 2010;18:476–99. doi: https://doi.org/10.1016/j.joca.2010.01.013.
[54] Karlson EW, Daltroy LH, Liang MH, Eaton HE, Katz JN. Gender differences in patient preferences may underlie differential utilization of elective surgery. Am J Med 1997;102:524–30.
[55] Vina ER, Cloonan YK, Ibrahim SA, Hannon MJ, Boudreau RM, Kwoh CK. Race, sex, and total knee replacement consideration: Role of social support. Arthritis Care Res 2013;65:1103–11. doi: https://doi.org/10.1002/ACR.21925/ABSTRACT.
[56] Hawker GA, Wright JG, Coyte PC, Williams JI, Harvey B, Glazier R, et al. Differences between Men and Women in the Rate of Use of Hip and Knee Arthroplasty. N Engl J Med 2000;342:1016–22. doi: https://doi.org/10.1056/NEJM200004063421405.
[57] Borkhoff CM, Hawker GA, Kreder HJ, Glazier RH, Mahomed NN, Wright JG. The effect of patients' sex on physicians' recommendations for total knee arthroplasty. CMAJ 2008;178:681–7. doi: https://doi.org/10.1503/CMAJ.071168.
[58] Borkhoff CM, Hawker GA, Kreder HJ, Glazier RH, Mahomed NN, Wright JG. Patients' gender affected physicians' clinical decisions when presented with standardized patients but not for matching paper patients. J Clin Epidemiol 2009;62:527–41.
[59] McMurray RJ, Clarke OW BJ et al. Gender disparities in clinical decision making. Council on Ethical and Judicial Affairs, American Medical Association. JAMA. 266:559–62. http://www.ncbi.nlm.nih.gov/pubmed/1843800. Accessed 15 Oct 2019.
[60] Yeh H-J, Chou Y-J, Yang N-P, Huang N. Receipt of Physical Therapy Among Osteoarthritis Patients and Its Influencing Factors. Arch Phys Med Rehabil 2015;96:1021–7. doi: https://doi.org/10.1016/j.apmr.2015.02.006.
[61] Bawa HS, Weick JW, Dirschl DR. Gender Disparities in Osteoarthritis-Related Health Care Utilization Before Total Knee Arthroplasty. J Arthroplasty 2016;31:2115–2118.e1. doi: https://doi.org/10.1016/j.arth.2016.03.044.
[62] Lange T, Luque Ramos A, Albrecht K, Günther KP, Jacobs H, Schmitt J, et al. Prescription frequency of physical therapy and analgesics before total hip and knee arthroplasty: An epidemiological analysis of routine health care data from Germany. Orthopade 2018;47:1015–23.
[63] Rosemann T, Backenstrass M, Joest K, Rosemann A, Szecsenyi J, Laux G. Predictors of depression in a sample of 1,021 primary care patients with osteoarthritis. Arthritis Care Res 2007;57:415–22.
[64] Agustini B, Lotfaliany M, Woods RL, McNeil JJ, Nelson MR, Shah RC, et al. Patterns of Association between Depressive Symptoms and Chronic Medical Morbidities in Older Adults. J Am Geriatr Soc 2020;68:1834–41. doi: https://doi.org/10.1111/JGS.16468.
[65] Zheng S, Tu L, Cicuttini F, Zhu Z, Han W, Antony B, et al. Depression in patients with knee osteoarthritis: risk factors and associations with joint symptoms. BMC Musculoskelet Disord 2021;22.
[66] Neuprez A, Neuprez AH, Kurth W, Gillet P, Bruyère O, Reginster JY. Profile of osteoarthritic patients undergoing hip or knee arthroplasty, a step toward a definition of the "need for surgery". Aging Clin Exp Res 2018;30:315–21. doi: https://doi.org/10.1007/S40520-017-0780-1.
[67] Nguyen C, Boutron I, Roren A, Anract P, Beaudreuil J, Biau D, et al. Effect of Prehabilitation Before Total Knee Replacement for Knee Osteoarthritis on Functional Outcomes A Randomized Clinical Trial + Visual Abstract + Supplemental content. JAMA Netw Open 2022;5:. doi: https://doi.org/10.1001/jamanetworkopen.2022.1462221462.
[68] Ackerman IN, Bennell KL, Osborne RH. Decline in Health-Related Quality of Life reported by more than half of those waiting for joint replacement surgery: a prospective cohort study. BMC Musculoskelet Disord 2011;12. doi: https://doi.org/10.1186/1471-2474-12-108.
[69] Clement ND, Weir DJ, Holland J, Deehan DJ. Is there a Threshold Preoperative WOMAC Score That Predicts Patient Satisfaction after Total Knee Arthroplasty? J Knee Surg 2021;34:846–52. doi: https://doi.org/10.1055/S-0039-3401826.
[70] Walker LC, Clement ND, Bardgett M, Weir D, Holland J, Gerrand C, et al. The WOMAC score can be reliably used to classify patient satisfaction after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2018;26:3333–41. doi: https://doi.org/10.1007/S00167-018-4879-5.
[71] Kauppila AM, Kyllönen E, Ohtonen P, Leppilahti J, Sintonen H, Arokoski JP. Outcomes of primary total knee arthroplasty: the impact of patient-relevant factors on self-reported function and quality of life. Disabil Rehabil 2011;33:1659–67. doi: https://doi.org/10.3109/09638288.2010.543749.
[72] Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KDJ. Patient satisfaction after total knee arthroplasty: Who is satisfied and who is not? In: Clinical Orthopaedics and Related Research. New York: Springer; 2010. p. 57–63.
[73] Riddle DL, Perera RA, Jiranek WA, Dumenci L. Using surgical appropriateness criteria to examine outcomes of total knee arthroplasty in a United States sample. Arthritis Care Res (Hoboken) 2015;67:349–57. doi: https://doi.org/10.1002/ACR.22428.
[74] Gademan MGJ, Putter H, Van Den Hout WB, Kloppenburg M, Hofstede SN, Cannegieter SC, et al. The course of pain and function in osteoarthritis and timing of arthroplasty: the CHECK cohort. Acta Orthop 2018;89:528–34. doi: https://doi.org/10.1080/17453674.2018.1502533.
[75] Desmeules F, Dionne CE, Belzile E, Bourbonnais R, Frémont P. The burden of wait for knee replacement surgery: effects on pain, function and health-related quality of life at the time of surgery. Rheumatology (Oxford) 2010;49:945–54. doi: https://doi.org/10.1093/RHEUMATOLOGY/KEP469.
[76] Yong PFK, Milner PC, Payne JN, Lewis PA, Jennison C. Inequalities in access to knee joint replacements for people in need. Ann Rheum Dis 2004;63:1483–9.
[77] Skinner J, Weinstein JN, Sporer SM, Wennberg JE. Racial, Ethnic, and Geographic Disparities in Rates of Knee Arthroplasty among Medicare Patients. N Engl J Med 2003;349:1350–9.