

Sports activity is maintained or increased following total knee arthroplasty

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Abstract

Purpose The purpose of this study was to investigate sports activities and functional abilities in patients following total knee arthroplasty (TKA). It was hypothesized that patients who had undergone TKA would return to a higher activity level as that experienced preoperatively.

Methods Two hundred patients were included in this prospective single-cohort study. All the patients completed subjective questionnaires (Tegner Activity Level, Oxford Knee Score, Visual Analog Scale for pain) prior to surgery as well as at 6, 12, and 24 months postoperatively. Additionally, sports behaviour was evaluated. Sports frequency was divided into four categories: more than 5 times a week, 2–3 times a week, occasionally, and no sports activities. Additionally, the patients were asked to state their three favourite summer and winter sports.

Results All patient-reported outcome scores improved significantly over time ($p \leq 0.005$). The Tegner Activity Level increased significantly from the preoperative state to 24 months postsurgery ($p = 0.005$). Six months after

surgery, 43% of the patients returned to the same and 35% to a higher Tegner Activity Level than prior to surgery. Gender-related differences were observed for the Tegner Activity Level showing a higher activity level for the male than for the female patients. Overall, 24 months postsurgery 83% of the patients practiced sports in comparison with 79% prior to surgery.

Conclusions Following TKA, the patients were able to increase sports performance, while pain was reduced. Therefore, patients who want to continue their desired sports may safely consider TKA.

Level of evidence II.

Keywords Total knee arthroplasty · Sports activity · Tegner Activity Level · Oxford Knee Score · Visual Analog Scale · Functional abilities

Introduction

Osteoarthritis (OA) has detrimental effects on quality of life (QoL) including restriction of activities of daily living and sports participation. Total knee arthroplasty (TKA) is a reliable and well-accepted treatment option for patients with end-stage OA to reduce pain, improve health-related quality of life (HRQoL), and enable return to function [13, 16, 23]. Over the past decade, the number of TKAs has increased rapidly, doubling between 2000 and 2013 [38]. The desire to return to various activities, including sports participation, plays an increasingly important role in the decision to undergo surgery [2, 16, 19, 44, 48]. To date, the methods for evaluating TKA outcomes have been based mainly on standard patient-reported outcome scores, physical examination, and radiographic evaluation [14, 25]. Expectations, real need, and QoL are not currently taken

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into account [14]. However, assessing the patient's perspective using HRQoL instruments is of increasing interest to the orthopaedic community when evaluating patients following TKA [25] in response to the higher expectations of patients regarding activities after TKA. Physicians are currently faced with patients' questions regarding their involvement in sports activities and what level of participation will be possible post-TKA [49, 50]. As sports participation is found to be closely related to patients' QoL, their desire to return to a certain activity has become an important factor in the decision whether to undergo surgery. Only a few studies investigated sports participation [1, 13, 22, 29, 31] and QoL [6, 17, 36, 37] following TKA.

The existing recommendations are more often evidence based rather than evidence based [19, 20, 23]. The expectations of patients with OA are different [27, 41, 42], but being active following TKA is a common goal [10]. It would be helpful for both clinicians and patients to know what type of sports patients can be expected to engage in following TKA.

To the best of the authors' knowledge, this is the first study investigating Tegner Activity Level, Oxford Knee Score (OKS), and Visual Analog Scale (VAS) for pain in patients following TKA over 24 months. Therefore, the purpose of this study was to evaluate sports behaviour and functional abilities in TKA patients pre- and up to 24 months postoperatively. The hypothesis of this study is that following TKA, patients will return to a higher activity level as that prior to surgery.

Materials and methods

A prospective, longitudinal, single-cohort study investigating sports activities, QoL, and pain in patients following TKA was performed between 2010 and 2014. The study was approved by the ethics committee of the Medical University of Innsbruck (AN2016-0117).

All patients undergoing primary TKA between 2010 and 2014 at our institution (Gelenkpunkt—Sports and Joint Surgery) were considered for recruitment ($n = 218$). To be enrolled, patients had to meet the following inclusion criteria: (1) diagnosis of primary osteoarthritis, (2) age 55–90 years, (3) willingness to participate in 24-month follow-up, (4) adequate cognitive function to complete the questionnaires, and (5) willingness to cooperate with the study protocol.

Fifteen patients did not meet the inclusion criteria ($n = 4$ were out of the age limit; $n = 11$ did not give their written informed consent). Since the loss to follow-up was small ($n = 3$), we did not consider missing values imputation for this. Thus, these patients have been excluded for the final data analysis. A total of 200

patients gave their written informed consent and were finally included in this study.

All the surgeries were performed by one of the three experienced surgeons using a cemented cruciate-retaining total knee implant (NexGen CR, Zimmer Inc.). A medial parapatellar approach was performed. The mean tourniquet time was 82 ± 16 min. Overall, three complications were observed (two patients needed manipulation under anaesthesia (MUA) 8 weeks postoperative due to a flexion contracture; one patient received replacement of a previously retained patella). The rehabilitation programme consisted of a four-point gait pattern within the first two weeks after surgery. The patients were advised to use crutches for four weeks.

The primary objective of the study was to demonstrate whether patients return to their preoperative activity levels according to the Tegner Activity Score following TKA. The secondary objective was to evaluate whether QoL, as measured by the OKS, changes between the preoperative and postoperative state. Additionally, the VAS for pain was compared over time. Furthermore, patients were asked about their sports behaviour in detail, including type of sports and hours of participation.

All the subjects completed subjective questionnaires prior to surgery and at 6, 12, and 24 months postoperatively. The preoperative questionnaire enquired about the patients' condition "within the last 4 weeks prior to surgery". The outcome measures included the OKS, the Tegner Activity Level, the VAS for pain, and sports activity. Activity level was measured using the Tegner Activity Level, ranging from 0 (=sick leave or disability pension because of knee problems) to 10 (=competitive sports—national elite) [45]. The Tegner score demonstrated acceptable relative reliability: intraclass correlation coefficient (ICC): 0.79; confidence interval (CI): 0.63/0.89 [43]. The test–retest reliability of the Tegner score for patients with OA has been found to be 0.84 [35]. The OKS is a self-reported questionnaire that was developed to evaluate patients' perception following TKA. The questionnaire consists of 12 questions covering pain and function parameters [15] scored from 0 to 48, with higher scores indicating better patient-reported outcome [33]. The OKS has an excellent test–retest reliability and varies from 0.91 to 0.94 [12, 15]. Pain was measured with the VAS for pain, and the patients specified their subjective pain perception on a scale from 0 (=no pain) to 10 (=severe pain) [7]. Sports frequency was divided into four categories: more than 5 times a week, 2–3 times a week, occasionally, and no sports activities. Additionally, the patients were asked to state their three favourite summer and winter sports, and multiple answers were possible.

Statistical analysis

A post hoc power analysis was performed with G*Power 3.1.9.2 (Franz Paul, Kiel, Germany) to determine the power of the present study. Based on the results from the Tegner Activity Level preoperatively and at 24 months, and a two-sided alpha error of 0.05, a power of 0.85 was achieved.

The data were analysed using IBM® SPSS® Statistics 23 (SPSS, Armonk, NY, USA). The Kolmogorov–Smirnov test was used to test for normal distribution. Due to the nonnormal distribution of all of the scores, nonparametric tests were performed. For comparison over time, the Friedman test was used. The Mann–Whitney *U* test was performed to detect differences between the groups. For both comparisons, Bonferroni corrections were applied. Spearman correlations were performed to investigate the influence of body mass index (BMI), age, and prosthesis (unilateral versus bilateral) and to detect possible confounders. Additionally, correlations were performed to demonstrate the influence of sports activity as measured by the Tegner Activity Level. Furthermore, a grouping in “young” (age 55–72) and

“old” (age 73–90) was done because of the correlation between the Tegner Activity Level and age. The significance level was set at $p < 0.05$. The patients favourite sports were classified into low-impact, medium-impact, and high-impact sports.

Results

The patients’ demographics at baseline are shown in Table 1.

Primary outcomes

The Tegner Activity Level increased significantly from the preoperative state to 24 months postsurgery ($p = 0.005$) (Table 2; Fig. 1). The changes between

Table 1 Patients’ demographics at baseline

	<i>n</i>	<i>n</i> %	Mean ± SD
Gender			
Male	80	40.0	
Female	120	60.0	
TKA			
Unilateral	165	82.5	
Bilateral	35	17.5	
TKA			
Left	93	46.5	
Right	107	53.5	
Age (years)			72.2 ± 7.7
BMI			27.2 ± 5.0

n number of patients, *SD* standard deviation, *BMI* body mass index

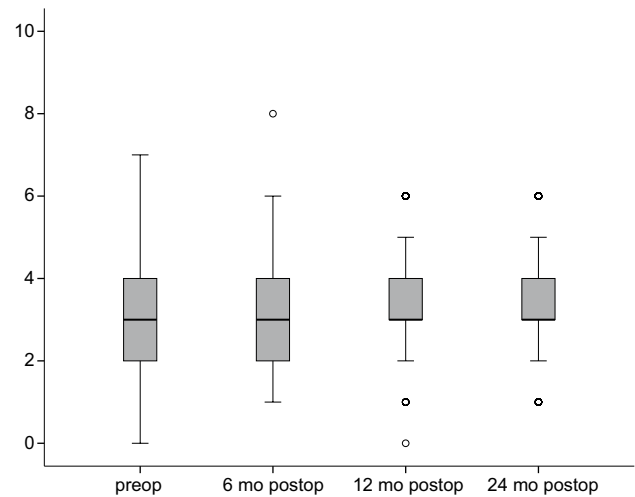


Fig. 1 Tegner Activity Level of TKA patients prior to surgery and 6, 12, and 24 months postoperative. The Tegner Activity Level of TKA patients increased significantly from preoperative to the 24-month postoperative state

Table 2 Patient-reported outcomes prior to surgery and 6, 12, and 24 months postoperative

	Preoperative			6 months postop			12 months postop			24 months postop			Time effect <i>p</i>
	Median	Percentile		Median	Percentile		Median	Percentile		Median	Percentile		
		25	75		25	75		25	75		25	75	
Tegner	3.0	2.0	4.0	3.0	2.0	4.0	3.0	3.0	4.0	3.0	3.0	4.0	0.005*
OKS	25.0	18.0	30.0	38.0	30.0	43.0	41.0	33.0	46.0	43.0	34.0	46.0	<0.001*
VAS	6.0	4.0	7.0	1.0	0.0	3.0	1.0	0.0	1.0	0.0	0.0	1.0	<0.001*

Tegner Tegner Activity Level scale, OKS Oxford Knee Score, VAS Visual Analog Scale for pain

* Significant differences after Bonferroni correction ($p < 0.0167$)

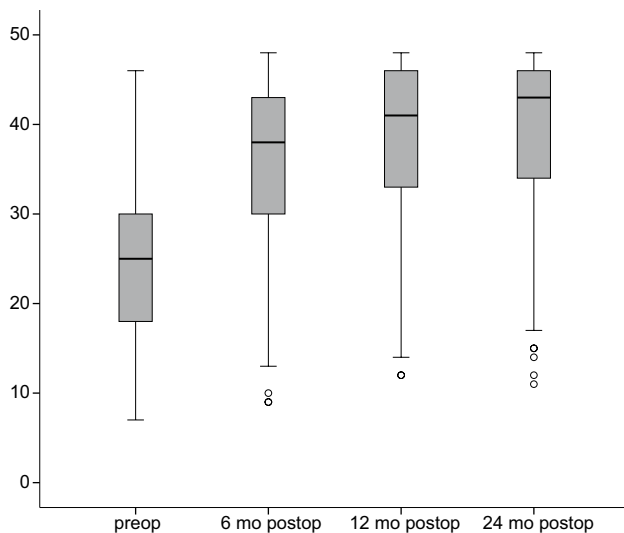


Fig. 2 OKS of TKA patients prior to surgery and 6, 12, and 24 months postoperative. The median OKS of patients following TKA increased significantly over time

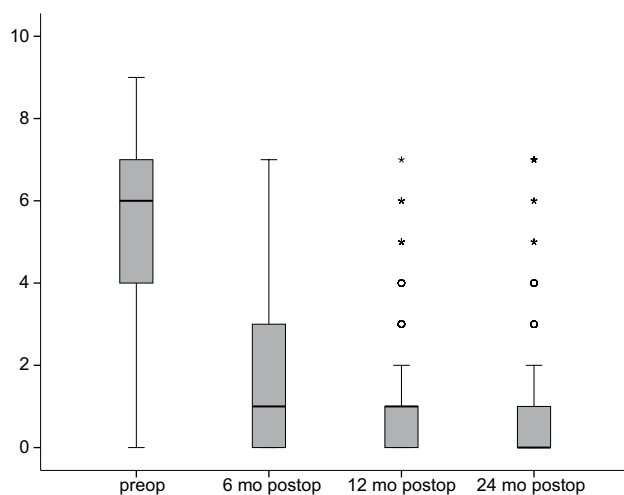


Fig. 3 VAS of TKA patients prior to surgery and 6, 12, and 24 months postoperative. A decrease in the median VAS from preoperative to 6, 12, and 24 months postoperative for TKA patients could be observed

preoperative and 6 months postoperative were statistically significant ($p = 0.037$), whereas the differences were not significant for the changes from 6 to 12 months and from 12 to 24 months (n.s.). At the time of the 6-month follow-up, 78% of the patients have returned to the same (43%) or a higher (35%) level of activity.

The median OKS increased significantly between the baseline and final follow-up ($p < 0.001$) (Table 2; Fig. 2).

The median VAS for pain decreased significantly from the preoperative state to 24 months postoperative ($p < 0.001$) (Table 2; Fig. 3).

Median and range values of the Tegner Activity Level, the OKS, and the VAS are demonstrated in Table 2.

Gender-related differences were observed only for the Tegner Activity Level. A higher activity level was recorded for the male at 6, 12, and 24 months postoperative (Table 3).

Secondary outcomes

Unilateral or bilateral TKA did not correlate with BMI. Further, BMI was not correlated with any of the subjective outcome scores.

No correlation was found between age and OKS or VAS. However, there was a significant negative correlation ($p < 0.010$) between age and the Tegner Activity Level at all the time points ($r = -0.182$; $r = -0.194$; $r = -0.207$; $r = -0.245$ preoperatively, at 6, 12, and 24 months, respectively). Categorizing the patients into two age groups (“young”: aged 55–72 years; “old”: aged 73–90 years) did not result in statistically significant differences (Table 4).

Sports participation among patients following TKA is displayed in Fig. 4.

For the TKA patients, the most popular summer sports were hiking, cycling, and swimming. During the winter, the patients preferred skiing, cross-country skiing, and hiking (Fig. 5). Regarding the patients’ preferred sports, no statistically significant (n.s.) change from preoperative to 24 months postoperative was observed as shown in Fig. 6.

Discussion

The most important finding is that the Tegner Activity Level increased significantly from the preoperative state to 24 months postoperatively. The results show that at 6 months after surgery, the patients reach or even exceed their preoperative activity level.

Twenty-four months postoperatively, an increase in sport participation of 4% ($n = 8$) was seen. Regarding sports participation in more strenuous activities (i.e. alpine skiing), patients were only encouraged to continue if they have had previous experience.

Conflicting results have been reported in terms of sports participation following TKA. While some studies found an increase in sports activity [28, 29], others found a decrease in participation and intensity of sports activities among patients following TKA [10, 19].

Argenson et al. reported that 86% of patients who have undergone TKA reach the same or a higher activity level than that prior to surgery [1]. This is consistent with the findings of the present study. In patients following lateral unicompartmental knee arthroplasty, the return to activity rate is actually up to 98% [47]. Another

Table 3 Patient-reported outcomes for male and female patients prior to surgery and 6, 12, and 24 months postoperative

	Preoperative		6 months postop		12 months postop		24 months postop					
	Median	Percentile	Median	Percentile	Median	Percentile	Median	Percentile				
		25 75		25 75		25 75		25 75				
Tegner												
Male	3.0	2.0 4.0	4.0	3.0 5.0	4.0	3.0 5.0	4.0	3.0 6.0				
Female	3.0	2.0 4.0	3.0	2.0 4.0	3.0	3.0 4.0	3.0	3.0 4.0				
Group effect	n.s.		<0.001*		0.003*		0.004*					
OKS												
Male	27.0	20.0 32.0	40.0	33.0 44.0	40.0	34.0 47.0	43.0	38.0 47.0				
Female	23.5	17.0 28.75	37.0	28.25 43.0	41.0	32.0 45.0	43.0	33.0 46.0				
Group effect	n.s.		n.s.		n.s.		n.s.					
VAS												
Male	6.0	3.25 7.0	1.0	0.0 2.0	1.0	0.0 2.0	0.0	0.0 1.0				
Female	6.0	4.0 7.0	1.0	0.0 3.0	1.0	0.0 1.0	0.0	0.0 1.0				
Group effect	n.s.		n.s.		n.s.		n.s.					

Tegner Tegner Activity Level scale, OKS Oxford Knee Score, VAS Visual Analog Scale for pain

* Significant differences after Bonferroni correction ($p < 0.0042$)

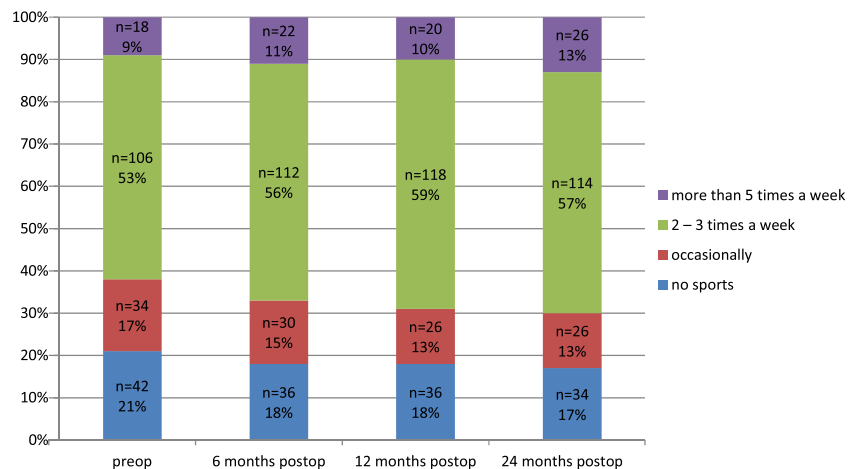
Table 4 Tegner Activity Level outcome for male and female patients according to age

	Preoperative		6 months postop		12 months postop		24 months postop		
	Median	Percentile	Median	Percentile	Median	Percentile	Median	Percentile	
		25 75		25 75		25 75		25 75	
Male									
Old*	3.0	2.0 4.0	3.0	2.75 5.25	3.5	2.0 6.0	4.0	2.25 6.0	
Young**	4.0	3.0 6.0	4.0	3.0 5.5	4.0	3.0 5.0	4.0	3.0 5.0	
Group effect	n.s.		n.s.		n.s.		n.s.		
Female									
Old*	3.0	2.0 3.0	3.0	2.0 3.0	3.0	2.0 4.0	3.0	2.0 3.0	
Young**	3.0	2.0 4.0	3.0	3.0 4.0	3.0	3.0 4.0	3.5	3.0 4.0	
Group effect	n.s.		n.s.		n.s.		n.s.		

* Age 73–90 years; ** age 55–72 years

*** Significant differences after Bonferroni correction ($p < 0.0063$)

Fig. 4 Sports participation among TKA patients preoperative and 6, 12, and 24 months postoperative. Sports participation increased from preoperative to 24 months postoperative. Preoperatively 21% of the subjects did not participate in sports compared to 17% at the 24-month follow-up. Twenty-four months postsurgery, patients participated in sports activities more often than prior to surgery



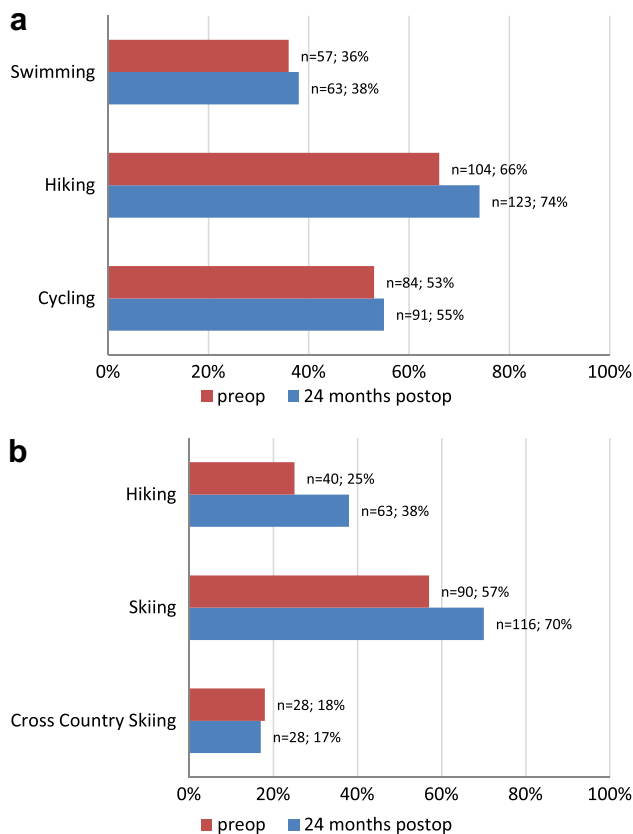


Fig. 5 The most common summer sports (a) and winter sports (b) of TKA patients preoperative and 24 months postoperative. A comparison of the preoperative and 24 months state showed an increase in the most popular summer sports. In winter, an increase in skiing and hiking activities occurred at the 24-month follow-up. Only cross-country skiing decreased at the 24-month state in comparison with prior to surgery

study also showed—consistent with our study—a significant improvement in the Tegner Activity Level from the preoperative to postoperative state. Further, the authors found age to be a negative predictor of the Tegner Activity Level. However, the mean follow-up in the study by Vielgut et al. [46] was 14.9 years.

With regard to the patients' preferred sports, no change was observed in the present study. Both prior to and after surgery, the TKA patients state a preference for low-impact sports such as swimming, cycling, cross-country skiing; medium-impact sports (i.e. hiking); and high-impact sports (i.e. skiing). This is in contrast with other studies showing a shift from preoperative activities [32].

The rate of surgical treatment for osteoarthritis depends on gender and region, among other factors [41]. The expectations of patients following TKA are influenced by personal experiences and social environment [42] and based on geographic differences [27]. Previous studies showed that the type of sports practiced depends on the region. In

alpine regions, skiing and mountain hiking are also practiced by patients following TKA [4, 20, 22, 34] in contrast to studies in the lowlands that found swimming and cycling to predominate [5, 8, 21]. Prior experience and the way patients perform their favourite sport play an important role with regard to sports participation after TKA [26]. The patients in the present study are generally practicing the same sports pre- and postoperatively. Medium- and high-impact sports—such as hiking and skiing—are also enjoyed prior to surgery and therefore can be recommended for TKA patients following surgery.

The BMI of the patients following TKA was revealed to be very high in the present study; nevertheless, there is no discernible correlation between BMI and the Tegner Activity Level. This demonstrates not only that the active and athletic patients are practicing sports regularly, but also that even patients with a higher BMI are participating in sports and returning to sporting activity following TKA.

Another important finding is that the OKS improved significantly over time. Data from this study suggest an improvement at all time points during the follow-up. Various other studies have also detected an enhancement of the OKS in patients following TKA [11, 18, 40]. However, comparison with these studies is difficult due to their use of different scoring measures for the OKS. A recent study suggested that the minimal important change (MIC) over time in a single group should be 9 points for the OKS [3]. In the current study, the OKS change was 11 points when comparing the preoperative state with that at 6 months.

The VAS for pain decreased significantly after surgery. A recent study aimed to investigate changes in the VAS following TKA, and it showed an improvement of 73% under resting and of 81% under active conditions after surgery [32]. A study by Vielgut et al. showed that at a mean follow-up of approximately 15 years, the average VAS decreased to 1.42 [46].

The preoperative Tegner Activity Level of the patients in the present study was already moderate (Tegner Activity Level = 3), but the patients were suffering from pain. Postoperatively, the Tegner Activity Level increased, while pain decreased. The increase in activity levels postoperatively is likely to be due to the reduction in pain and the improvement in functional abilities. Nonetheless, following TKA, patients can practice their favourite sport but with reduced pain.

One limitation of this study is that no objective parameters were gathered. The use of only subjective questionnaires could potentially lead to an overestimation by patients of their physical activities [30, 39]. Not using newer validated patient-reported outcome instruments might be a limitation of the present study. Additionally, a selection bias cannot be excluded because 10% of

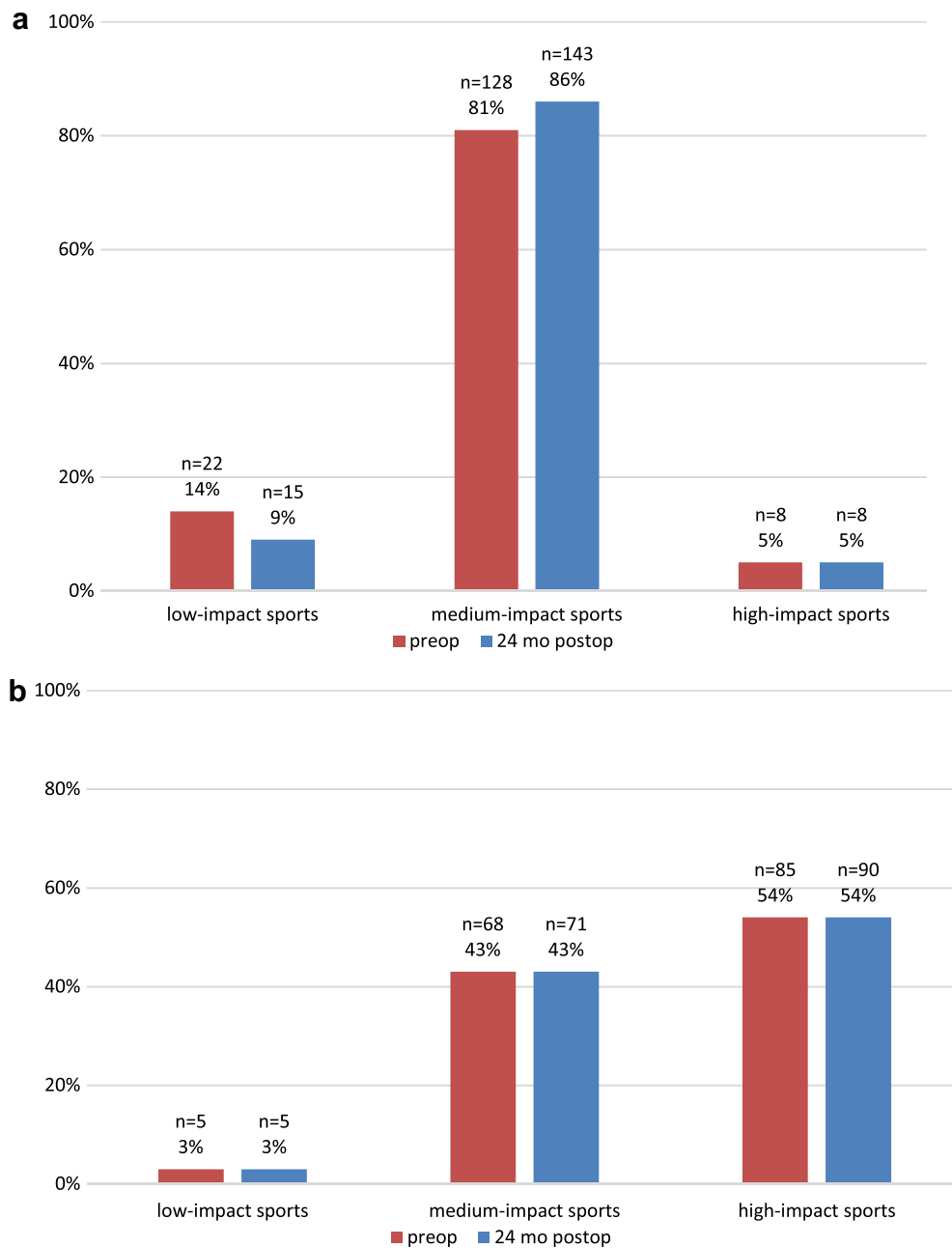


Fig. 6 Patients' preferred summer sports (a) and winter sports (b) of TKA patients preoperative and 24 months postoperative. Prior to surgery 14% ($n = 23$) of TKA patients participated in low-impact sports in comparison with 9% ($n = 15$) during summer. An increase in participation in medium-impact sports in summer could be demonstrated

patients did not participate in the study due to loss to follow-up. Another limitation is that in instances in which the patients did not return to their preoperative activity levels, the questionnaires did not elicit the reason. A study by Chang et al. showed that the perceived reasons hindering regular sports activity in patients following TKA were not in fact directly related to problems with the replaced knee [9]. A systematic review demonstrated

(81% preoperative; 86% postoperative). Regarding high-impact sports no change from prior surgery to 24 months postoperative occurred. The participation in TKA patients' favourite winter sports did not change from preoperative to 24 months postoperative

that patients' postoperative outcomes are influenced by patients' psychological factors prior to surgery [24]. It would be of interest to determine why TKA patients fail to return to their preoperative level. The limited length of follow-up and the lack of clinical and radiological data do not allow any statement to be made regarding the beneficial or detrimental effect of sports participation on the longevity of the implant itself.

The results of the present study may support surgeons in their decision-making when they are faced with patients' questions about sports participation (type and intensity) following TKA.

Conclusions

The present study demonstrates that patients following TKA have an increased activity level, better results in the OKS and reduced pain compared to the preoperative state. Therefore, the 2-year results of this study suggest that patients who want to continue their desired sports may safely consider TKA.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest related to this study.

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Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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