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Differences in case mix and outcomes between Swiss and Scottish total knee arthroplasty patients

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Abstract

Purpose The clinical benefits of total knee arthroplasty (TKA) are well defined, but little attention has been paid to the cross-cultural variation. The objective of this study was to compare case mix and outcomes following TKA in Swiss and Scottish patients.

Methods Data from local registries at a Swiss and a Scottish orthopaedic hospital were extracted to evaluate: (A) age, sex, body mass index (BMI), self-reported health status (EQ-5D), and joint awareness (Forgotten Joint Score-12 (FJS-12)) at pre-surgery, (B) improvement in EQ-5D and FJS-12 scores from pre-surgery to 1 year, and (C) patient satisfaction at 1 year.

Results Data from 2075 Swiss and 994 Scottish TKA patients were available from the local registries. Swiss and Scottish patients differed in age (69.3 vs 68.8 years, $p=0.046$), sex ratio (62.9% vs 56.9% women, $p=0.002$) and BMI (29.6 vs 30.9, $p<0.001$). At pre-surgery, FJS-12 scores were comparable (Swiss 12.1 vs Scottish 10.9, n.s.), but EQ-5D scores were better in Swiss patients (0.52 vs 0.40, $p<0.001$). Post-operative improvement was greater in Switzerland for the FJS-12 (+55.1 vs +32.2, $p<0.001$), but not for the EQ-5D (+0.31 vs +0.29, n.s.). The satisfaction rate was similar in both groups (88.3% vs 89.6%, n.s.).

Conclusion Subtle cross-cultural variation was evident in TKA case-mix factors between the two countries. Satisfaction and improvement in health status were similar, while improvement in joint-specific outcome was notably greater in Switzerland. Understanding cross-cultural variability of the outcome has important implications when interpreting study and registry data from other countries and when counselling a patient in daily practice.

Level of evidence Retrospective cohort, Level III.

Keywords Total knee arthroplasty · Comparative study · Patient-reported outcome · Forgotten Joint Score-12 · EQ-5D · Cross-cultural

Abbreviations

BMI	Body mass index
CI	Confidence interval
EQ-5D	EuroQol 5 dimensions
FJS-12	Forgotten Joint Score-12
PRO	Patient-reported outcome
SD	Standard deviation
TKA	Total knee arthroplasty
UK	United Kingdom
US	United States
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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Introduction

Due to ageing population and an increasing prevalence of obesity in industrialised countries, total knee arthroplasty (TKA) has become a routine procedure for the treatment of end-stage osteoarthritis, which is expected to become even more frequent in the future [21, 27]. To evaluate the outcome associated with TKA, national joint registries have been established since the 1970s that collect basic parameters such as implant survival or complication rates at a large scale. More recently, patient-reported outcome (PRO) measures have been implemented in various countries (e.g., Sweden, Denmark, UK) to complement the joint registries with the patients' perspective on the outcome [30]. While PRO data collection has to be very concise at a national level to ensure feasibility in daily routine, local joint registries can collect more PRO data to obtain a detailed perspective on surgical outcome. PRO questionnaires are typically used to assess general health, joint-specific parameters such as pain and function, or patient satisfaction.

Data from national registries provide accurate information on the prevalence of TKA and allow identifying variation within and across countries regarding patient demographics and hard endpoints like revision surgery or infection. However, with regard to PRO, only limited information is available. In general, different countries use different parameters [29–31] and questionnaires. Therefore, direct comparisons at a national level often are impossible.

TKA is an elective procedure and unlike in other medical fields, there are no international guidelines and a lack of consensus in the medical community concerning indication for TKA [9]. The right point in time to undergo TKA is discussed and defined by the patient together with his surgeon on a rather individual basis. For this reason, there is substantial variability across patient populations undergoing TKA in terms of age, sex, symptom burden [1, 22], but also with regard to various lifestyle factors such as obesity [15, 22] or activity levels [28]. In addition, country-specific differences in health care systems, in particular availability of resources and waiting times to treatment, may have substantial influence on access to surgery [27]. Therefore, marked differences in patient characteristics between countries may be present.

To date, only a few studies have investigated cross-cultural differences in pre-surgery case mix and surgical outcome in terms of health status, patient satisfaction or joint-specific PROs. Those studies available from the literature have reported relevant variation between countries comparing, e.g., the US vs Switzerland [14] or Sweden vs. Australia [12] or US vs UK vs Australia [20]. This raises the question of generalizability and direct comparability of study findings from different countries. Generally, little attention has been paid to between-country differences in the orthopaedic literature when interpreting results from clinical trials or registry data.

The health care systems in Switzerland and the UK (which includes Scotland) are generically reflective of evolved industrialised countries but differ substantially with regard to financial resources and structural organisation [5]. Furthermore, the Swiss and Scottish general populations differ substantially with regard to body mass index (BMI). While especially the Scottish are on the upper end of the European BMI ranking, the Swiss are ranking amongst the slimmest [26, 34]. In both the countries, national joint registries have been implemented, that collect basic patient characteristics and data on implant survival, but comparable PRO data are not available.

In this study, we evaluated the hypothesis that national demographics are reflected in pre-operative case mix and that this in turn influences post-operative outcomes following TKA. In detail, the study followed up on the following aspects:

- Comparison of pre-surgery patient characteristics (sex, age, BMI, comorbidity), health status and joint awareness.
- Comparison of improvement in health status and joint awareness from pre-surgery to 1-year follow-up.
- Comparison of patient satisfaction at 1-year follow-up.

Materials and methods

This was a retrospective cohort study that evaluated data from the local TKA registries at large representative Swiss and Scottish orthopaedic hospitals. Both registries provided data on patients' sex, age, comorbidities and BMI at pre-surgery and patient satisfaction ratings at 12-month follow-up. In addition, patient-reported outcome (PRO) scores were available at pre-surgery and at 12 months for joint awareness (measured with the Forgotten Joint Score-12) and patients' health status (measured with the EQ-5D).

Patients were eligible for the study if they underwent primary TKA (no revision surgery) at a study centre, were included in the joint registry and were aged above 18 years.

Patient assessment

The Forgotten Joint Score-12 (FJS-12; [3]) is a 12-item patient-reported outcome (PRO) measure of joint awareness in patients with knee or hip pathologies. The total score derived from the individual questions ranges from 0 to 100 with high scores indicating good outcome, i.e., a low level

of joint awareness. The questionnaire has shown good reliability and validity in psychometric analyses [6, 18] and has been validated in German [2, 3] and English [18].

The EQ-5D-3L [13] is a generic self-report questionnaire measuring the patient's health status. The instrument consists of five questions covering self-care, mobility, depression/anxiety, pain and usual activities. From these five questions, health utility can be calculated with a score of 1 reflecting full health, 0 indicating a health state equalling death and negative values describing health states that patients consider worse than being dead. This widely used questionnaire has shown satisfying measurement characteristics in knee patients [8]. In line with recommendations from the user guide [35] concerning country comparisons, we have used the same scoring procedure in both countries (UK valuation sets [11]). The EQ-5D-3L has been validated in German [17] and English [11].

Patient satisfaction was assessed at both study centres with a number of single questions. The question on overall satisfaction had different response categories at the two centres, which made a meaningful comparison impossible. As such, we focused on the one question that we could compare, i.e., the question on being willing to undergo surgery again:

> Swiss centre: If you had the choice, would you undergo the procedure again under the same conditions? Yes–No.
>
> Scottish centre: Would you have this operation again if it was required on another joint? Definitely yes—probably yes—unsure—probably not—definitely not—I don't know.

For the purpose of comparison, the response categories "unsure" and "I don't know" were excluded and the response categories used at the Scottish centre as follows: "Definitely yes" and "probably yes" merged into "Yes", "Probably not" and "Definitely not" merged into "No" were dichotomised.

Approval for registry data analysis was obtained from the local ethics committee in Switzerland (EKSG 10/138) and Scotland (16/SS/0026).

Statistical analysis

Patient characteristics at baseline are reported as absolute and relative frequencies, means and standard deviations. Statistical comparisons of UK and Swiss patients at pre-surgery were based on a Fisher's exact test and *t* test as appropriate. Comparisons of FJS-12 and EQ-5D scores at baseline were done with *t* test for independent samples. Dichotomised patient satisfaction ratings at 12-month follow-up were compared by means of a Fisher's exact test.

To investigate differences with regard to post-operative improvement in terms of FJS-12 and EQ-5D scores, we used the linear mixed models. Each model comprised the score as the dependent variable and a centre variable, a time point variable and the two-way interaction as fixed effects. Furthermore, each model included a random intercept at patient level. Based on these models, we calculated estimated marginal means with 95% confidence intervals for the two centres at pre-surgery and follow-up as well as for the change score. In addition, we also present estimated marginal means adjusted for baseline differences between centres with regard to sex, age and BMI. Frequency of missing data is given per variable for each centre and time point separately. Statistical analysis was done with SPSS 24.0.

The sample size in our group comparisons provided at least 80% power ($\alpha = 0.05$, two sided) to detect a difference between Swiss and Scottish patients with an effect size of Cohen's $d = 0.20$ for metric variables (i.e., a small difference [7]), and a difference of 5% in our comparison of categorical variables.

Results

The study accessed data from 2075 patients registered at the Swiss centre between 2006 and 2016 and 994 patients from the registry at the Scottish centre included in 2013 and 2014. In Switzerland, the FJS-12 was implemented into the registry in 2007 for post-operative assessments, and in 2012 for pre-surgery assessments (administration paused in 2013 and 2014). This resulted in FJS-12 data being available from 260 patients at pre-surgery and from 958 patients at 1-year follow-up. In Scotland, the FJS-12 was administered at pre-surgery and follow-up in 2013 and 2014 resulting in data from 701 patients at pre-surgery and 428 patients at 1 year.

Mean age at surgery was subtly higher in the Swiss patients compared to Scottish patients (69.3 years vs 68.6 years, $p = 0.046$). In Switzerland, the proportion of women undergoing surgery was higher than in Scotland (62.9% vs 56.9%, $p = 0.002$). Mean BMI was slightly lower in Swiss patients compared to Scottish patients (29.6 vs 30.9, $p < 0.001$), with obesity rates (BMI > 30.0) of 42.3% in Swiss patients and 51.1% in Scottish patients (see Table 1).

Joint-specific outcome as measured by the FJS-12 score was similar between the two cohorts (Switzerland 12.1 vs Scotland 10.9, n.s.), whereas general health (EQ-5D utility values) in Switzerland was better than in Scotland (0.52 vs 0.40, $p < 0.001$). Details are reported in Table 1.

Improvement in patient-reported outcome from pre-surgery to 1-year follow-up

Longitudinal analysis of EQ-5D utility values in Swiss patients showed an increase from 0.52 at pre-surgery to 0.83 at 1-year follow-up (change + 0.31). In Scottish patients,

Table 1 Comparison of patient characteristics and patient-reported outcomes at pre-surgery

	Switzerland ($N=2075$)		Scotland ($N=994$)		
	N	Mean (SD) or %	*N*	Mean (SD) or %	
Age at surgery	2070	69.3 (10.4)	984	68.6 (9.6)	$t=2.00$; $p=0.046$
Sex					
Women	1306	62.9	566	56.9	$p=0.002$
Men	769	37.1	428	43.1	
BMI	1671	29.6 (5.7)	616	30.9 (5.9)	$t=-4.67$; $p<0.001$
BMI categories					
< 25: normal weight	359	21.5	93	15.1	
25–30: pre-obesity	605	36.2	208	33.8	
30–35: class I obesity	449	26.9	169	27.4	
35–40: class II obesity	172	10.3	100	16.2	
≥ 40: class III obesity	86	5.1	46	7.5	
Forgotten Joint Score-12	260	12.1 (13.7)	701	10.9 (12.5)	$t=1.21$; n.s.
EQ-5D	1600	0.52 (0.29)	987	0.40 (0.31)	$t=10.38$; $p<0.001$

Percentages are given for valid cases

SD standard deviation, *BMI* body mass index, *n.s.* not statistically significant ($p>0.05$)

values increased from 0.40 to 0.69 in the same period (change + 0.29). The change was not statistically significantly different between the two groups. Adjusting the analysis for sex, age and pre-surgery BMI resulted in estimates for improvement that differed by less than 0.01 from the unadjusted estimates.

For the FJS-12, we observed a statistically significant difference between Swiss and Scottish patients with regard to post-operative improvement ($p<0.001$). Swiss patients improved on average by + 54.1 points (from 12.5 to 66.6 points), whereas Scottish patients improved by + 32.1 points (from 10.9 to 42.9 points). An adjusted analysis taking sex, age and pre-surgery BMI into account showed slightly larger improvement rates (Swiss + 55.1 points, Scottish + 32.2 points). Further details are given in Table 2, Figs. 1 and 2.

Table 2 Comparison of post-operative improvement in patient-reported outcome

	Switzerland		Scotland		
	Mean	(95% CI)	Mean	(95% CI)	
EQ-5D Utility Score (unadjusted analysis)					
Pre-surgery	0.52	(0.51–0.54)	0.40	(0.38–0.42)	Group $F=168.3$; $p<0.001$
1-year follow-up	0.83	(0.82–0.85)	0.69	(0.67–0.72)	Time $F=1340.4$; $p<0.001$
Change over time	0.31	(0.29–0.33)	0.29	(0.27–0.32)	Interaction $F=1.061$; n.s.
EQ-5D Utility Score (adjusted analysis)*					
Pre-surgery	0.53	(0.52–0.54)	0.42	(0.38–0.42)	Group $F=131.0$; $p<0.001$
1-year follow-up	0.84	(0.83–0.86)	0.71	(0.68–0.73)	Time $F=1197.0$; $p<0.001$
Change over time	0.31	(0.29–0.33)	0.29	(0.26–0.31)	Interaction $F=2.413$; n.s.
Forgotten Joint Score-12 (unadjusted analysis)					
Pre-surgery	12.5	(9.2–15.7)	10.9	(8.9–12.8)	Group $F=97.27$; $p<0.001$
1-year follow-up	66.6	(64.9–68.3)	42.9	(40.4–45.5)	Time $F=1297.1$; $p<0.001$
Change over time	54.1	(50.6–57.7)	32.1	(29.0–35.2)	Interaction $F=84.96$; $p<0.001$
Forgotten Joint Score-12 (adjusted analysis)**					
Pre-surgery	12.5	(9.2–15.8)	11.6	(9.5–13.8)	Group $F=86.67$; $p<0.001$
1-year follow-up	67.5	(65.8–69.3)	43.8	(41.1–46.5)	Time $F=1192.5$; $p<0.001$
Change over time	55.1	(51.4–58.7)	32.2	(28.9–35.5)	Interaction $F=81.89$; $p<0.001$

CI confidence interval, *n.s.* not statistically significant ($p>0.05$)

*Adjusted for sex, age and BMI; mean estimates given at age = 69.1 and BMI = 30.0

**Adjusted for sex, age and BMI; mean estimates given at age = 69.2 and BMI = 30.2

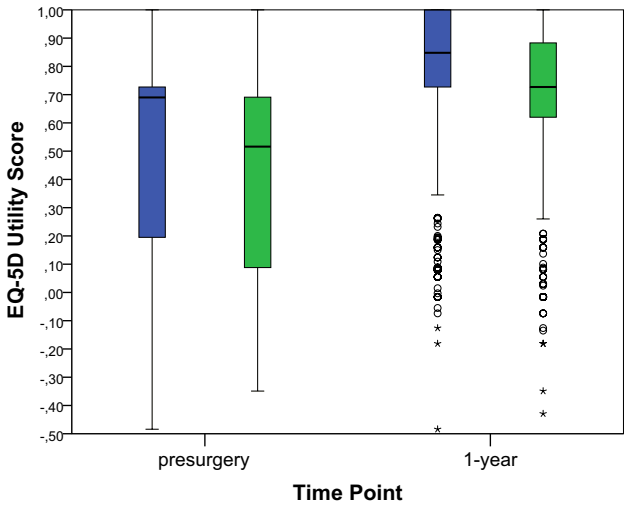

Fig. 1 EQ-5D Utility Score (observed values) at pre-surgery and 1-year follow-up in Switzerland (blue) and Scotland (green)

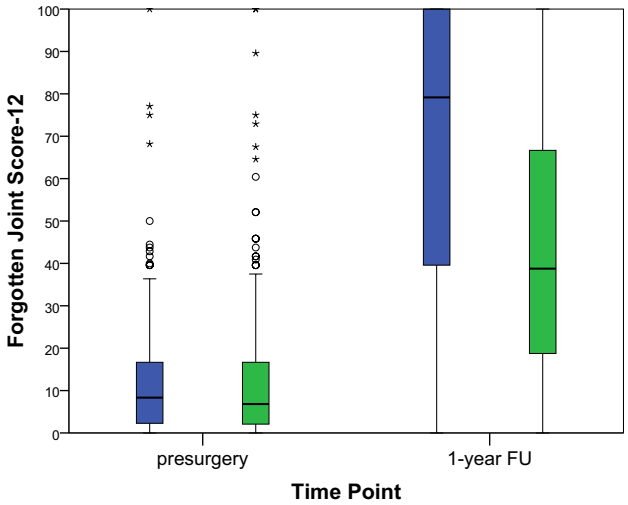

Fig. 2 Forgotten Joint Score-12 (observed values) at pre-surgery and 1-year follow-up in Switzerland (blue) and Scotland (green)

Patient satisfaction at 1-year follow-up

At the Scottish centre, 54.8% of the patients answered "Definitely yes" when asked if they would be willing to undergo TKA again, 34.8% answered "Probably yes", 5.2% said "Probably not", and another 5.2% "Definitely Not". In total, 89.6% of the Scottish patients would undergo TKA again, compared to 88.3% of the patients in Switzerland (n.s.). Details are given in Table 3.

Table 3 Patient satisfaction at 1-year follow-up

	Switzerland		Scotland		
	N	(%)	*N*	(%)	
Willingness to undergo the procedure again*					
Yes	1158	88.3	327	89.6	n.s.
No	153	11.7	38	10.4	
(Definitely yes)	–		200	54.8	
(Probably yes)	–		127	34.8	
(Probably not)	–		19	5.2	
(Definitely not)	–		19	5.2	

n.s. not statistically significant ($p > 0.05$)

*The response categories "unsure" ($N = 28$) and "I don't know" ($N = 28$) have been excluded from the analysis

Discussion

The most important finding of the present study was the cross-cultural variation in case mix at baseline and in outcome following TKA at 1-year follow-up between the Swiss and the Scottish cohorts. However, this variation was not consistent through all parameters, and baseline case-mix factors were more similar than national demographic factors. Demographic differences in patient age and sex ratio between Scotland and Switzerland though statistically significant may be too small to be of clinical relevance. Average BMI differed to a moderate degree with a mean difference of 1.3 points, however, a difference in obesity rates of 8.8% was evident, with more class 2 and 3 obese individuals undergoing TKA in Scotland. PRO data showed no difference with regard to joint awareness at pre-surgery, but a better general health status in the Swiss population.

Post-operative improvement of joint awareness was substantially better in the Swiss population, whereas general health improved to a similar degree in both populations following TKA. The percentage of patients that would be willing to undergo TKA again was near 90% in both groups.

Differences in BMI were expected based on the general population data, it is, however, noteworthy that differences in TKA patients were substantially smaller than in general population, where obesity rates were about three times higher in Scotland compared to Switzerland (10% vs 29% in general population; [26, 34]). It would appear that though the national reference populations differ widely, the consistency of surgical training and similar indications for TKA employed across Europe somewhat homogenise the surgical case mix. Pre-surgery FJS-12 scores highlight essentially the same disease and dysfunction burden in patients from both countries, suggesting that selection of patients for TKA seems to follow identical thresholds for joint-specific symptom burden (as measured with the FJS-12). The EQ-5D, however, showed larger between-country

differences in health status at both study time points. The size of the difference in EQ-5D score between countries (adjusted analysis: 0.12 at pre-surgery, 0.13 at 1 year) is in line with differences in the respective general populations. While specific EQ-5D population norms are not available for Switzerland and Scotland, a comparison of similarly aged persons (aged 65–74 years) in Germany and the UK showed values of 0.89 and 0.78, i.e., a difference of 0.11 [19]. Post-operative improvement was greater in Swiss patients than in Scottish patients for the FJS-12, but not for the EQ-5D. We attribute this differential finding to the sensitivity of the two instruments to pick up joint-specific changes, which has been reported in the literature to be larger for the FJS-12 than for the EQ-5D [16]. We hypothesise that the difference in improvement of joint awareness may be related to the differences in activity levels or the different general health already at baseline. Interestingly, the different joint-specific improvement was not mirrored by differences in patient satisfaction, possibly reflecting lower expectations towards outcome of TKA in Scottish patients.

Regarding wider generalisability of our registry data, we found that the data from the Swiss centre compared well against the Swiss National Registry [32]. For primary TKA, the Swiss national registry reported for 2015 a proportion of women of 61.3% (Swiss centre 62.9% women), a mean of age 69.4 years (Swiss centre 69.3 years) and a mean BMI of 29.4 (Swiss centre 29.6).

Data from the Scottish centre also compared well against data on mean age available from the Scottish Arthroplasty Project Report on data for primary TKAs in 2015 [33]: (Scottish centre 68.6 years, general Scottish data 68.6 years). Unfortunately, no data on sex ratio and BMI were available from this report. The National Joint Registry [23] covering England, North Ireland and Wales reported a mean age of 69.3 years for patients in 2014, a proportion of women of 57.0% (Scottish centre 56.9%) and a mean BMI of 30.9 (Scottish centre 30.9). This shows that case mix in the local joint registries analysed in our study was very similar to the national registries and supports generalisability of our findings in these countries.

The lack of published population demographic case mix data makes it somewhat difficult to contrast these cohorts more widely across Europe. Comparing against the national Swedish knee arthroplasty registry [25], Swiss and Scottish patients are similar with regard to mean age at time of surgery (68.9 in Sweden) and post-surgical satisfaction rates [91.1% (very) satisfied patients in Sweden]. Some variance is evident in the sex ratio, with the Scottish data more similar to Sweden than in Switzerland (56.5% women in Sweden). However, there is also a strong variation in the sex ratio among Nordic countries (e.g., 68.2% women in Finnish registry data [24]. The percentage of obese patients (BMI > 30) was 37.7% in the Swedish registry, which is even lower than in the Swiss data (42.3%).

This is the first study to compare patients from Switzerland and Scotland, and the wider literature provides only a few examples of cross-cultural comparisons of TKA patients to draw upon. A study by Franklin et al. [14] compared Swiss against US patients using data from the local joint registry at Geneva University Hospital and from a cohort at the University of Massachusetts Medical School. The authors report several baseline differences, with Swiss patients being more likely to be female (68.9% vs 62.0%), older (72.3 vs 66.7 years), less obese (mean BMI 29.6 vs 31.5). In addition, baseline WOMAC pain and function scores indicated a clinically relevant higher burden in Swiss patients compared to US patients. While the mean age in the Swiss cohort deviates somewhat from the above national Swiss data, the pronounced difference in patient age and symptom burden indicates important differences in indication for surgery between the two patient groups. We assume that the strong difference in the educational level in this study may result from a misspecification of professional training (apprenticeship), as it is probably incorrect that 41.1% of the Swiss patients had ≤ 8 years of education, compared to 1.6% in the US. Unfortunately, this study did not provide follow-up that would have allowed comparison of post-operative improvement. In another study by Dowsey et al. [12], comparing post-operative improvement in terms of pain and function between Swedish and Australian cohorts found similar improvements after 1 year despite a number of differences in patient characteristics at baseline including sex, BMI and symptom burden.

An important limitation of the study is the amount of missing data that may have affected in particular the analysis of the FJS-12 and patient satisfaction. Data may not be missing at random for various reasons. Patients with good outcome may consider follow-up visits less important, elderly patients with deteriorating health may be lost to follow-up since they are dealing with other more pressing health issues and give little importance to their knee, while patients with low satisfaction may seek further treatment at another hospital or practice. While these different reasons for data not being missing at random may result in over- or underestimation of true post-operative improvement, it may be reasonable to assume that data from the two registries were biased in a similar way.

A further limitation of our study is that the data on comorbidity were not comparable between the two registries, as comorbidity classifications differed substantially. In addition, comorbidity data were patient reported at the Scottish centre, but derived from medical charts and clinician reports at the Swiss centre. Furthermore, specific PROs for pain and function could not be compared, as different

instruments were used, the WOMAC [4] at the Swiss centre and the Oxford Knee Score [10] at the Scottish centre.

Conclusion

In conclusion, case mix in TKA patients is mostly comparable between Switzerland and Scotland and willingness to undergo TKA again at 1 year is nearly identically high. There is, however, a pronounced difference in post-operative improvement in joint awareness between Switzerland and Scotland that is not explained by baseline characteristics, which warrants further research on possible explanatory factors. Caution should be taken when generalising results from TKA studies, as benefits from surgery may differ substantially across countries. Thus, relying on national data is recommended for counselling a patient in orthopaedic clinics and for patient expectation management.

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Compliance with ethical standards

Conflict of interest Two authors are copyright holders of the Forgotten Joint Score-12. Royalties are payable for commercial use of the questionnaire.

Ethical approval Approval for registry data analysis was obtained from the local ethics committee in Switzerland (EKSG 10/138) and Scotland (16/SS/0026).

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