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**IMPACT OF AGE, BODY MASS INDEX AND PREOPERATIVE SEVERITY OF OSTEOARTHRITIS ON EARLY – TERM TOTAL KNEE ARTHROPLASTY RESULTS. DEMOGRAPHICS AND KNEE ARTHROPLASTY RESULTS**

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**SUMMARY**

**Introduction**

Total Knee Arthroplasty (TKA) is an efficient method of end-stage knee osteoarthritis (OA) treatment. It leads to pain relieve and Quality of Life improvement. Each year, the number of TKA procedures grows and the profile of patients, who are qualified is extended. It is estimated, that one in five patients may be dissatisfied due to results of the surgery.

**Aim**

Aim of the study was an identification of demographic risk factors correlating with lower surgery outcomes.

**WPLYW WIEKU PACJENTÓW, BMI ORAZ PRZEDOPERACYJNEGO ZAAWANSOWANIA ZMIAN ZWYRODNIENIOWYCH NA WCZESNE WYNIKI CAŁKOWITEJ ALOPLASTYKI STAWU KOLANOWEGO. CZYNNIKI DEMOGRAFICZNE, A WYNIKI ALOPLASTYKI STAWU KOLANOWEGO**

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**STRESZCZENIE**

**Wstęp**

Aloplastyka stawu kolanowego (TKA) jest skuteczną metodą leczenia zaawansowanej choroby zwyrodnieniowej (OA) kolana. Prowadzi do usunięcia dolegliwości bólowych oraz poprawy jakości życia. Co roku wzrasta liczba tych procedur, a profil kwalifikowanych pacjentów jest szerszy. Szacuje się, że co 5 pacjent może być niezadowolony z wyniku operacji.

**Cel**

Celem pracy była identyfikacja demograficznych czynników ryzyka, mogących wpłynąć na osiągnięcie suboptymalnych efektów operacji.

### Material and methods

Fifty-one patients with end knee OA were enrolled in the study. Each one before surgery completed the following scales: Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC), Knee injury and Osteoarthritis Outcome Score (KOOS), Visual Analogue Scale (VAS) and 36-Item Short Form Survey (SF-36). After 12 months, 33 patients completed the same scales again and the results were correlated with demographic factors such as age, body mass index (BMI) and OA advancement based on Kellgren-Lawrence skill (KL).

### Results

In each scale, the results after surgery were significantly better. According to age, only results of KOOS – pain subscale was statistically significant. None of the scales showed BMI significance on TKA results. In all administered scales, we revealed correlations in OA advancement and TKA results.

### Conclusions

In general, age and BMI did not affect TKA outcomes. According to that, if no other contraindications exist, these factors should not be limiting in TKA qualification process. Important prediction factor was OA advancement assessed based on KL scale.

**Keywords:** Total Knee Arthroplasty (TKA), Body Mass Index (BMI), Age, Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC), 36-Item Short Form Survey (SF-36)

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### Materiał i metody

Do pracy włączono 51 pacjentów operowanych z powodu OA stawu kolanowego, u których przed operacją wykonano kwestionariusze: Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC), Knee injury and Osteoarthritis Outcome Score (KOOS), Visual Analogue Scale (VAS) oraz 36-Item Short Form Survey (SF-36). Po 12 miesiącach u 33 chorych oceniono wyniki operacji na podstawie tych samych kwestionariuszy oraz skorelowano je z danymi demograficznymi, takimi jak: wiek, wskaźnik masy ciała (BMI) oraz stopień zaawansowania OA oceniany na podstawie skali Kellgrena-Lawrence'a (KL).

### Wyniki

W każdej z wykonanych skal obserwowano poprawę wyników po operacji. W przypadku wieku jedyna istotnie statystycznie korelacja dotyczyła podskali KOOS oceniającej ból. W żadnym przypadku nie obserwowano istotnej statystycznie korelacji pomiędzy wynikami pacjentów, a BMI. W każdej ze skal wykazano istotne statystycznie korelacje z przedoperacyjnym zaawansowaniem OA, a wynikami TKA.

### Wnioski

Wiek chorych i BMI nie wpływały na pogorszenie wyników TKA, w związku z tym, jeśli nie ma innych przeciwwskazań, czynniki te nie powinny być decydujące w aspekcie kwalifikacji do operacji. Istotnym czynnikiem predykcyjnym gorszych wyników okazał się być stopień zaawansowania OA na podstawie skali KL.

**Słowa kluczowe:** całkowita aloplastyka stawu kolanowego (TKA), wskaźnik masy ciała (BMI), wiek, skala WOMAC, skala SF-36

*Data otrzymania: 30 listopada 2017*

*Data zaakceptowania: 14 lutego 2018*

## Introduction

Due to increasing average lifespan and aging of the worldwide population, there is an increased incidence of conditions partially related to natural degeneration processes in the body. Osteoarthritis (OA) is one of them, affecting initially large joints of the lower extremity – knee and hip joint. Joint replacement is a highly effective treatment method of severe knee OA (Buly and Sculco, 1995). The primary goal of these procedures is to restore painless and optimal mobility in an affected joint from the patient's point of view (Blumenfeld, 2013). In view of the above considerations, Total Knee Arthroplasty (TKA) is a procedure with an increasing incidence with a further clear increasing tendency assessed based on observation over the past 10 years (Losina, Thornhill, Rome, Wright, & Katz, 2012) (Weinstein *et al.*, 2013). Patel *et al.* demonstrate that in the US until 2030 need for primary TKA procedures will increase to 673% versus 2005 (Patel *et al.*, 2015).

Surgical treatment provides long-term positive clinical results with patient satisfaction rates reaching 90–95% and approximately 90% implant survival over 15 years of follow-up (Bhan *et al.*, 2005). Other data indicates that as many as 20% will not be fully satisfied with the surgical outcomes (Mahomed *et al.*, 2011; Pivec *et al.*, 2015), and approximately 5% of patients will require revision procedure within 10 years after the surgery (Khan *et al.*, 2016). The most common patient-related factors affecting the outcome of the surgical treatment include co-morbidities, age and pain intensity and severity of the osteoarthritis (Pivec *et al.*, 2015). Thus, much emphasis has been put on the improvement of surgical methods and analysis of factors that can affect the outcome of a surgical procedure to achieve better clinical outcomes, patient rehabilitation and shorten the hospitalization period (den Hertog *et al.*, 2012).

## Aim

The aim of the research was to assess TKA outcomes during 12 months after the surgical procedures based on clinical scales completed by patients and to correlate them with selected demographic factors. The authors hypothesized that demographic factors such as: higher patient age during the surgical procedure, Body Mass Index (BMI) and higher OA severity before the surgical procedure, assessed based on Kellgren – Lawrence (KL) scale, will affect worse patient outcomes after the procedure, determined on the basis of scales.

## Material and methods

### *Description of the Study Population*

TKA was performed in 51 study subjects, 40 women (78.43%) and 11 men (21.57%). During the procedure, half of the study subjects aged from 66 to 77 years. The oldest study subject was 87 years old, the youngest one was 49 years old. An average age was  $71.41 \pm 7.87$  years. The highest recorded BMI among the study subjects was 40.00, while the lowest was 18.0. An average BMI was  $30.42 \pm 4.50$ . There were relatively few smoking study subjects ( $N = 4$ , 7.84%) versus non-smoking ones ( $N = 47$ , 92.16%). Regarding the severity of the knee osteoarthritis, the most severe stage IV disease was found more commonly ( $N = 39$ , 76.47%) in this patient group, stage III was less common ( $N = 10$ , 19.61%), while stage II was the least common ( $N = 2$ , 3.92%). No stage I or stage 0 disease was found. All patients agreed for participation in a study and signed informed consents.

### *Methods/Procedures Used*

All patients underwent surgical treatment for the knee osteoarthritis at the Department of Orthopedics and Traumatology of the Motor System, Medical University of Warsaw (WUM) in 2016. Before the surgical procedure, each patient was tested with the following scales: Western Ontario & McMaster Universities Osteoarthritis Index

(WOMAC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Visual Analogue Scale (VAS) and 36-Item Short Form Survey (SF-36). The outcome of the surgical procedure was assessed after one year with the same scales. 33 patients (64.70%) attended the follow-up visit to complete the scales again.

*Statistical methods*

Continuous variables were characterized using range, mean and standard deviation and medians along with minimum and maximum values for the distribution, while categorical variables were presented using frequency tables. Wilcoxon signed rank test was used to compare dependent variables. Pearson correlations were used to compare correlations between quantitative variables. The level of significance was set at 0.05. All calculations were made using a statistical package STATISTICA, version 13.1.

After the TKA procedure, the patients achieved a statistically significant improvement in the pain domain, supported by the Wilcoxon signed-rank test ( $p < 0.05$ ) (median 1.00 versus baseline 38.89). No statistically significant difference was achieved in the rigidity domain of the WOMAC scale (median 5.00 versus baseline 4.00). However, statistically significant difference ( $p < 0.05$ ) was achieved in the physical function domain (median 30.00 versus baseline 41.00). There was found a statistically significant correlation between OA severity and improvement of the score in this domain (Pearson  $r:0.36$ ,  $p < 0.5$ ). Furthermore, total WOMAC score was significantly ( $p < 0.05$ ) reduced (median 36.00 versus baseline 58.00), indicating the positive effect of the surgical procedure on the patient’s quality of life. WOMAC scores are presented in Table 1 and Figure 1. Figure 1 presents only statistically significant results.

**Table 1.** Comparison of scale scores in patients before and after TKA – WOMAC.

The Western Ontario and McMaster Universities Osteoarthritis Index								
	N	Mean	Median	Minimum	Maximum	Lower Q	Upper Q	SD
<b>Pain</b>								
BEFORE	51	41.07	38.89	8.33	80.56	27.78	55.56	16.81
AFTER	33	1.45	1.00	0.00	6.00	0.00	3.00	1.79
p = 0.000001								
<b>Stiffness</b>								
BEFORE	51	3.88	4.00	0.00	8.00	2.00	6.00	2.36
AFTER	33	5.30	5.00	0.00	17.00	2.00	7.00	4.61
p = 0.299311								
<b>Physical function</b>								
BEFORE	51	43.02	39.71	8.82	89.71	30.88	51.47	16.38
AFTER	33	74.51	80.88	22.06	100.00	58.82	91.18	21.13
p = 0.000136								
<b>Overall outcome</b>								
BEFORE	51	53.61	58.00	9.00	87.00	45.00	65.00	15.67
AFTER	33	35.97	36.00	0.00	70.00	26.00	44.00	18.84
p = 0.000012								

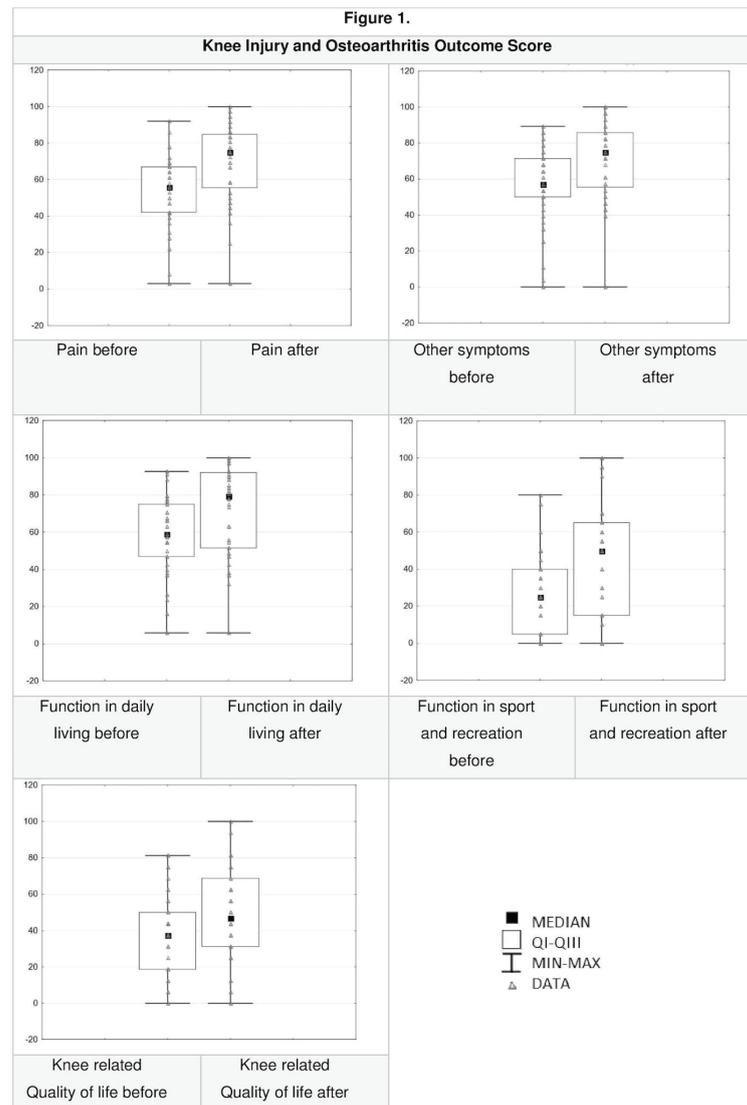
**Results**

*WOMAC Scale (McConnell, Kolopack, & Davis, 2001)*

WOMAC scale comprises 24 questions in 3 categories: pain (5 questions), rigidity (2 questions), physical function (17 questions). The Higher score indicates more burdensome complaints related to osteoarthritis.

*KOOS Scale (Roos & Lohmander, 2003)*

KOOS scale comprises 5 subscales: pain, other symptoms, daily functioning, functioning in sports and recreation, the effect of knee-related complaints on the quality of life. A normalized score (100 indicates lack of symptoms, 0 – most severe symptoms) is calculated for each subscale.



**Figure 1.** Comparison of scale scores in patients before and after TKA – WOMAC.

Subjects who underwent TKA achieved the highest scores in the KOOS scale related to pain sensation versus baseline results (median 83.33 versus baseline 38.89). After the surgical procedure, patients achieved statistically significantly higher score on the subscale of other symptoms (median 85.71 versus baseline 42.86). Patients achieved higher scores after the procedure also on the subscale of daily functioning (median 80.88 versus baseline 39.71). Functioning in sports and recreation was also improved (median 21.21 versus baseline 4.90). Effect of knee-related complaints on the quality of life was most significantly reduced out of KOOS subscales (median 62.69 versus baseline

18.75). The significance of differences in specific KOOS subscales was confirmed by Wilcoxon signed-rank test ( $p < 0.05$ ). KOOS scores are presented in Table 2 and Figure 2.

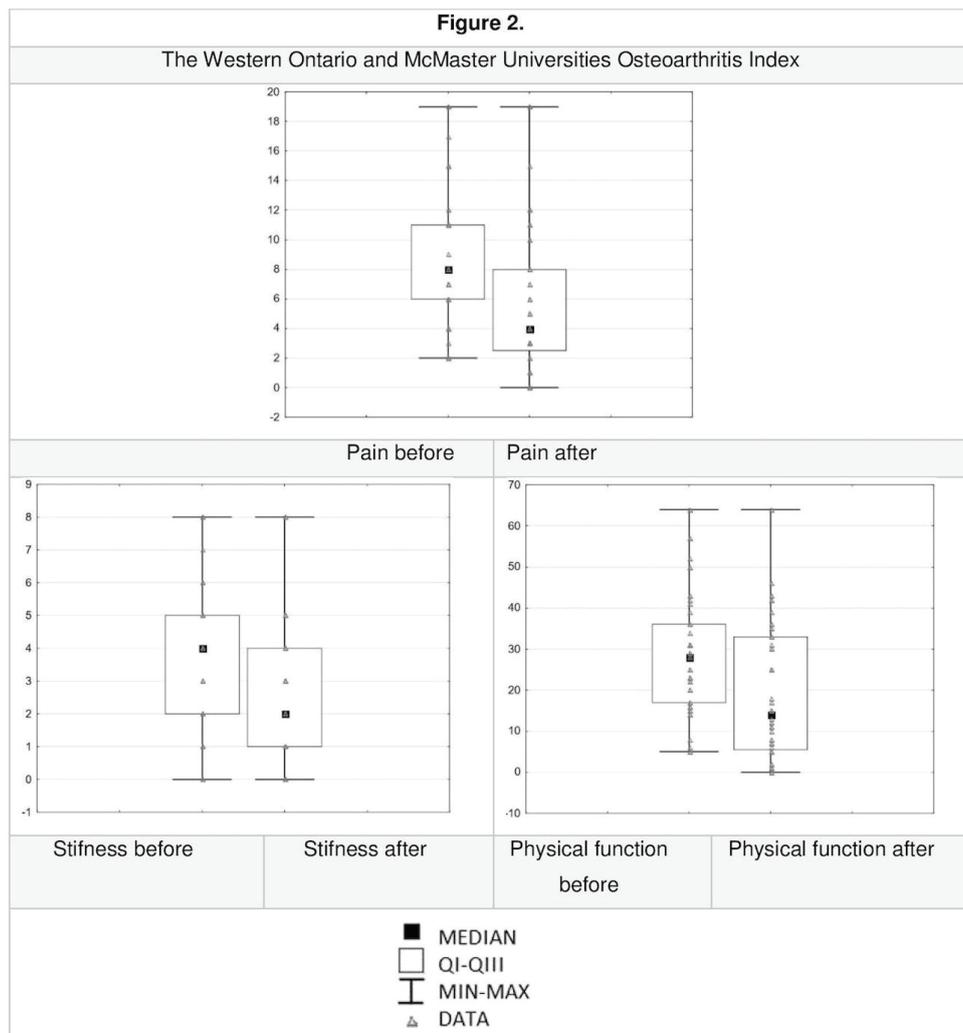
*Scale SF-36 (Ware & Sherbourne, 1992)*

The SF-36 scale comprises 36 questions in 8 subscales: physical functioning, role limitations due to physical problems, role limitations due to emotional problems, vitality, pain, emotional functioning, social functioning, general health perceptions. The lower the score, the more severe is the disability.

General SF-36 score was significantly higher (median 75.00 versus baseline 25.00). Similarly, statistically significant

**Table 2.** Comparison of scale scores in patients before and after TKA – KOOS.

<b>Table 2</b>								
<b>Knee Injury and Osteoarthritis Outcome Score</b>								
	<b>N</b>	<b>Mean</b>	<b>Median</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Lower Q</b>	<b>Upper Q</b>	<b>SD</b>
<b>Pain</b>								
BEFORE	51	41.07	38.89	8.33	80.56	27.78	55.56	16.81
AFTER	53	77.95	83.33	22.22	100.00	63.89	94.44	22.18
p = 0.000003								
<b>Other symptoms</b>								
BEFORE	51	47.97	42.86	17.86	100.00	32.14	64.29	21.34
AFTER	33	77.71	85.71	28.57	100.00	60.71	96.43	21.05
p = 0.000014								
<b>Function in daily living</b>								
BEFORE	51	43.02	39.71	8.82	89.71	30.88	51.47	16.38
AFTER	33	74.51	80.88	22.06	100.00	58.82	91.18	21.13
p = 0.000001								
<b>Function in sport and recreation</b>								
BEFORE	51	4.90	0.00	0.00	45.00	0.00	5.00	10.51
AFTER	33	21.21	0.00	0.00	100.00	0.00	25.00	30.18
p = 0.020634								
<b>Function in daily living</b>								
BEFORE	51	18.75	12.50	0.00	50.00	6.25	31.25	13.75
AFTER	33	62.69	62.50	6.25	100.00	43.75	87.50	28.58
p = 0.000002								



**Figure 2.** Comparison of scale scores in patients before and after TKA – KOOS.

improvement after the surgical procedure was also found for physical functioning (median 60.00 versus baseline 0.00), role limitations due to physical problems (median 75.00 versus baseline 0.00), role limitations due to emotional problems (median 100.00 versus baseline 50.00). Social functioning was also improved (median 12.50 versus baseline 100.00). Regarding emotional functioning, baseline score did not significantly differ from the one after the surgery. For vitality, pain, and general health perceptions subscales, there were no statistical differences between the scores after the procedure and the baseline scores. SF-36 scores are presented in Table 3 and Figure 3. Figure 3 presents only statistically significant results.

*VAS Scale (de Nies & Fidler, 1997)*

VAS scale is a measuring instrument for subjective pain sensation. After the TKA procedure, the pain was significantly reduced (median 30.00 versus baseline 65.00), which was confirmed by Wilcoxon signed-rank test ( $p < 0.05$ ). Results for VAS scale are presented in Table 4 and Figure 4.

*Correlations – AGE – SCALE*

A statistically significant correlation between age and a difference between baseline score and score after the procedure on KOOS subscale of pain was found. Older age is associated with lower difference, which may indicate small improvement as regards pain in this group of patients (Pearson  $r = -0.35$   $p < 0.05$ ). No statistically significant

**Table 3. Comparison of scale scores in patients before and after TKA – SF 36.**

Table 3.								
The 36-Item Short Form Health Survey								
	N	Mean	Median	Minimum	Maximum	Lower Q	Upper Q	SD
<b>Physical functioning</b>								
BEFORE	51	13.92	0.00	0.00	100.00	0.00	0.00	30.89
AFTER	33	54.55	60.00	0.00	100.00	40.00	75.00	28.90
p = 0.000001								
<b>Physical role functioning</b>								
BEFORE	51	43.13	0.00	0.00	100.00	0.00	100.00	47.75
AFTER	33	63.64	75.00	0.00	100.00	0.00	100.00	43.79
p = 0.041889								
<b>Emotional role functioning</b>								
BEFORE	51	48.63	50.00	20.00	90.00	35.00	60.00	16.28
AFTER	33	82.83	100.00	0.00	100.00	100.00	100.00	35.47
p = 0.000307								
<b>Vitality</b>								
BEFORE	51	57.59	60.00	5.00	96.00	48.00	68.00	16.21
AFTER	33	61.36	60.00	15.00	100.00	45.00	80.00	22.47
p = 0.502830								
<b>Mental health</b>								
BEFORE	51	51.37	50.00	0.00	100.00	25.00	87.50	28.87
AFTER	33	66.91	72.00	4.00	96.00	56.00	80.00	21.36
p = 0.050404								
<b>Social role functioning</b>								
BEFORE	51	17.55	12.50	0.00	87.50	0.00	25.00	19.48
AFTER	33	89.39	100.00	0.00	100.00	100.00	100.00	23.20
p = 0.000001								
<b>Pain</b>								
BEFORE	51	42.70	45.00	25.00	65.00	35.00	50.00	9.76
AFTER	33	47.35	45.00	0.00	100.00	32.50	70.00	29.99
p = 0.365462								
<b>General health perceptions</b>								
BEFORE	51	22.55	25.00	0.00	100.00	0.00	50.00	25.13
AFTER	33	35.23	33.33	12.50	62.50	25.00	41.67	13.18
p = 0.075214								

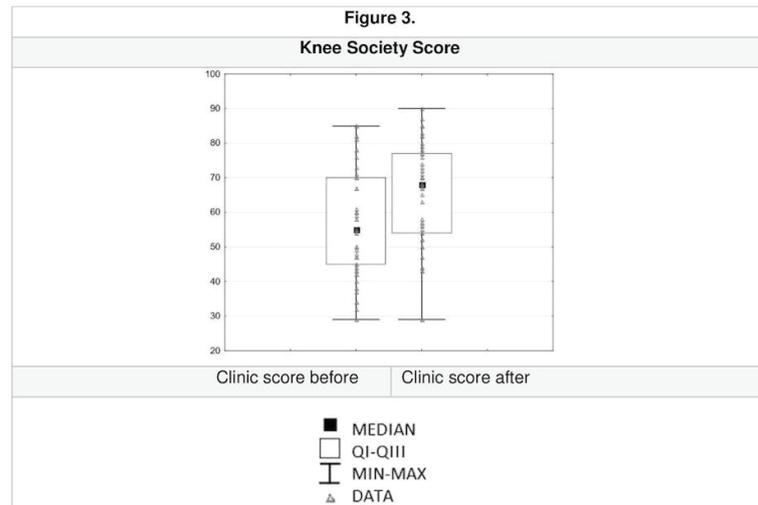


Figure 3. Comparison of scale scores in patients before and after TKA – SF 36.

Table 4. Comparison of scale scores in patients before and after TKA – VAS.

Visual Analogue Scale								
	N	Mean	Median	Minimum	Maximum	Lower Q	Upper Q	SD
BEFORE	51	61.9	65.00	1.00	100.00	51.00	78.00	23.78
AFTER	33	29.7	30.00	0.00	100.00	0.00	45.00	28.34

p = 0.000184

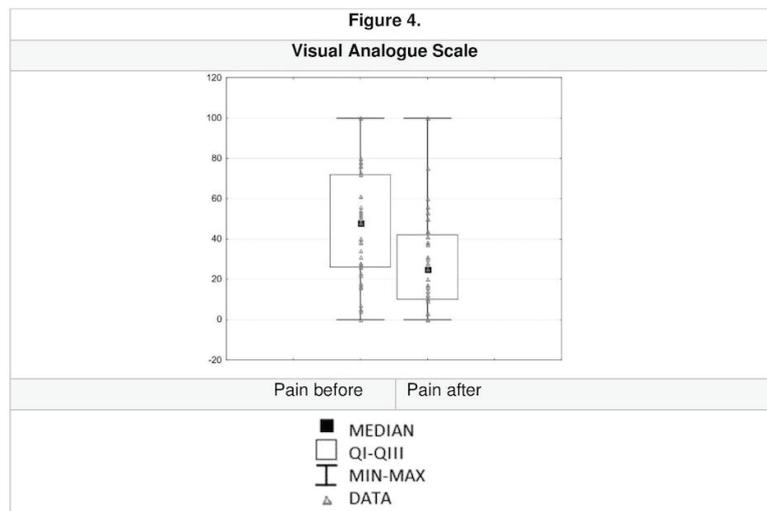


Figure 4. Comparison of scale scores in patients before and after TKA – VAS.

correlation between patient’s age and TKA outcomes was found in other cases.

*Correlations – BMI – SCALE*

No statistically significant correlation between patients’ scores and their BMI was found in any case.

*Correlations – OA Severity on KL Scale – Scales*  
In accordance with the WOMAC scale, subjects with more severe OA exhibit smaller improvement of function after the surgical treatment versus subjects with less severe OA.

Negative correlation on KOOS scale was found between OA severity and the difference in scores on the subscale of sports and recreation (Pearson  $r = -0.42$   $p < 0.05$ ),

indicating smaller improvement after the surgical procedure in subjects with more severe OA.

Regarding SF – physical functioning, there is a statistically significant correlation between improvement on this scale and OA severity. Subjects with more severe OA exhibit smaller improvement in this area (Pearson  $r = -0.40$   $p < 0.05$ ).

Statistically significant correlation between OA severity and improvement on VAS scale was found (Pearson  $r = 0.37$   $p < 0.05$ ). In subjects with severe OA, the pain was improved after the surgical procedure in a lesser degree than in subjects with less severe OA.

### Discussion

TKA is estimated to markedly improve the daily functioning of OA patients and markedly affect the improvement of health-related quality of life (Buly and Sculco, 1995). However, we just emphasize that some observations indicate that as many as one in five patients may be not satisfied with the outcomes of the surgical treatment (Pivec *et al.*, 2015). The outcomes are affected by multiple-patient related factors, including age, BMI and OA severity before the surgical procedure.

Due to the aging of the worldwide population and increasing average lifespan, dilemmas related to qualification of elderly patients to major orthopedic procedures emerge. A study assessing 921 primary TKA procedures in which patients were subdivided into age groups indicated that outcomes and level of patient satisfaction assessed on the SF-36 scale were similar in all subgroups (Fang *et al.*, 2015). Elmallah *et al.* demonstrated that TKA results were satisfactory also in the in the oldest group of patients ( $< 55$ ,  $55-74$  years,  $> 75$  years) (Elmallah *et al.*, 2016). Lizaur – Utrilla *et al.* (2017) assessed TKA outcomes in two patient cohorts, below the age of 55 years and older. Significantly better results at the follow-up visits after 5 years and later were found in both groups versus baseline ones. Regarding

WOMAC – pain, statistically significant differences between patients were not found at any time point. Based on SF-36 subscales of physical parameters Magone *et al.* (2017) found that better results of TKA may be expected in younger patients and subjects with a smaller number of co-morbidities. Pivec *et al.* (2015) demonstrated the relevance of age, sex and BMI of the patients for the outcome of the surgery assessed on SF – 36 scale. These factors significantly correlated with the physical component of this scale, while the correlation with mental component was not found. According to Sveikata *et al.* (Sveikata *et al.*, 2017) age, BMI and education of patients had no significant effect on TKA outcome in their patient cohort. We have found in our study that age has no effect on TKA outcomes on almost all assessed scales. There was a significant correlation between age and worse outcome only for KOOS subscale of pain. Similarly, as other authors, we found only very limited effect of age on outcomes of the surgical treatment assessed on multiple scales and their subcategories.

Analyzing BMI, Goh *et al.* (2015) also did not find any statistically significant correlations with TKA outcome in a cohort of Asian patients. Regarding SF-36 scale and incidence of complications in a short-term follow-up, no statistically significant differences were found for outcomes in obese and non-obese patients. Similar results were obtained by O'Neill *et al.* with the general division of patients to subjects with normal BMI and BMI above 25, based on WOMAC and SF-36 scales (O'Neill *et al.*, 2016). Clinical scales were completed before and 12 months after the surgical procedure. Other authors (Bonney-Mazure *et al.*, 2017) demonstrated that preoperative pain severity, determined based on WOMAC scale, was significantly higher in obese patients. However, after the surgical procedure, improvement in this cohort was higher than in non-obese patients. Consequently, irrespective of BMI, the authors found significant improvement

of biomechanical conditions and clinical symptoms after TKA. In our study, just as Goh *et al.* (2015) and O'Neill *et al.* (2016), we did not find any significant correlation between BMI of the operated patients and TKA outcomes. Results obtained on neither of subscales (WOMAC, KOOS, SF-36, and VAS) were worse in this group of patients versus in patients with normal BMI.

Effect of preoperative OA severity on the surgical outcomes has not been clarified. According to several studies, higher preoperative OA severity correlates with better postoperative outcomes (Keurentjes *et al.*, 2013; Cushnaghan *et al.*, 2009). Also, Kahn *et al.* (2013) demonstrated that higher OA severity assessed on KL scale correlated with better surgical outcomes on WOMAC scale. We did not confirm this correlation in our study. According to a study by Tilbury *et al.* (Tilbury *et al.*, 2015), there is a positive correlation between severity of radiographic changes assessed on Kellgren – Lawrence scale and postoperative reduction of pain and improved functionality in total hip arthroplasty (THA). Using the same principle, the authors assessed also 271 patients subjected to TKA and did not reveal any correlations between preoperative OA severity and better TKA outcomes. Outcomes of surgical treatment of the knee were assessed after one year with KOOS and SF-36 scales. On the other hand, according to our results, improvement after the surgical procedure in this cohort of patients on scales: WOMAC, KOOS – Sport, SF-36 – physical function and VAS was less pronounced than in patients with less severe changes.

### Conclusions

Outcomes of TKA ensure the marked improvement of the patient's condition assessed according to questionnaires. BMI, in the range studied in our study, does not adversely affect TKA outcomes. Regarding age, statistically significant worsening of outcomes was found only on a single subscale KOOS – pain. Thus, unless there are

other contraindications and co-morbidities, these factors should not limit patient qualification for surgical treatment. OA severity assessed on Kellgren – Lawrence scale, may be a significant predictor of worse outcome.

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