

Patient-Reported Activity Level After Total Knee Arthroplasty

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Abstract: We identified 1630 unrevised patients who underwent primary total knee arthroplasty (TKA) between 1995 and 2000. Patients were surveyed regarding clinical outcome and activity level, and were queried about actual participation in 40 different athletic activities. One thousand two hundred six patients (74%) responded at a mean of 5.7 years after arthroplasty. Average age at TKA was 67 years. Average University of California at Los Angeles (UCLA) activity level rating was 7.1. Satisfaction with activity level was 91%. Six hundred forty-three patients (53%) responded that their activities were limited by other joints. Patients older than 70 years at arthroplasty had lower UCLA ratings and Knee Society function scores ($P < .0001$) but higher self-assessment of activity vs peers ($P = .001$) than those younger than 70 years. Men had higher UCLA scores ($P < .0001$), Knee Society function scores ($P < .0001$), and higher self-assessment of activity level vs peers ($P < .0001$) than women. One hundred eighty-seven patients (16%) reported participating in heavy manual labor or sports deemed “not recommended” in a published Knee Society survey. **Key words:** activity, sports, arthroplasty, knee, function.
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Total knee arthroplasty (TKA) is a widely performed procedure that has been demonstrated to provide functional improvement and pain relief for most patients with advanced knee arthritis [1]. Standardized rating systems have been developed to evaluate outcome after TKA [2-4]. These outcome measures assess general aspects of patients' functional capability; however, there are few published data regarding patients' actual return to specific activities after TKA. Accumulating data suggest that prosthetic wear is not simply a

function of time in situ, but rather a function of use [5,6]. Pedometer studies have demonstrated wide individual variability in activity level among patients of similar demographics [6,7]; thus, activity assessments in patients who had undergone joint arthroplasty cannot be based on age and sex alone.

Published guidelines concerning activity after TKA discourage high levels of activity to theoretically prevent implant fixation failure and to minimize joint bearing surface wear [8-10]. Consensus recommendations for return to recreational and athletic activity after TKA were developed based on a survey of the Knee Society performed in 1999 [9]; however, reports regarding patient adherence to these Knee Society recommendations do not exist.

The goal of our study was to determine the functional and athletic activities of a large group of patients after modern TKA and examine factors that influence attainment of defined activity levels.

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Table 1. UCLA Activity-Level Rating Scale

Level	Activity
10	Regularly participate in impact sports such as jogging, tennis, skiing, acrobatics, ballet, heavy labor, or back packing.
9	Sometimes participate in impact sports.
8	Regularly participate in very active events, such as bowling or golf.
7	Regularly participate in active events, such as bicycling.
6	Regularly participate in moderate activities, such as swimming and unlimited house work or shopping.
5	Sometimes participate in moderate activity.
4	Regularly participate in mild activities, such as walking, limited house work, and limited shopping.
3	Sometimes participate in mild activity.
2	Mostly inactive: restricted to minimal activities or daily living.
1	Wholly inactive: dependent on others; cannot leave residence.

Materials and Methods

We identified 1718 patients who underwent primary TKA between 1995 and 2000 with a single condylar posterior cruciate substituting cemented implant (Press Fit Condylar or Sigma, DePuy, Johnson and Johnson, Warsaw, Ind). For these selection criteria, this represented a consecutive group of patients. Eighty-eight patients subsequently underwent revision total knee arthroplasty and were excluded, leaving 1630 unrevised patients. A survey was sent regarding clinical outcome and activity level after TKA. The survey instrument used in this study included questions allowing for calculation of 2 previously validated scores: the Knee Society (modified) clinical rating system [4] and University of California at Los Angeles (UCLA) activity rating scale (Table 1) [7,11]. In addition, patients were queried about actual participation in 40 different athletic activities corresponding to those

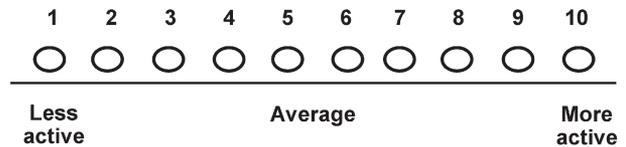


Fig. 1. The 10-point visual analog scale used to assess patient activity relative to peers. Patients were asked to rate their activity level relative to other people their age.

sports specifically documented in the 1999 Knee Society consensus guidelines (Table 2). Patients were asked to select a participation level of regularly (at least once per week), occasionally (less than once per week), or never for each athletic activity. A detailed question regarding return to work was also included. Patients were also asked whether they were satisfied with the level of activity achieved after TKA. Finally, a 10-point visual analog scale was added to allow self-assessment of activity vs peers (Fig. 1) [12].

Surveys were sent by mail. To maximize response rate, a follow-up survey was then sent to patients who failed to respond to the first mailing. Follow-up telephone calls were made to patients who failed to respond to the first and second mailings. All patients signed a consent form to participate in the survey. Health Insurance Portability and Accountability Act requirements were met by requiring written consent to use and disclose aggregated protected health information from surveyed participants. The study was reviewed and approved by our institutional review board.

Statistics

The relationships of patient characteristics to responses to survey items were evaluated using χ^2 tests. Scores were evaluated using the Wilcoxon rank sum test. Results are expressed as the

Table 2. 1999 Knee Society Survey Recommendations for Activity After TKA

Recommended/Allowed	Allowed with Experience	Not Recommended	No Conclusion
Low-impact aerobics	Road bicycling	Racquet ball	Fencing
Stationary bicycling	Canoeing	Squash	Rollerblading/inline skating
Bowling	Hiking	Rock climbing	Downhill skiing
Golf	Rowing	Soccer	Weightlifting
Dancing	Cross-country skiing	Singles tennis	
Horseback riding	Stationary skiing	Volleyball	
Croquet	Speed walking	Football	
Walking	Tennis	Gymnastics	
Swimming	Weight machines	Lacrosse	
Shooting	Ice skating	Hockey	
Shuffleboard		Basketball	
Horse shoes		Jogging	
		Handball	

Modified from Healy et al [9].

percentages for categorical variables and the mean \pm SD for continuous variables, unless otherwise stated. The analysis was conducted using SAS version 8.2 (SAS Institute, Cary, NC).

Results

One thousand two hundred six patients responded (74%). One thousand seventy patients (89%) resided in the midwest (Minnesota, Iowa, Wisconsin, Missouri, Illinois, Michigan, Indiana, and Ohio). The remaining 136 patients (11%) resided in the west, north central, southwest, south, or north-eastern United States. There was no statistical difference in age between those who responded to the survey and those who did not ($P = .24$), but the response rate was slightly higher in men (78%) than in women (71%) ($P = .002$). The average age at the time of TKA was 67 years (range, 20–91 years). The average age at the time of completion of the survey was 73 years (range, 27–97 years). The average follow-up (time from index operation to completion of the survey) was 5.7 years (range, 2–10 years). There were 544 (45%) men and 662 (55%) women. There were 632 patients (52%) who had undergone unilateral TKA and 574 (48%) who had undergone bilateral (staged or concurrent) TKA. Mean body mass index (BMI) at the time of TKA was 30.5 kg/m² (range, 14–70 kg/m²). Ninety-two percent of the patients underwent TKA for the diagnosis of degenerative arthritis, 4% for rheumatoid arthritis, and 4% “other.” One thousand one hundred ninety patients (99%) had the patella resurfaced at the time of total knee arthroplasty, whereas 16 patients (1%) did not undergo patellar resurfacing. Four hundred thirty-five patients (36%) reported that they were working. One hundred thirty-five patients (11%) reported participation in heavy manual labor such as heavy lifting or climbing. Three hundred patients (25%) reported participation in light manual labor such as computer or office work. Thirty-eight percent of patients had no formal physical therapy after hospital discharge.

Ninety-one percent of patients reported satisfaction with their activity level after TKA. There was no statistical difference in reported satisfaction with activity level between men and women; however, those aged older than 70 years had a slightly higher rate of reported satisfaction (93%) than those younger than 70 years (90%) ($P = .03$).

The average postoperative Knee Society pain score was 44 out of a possible 50 points (range, 0–50). Average modified Knee Society function score was 71 out of a possible 100 points (range,

0–100). Self-assessment of activity vs peers averaged 6.5 (range, 1–10) on a 10-point visual analog scale, where a score of 5 indicated activity level equal to that of others in a patient's age group.

Average UCLA activity level rating was 7.1 out of a possible 10 points (range, 1–10). Patients' UCLA scores were clustered into 3 main groups representing those participating in low, moderate, and high exertion activities (Fig. 2). When stratified by age, these 3 groups still emerged, although distribution of patients in each group changed slightly (Fig. 3). Patients older than 70 years had lower average UCLA activity ratings (6.8 vs 7.5, $P < .001$) and modified Knee Society function scores (36 vs 75, $P < .001$) compared with younger TKA recipients. However, the older TKA recipients had a higher self-assessment of activity vs peers (score, 6.8) than TKA recipients younger than 70 years (score, 6.3) ($P < .0001$) (Fig. 4). On average, men had higher UCLA scores ($P < .0001$), higher modified Knee Society function scores ($P < .0001$), and higher self-assessment of activity level vs peers ($P < .0001$) than women (Table 3). There was no significant difference in average UCLA scores between patients with unilateral TKA and those with bilateral TKA ($P = .4$). Patients with a BMI greater than 30 kg/m² had lower Knee Society function scores (70 vs 80, $P < .001$), decreased reported activity vs peers (6 vs 7, $P < .001$), and a trend toward decreased UCLA activity scores (7.0 vs 7.23, $P = .06$).

Six hundred forty-three patients (53%) responded that their activities were limited by other joints. Of these, the hip (78%), opposite knee (85%) and foot/ankle (35%) were most frequently cited. When patients were stratified according to unilateral vs bilateral TKA and presence or absence of limitations, patients with unilateral TKA who reported they were not limited by other joints had the highest

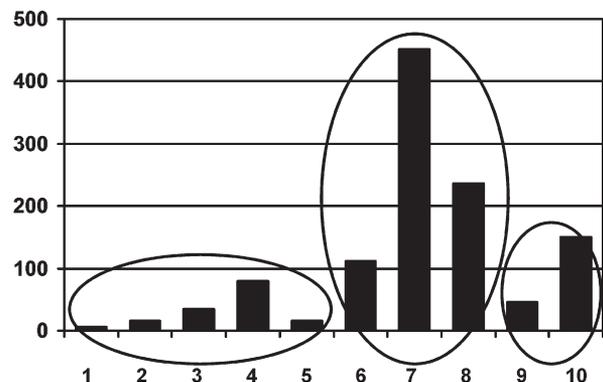


Fig. 2. UCLA scores of entire cohort. There were 3 main groups of patients, representing those participating in relatively low, moderate, and high activities.

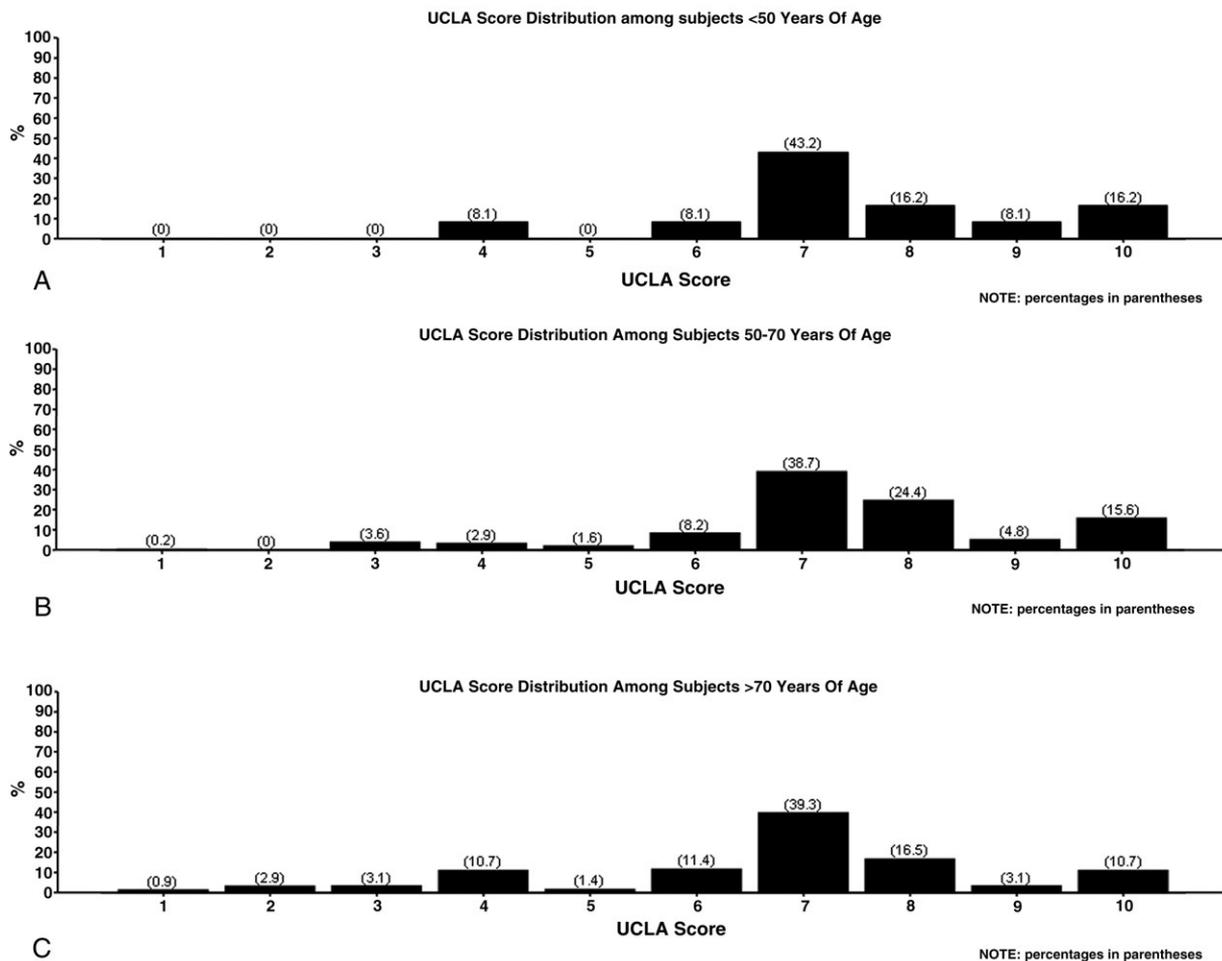


Fig. 3. Distribution of UCLA scores among age categories. (A) Distribution of UCLA scores among patients younger than 50 years. (B) Distribution of UCLA scores among patients aged 50 to 70 years. (C) Distribution of UCLA scores among patients older than 70 years.

mean UCLA scores (7.4, $P = .05$), highest modified Knee Society function scores (78, $P = .002$), and highest self-assessment of activity level vs peers (7.2, $P < .001$). These patients were most likely to achieve the same or higher activity level after surgery ($P = .03$).

With respect to individual athletic activities, patients most commonly reported participating in walking, stationary bicycling, swimming, dancing, and golf. A complete list of patient-reported athletic activity participation is represented in Table 4. Of note, only patients who selected a participation level of “regularly” or “occasionally” are represented.

One hundred eighty-seven patients (16%) reported participating in heavy manual labor or sports deemed “not recommended” in a published 1999 Knee Society survey [9]. Patients in this group, on average, were younger than the remainder of those surveyed: 62% of patients were younger than

70 years ($P = .0006$). These patients were also more likely to be men (79% vs 21%) ($P < .0001$). Notably, therefore, 38% of those participating in not recommended activities were older than 70 years at

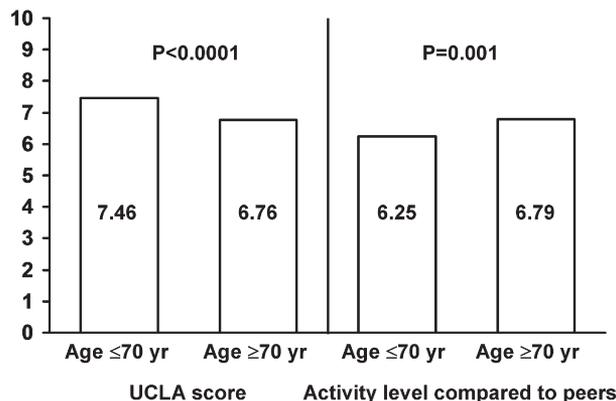


Fig. 4. UCLA score and activity level compared with peers by age group.

Table 3. Outcome Measures by Gender

Knee Score	Mean	SD	Median	Min	Max	P
UCLA						
Female	6.59	1.69	7	1	10	<.0001
Male	7.74	1.8	8	1	10	
Knee Society						
Pain score						
Female	43.11	11.29	45	0	50	.002
Male	45.06	9.32	50	10	50	
Knee Society						
function score						
Female	66.44	22.34	70	0	100	<.0001
Male	75.94	21.61	80	0	100	
Compared						
with peers*						
Female	6.17	2.67	6	1	10	<.0001
Male	6.93	2.6	7	1	10	

*Refers to self-assessment of activity vs peers on a 10-point visual analog scale.

operation, and 21% were women. The group participating in not recommended activities had higher average UCLA scores ($P < .001$), higher Knee Society pain scores (less pain) ($P = .017$), higher modified Knee Society function scores ($P < .0001$), and higher activity level vs peers ($P < .0001$) than the remainder of those surveyed (Table 5). There was no statistically significant difference with respect to activity level before surgery, diagnosis, unilateral vs bilateral TKA, satisfaction with activity level, number of postoperative therapy visits or patient's response regarding the adequacy of postoperative information between this group and the other patients.

Discussion

Total knee arthroplasty has been shown to be successful in relieving pain and improving function. The rating systems currently available for analysis of outcome of TKA focus primarily on pain, function, and satisfaction. In addition to being an important aspect of a patient's clinical outcome, activity level has been correlated with wear and potential implant failure [13,14].

To determine the activities in which patients actually engage after TKA, we performed a detailed survey of a large group of patients treated with modern knee implants. The response rate to the survey (74%) is very high and is a strength of the study. The large patient population, the relatively unselected nature of the series, and high survey response rate increase the likelihood that the findings are valid and generalizable. Nevertheless, it is possible that a patient's activity level could have biased the likelihood of response to the survey.

Notably, there was no significant age difference between those who responded to the survey and those who did not; however, the response rate was slightly greater in men (78%) than in women (71%). Patients in our study had an average UCLA activity score of 7.1, representing regular participation in active events such as bicycling. Our study included only knee arthroplasty patients whose implant had been in place between 2 and 10 years and excluded revisions. Thus, our findings perhaps represent a "best-case scenario" with respect to patient activity in the knee arthroplasty population because revision patients and those with long follow-up periods after operation, during which patient aging and/or deteriorating implants can reduce activity, are not included [15].

Table 4. Representation of Patient-Reported Participation in Sports Documented in the 1999 Knee Society Consensus Guidelines [9]

Sport/Activity	Participation Frequency, Number (%)
Walking (slow)	808 (67.0)
Walking (medium)	715 (59.3)
Stationary bicycle	546 (45.3)
Swimming	354 (29.4)
Dancing	303 (25.1)
Hiking	295 (24.5)
Golf	249 (20.7)
Low-impact aerobics	205 (17.0)
Road bicycling	179 (14.8)
Weightlifting	177 (14.7)
Weight machines	157 (13.0)
Shooting	139 (11.5)
Speed walking	125 (10.4)
Croquet	90 (7.5)
Canoeing	76 (6.3)
Horse shoes	73 (6.1)
Bowling	72 (6.0)
Stationary skiing	63 (5.2)
Shuffleboard	60 (5.0)
Rowing	41 (3.4)
Horseback riding	26 (2.2)
Cross-country skiing	24 (2.0)
Gymnastics*	19 (1.6)
Jogging*	15 (1.2)
Basketball*	14 (1.2)
Volleyball*	13 (1.1)
Doubles tennis	11 (0.9)
Rock climbing*	8 (0.7)
Downhill skiing	8 (0.7)
Singles tennis*	7 (0.6)
Fencing	7 (0.6)
Handball*	5 (0.4)
Ice skating	4 (0.3)
Football*	3 (0.3)
Racquetball*	2 (0.2)
Rollerblading/inline skating	2 (0.2)
Soccer*	1 (0.1)
Lacrosse*	1 (0.1)
Squash*	0 (0.0)
Hockey*	0 (0.0)

*Not recommended activity.

Table 5. Outcome Measures in Patients Participating in Heavy Manual Labor (HML) or Sports Deemed Not Recommended (NRS)

Knee Score	Patient Group	Mean	SD	Median	Min	Max	<i>P</i>
UCLA	HML/ NRS	9.79	0.41	10	9	10	<.0001
	All other patients	6.6	1.53	7	1	10	
Knee Society Pain score	HML/ NRS	45.63	8.61	50	10	50	.017
	All other patients	43.69	10.77	50	0	50	
Knee Society function score	HML/ NRS	84.59	16.75	90	20	100	<.0001
	All other patients	68.14	22.51	70	0	100	
Compared with peers*	HML/ NRS	8.14	2.11	8.5	1	10	<.0001
	All other patients	6.22	2.65	6	1	10	

*Refers to self-assessment of activity vs peers on a 10 point visual analog scale.

Despite the tremendous number of total knee arthroplasties performed each year, there is a surprising paucity of information concerning the specific postoperative activities of most patients. Several previous studies have examined the outcome of total knee arthroplasty in selected patient populations, such as in younger patients [16-18]. Diduch et al [16] reported results of 103 unrevised knees in 80 patients younger than 55 years. Tegner and Lysholm [19] scores were used to document activity level, with 19 patients (24%) achieving a score of 5 or higher, indicating participation in strenuous work or sports activity such as competitive cycling, skiing, or tennis. In our study, although men and patients younger than 70 years had higher mean UCLA scores and Knee Society function scores, 71 patients (38%) of those participating in heavy manual labor or sports deemed not recommended by a Knee Society survey were actually older than 70 years at the time of operation, and 21% were women. This underscores the value of careful activity assessment in patients who had undergone knee arthroplasty regardless of age or sex.

Recently, a Lower Extremity Activity Scale (LEAS) was developed and validated in a revision knee population [20]. Mean improvement on the LEAS scale for patients who underwent revision knee arthroplasty represented a transition from mostly household walking to community walking.

The UCLA activity-level rating has been previously validated for routine activity assessment in a clinical setting, and has been strongly correlated with average steps per day as measured with a pedometer [12]. A potential weakness of this scale is the reported variability in average number of steps per day taken by patients with the same UCLA score. Strengths of the UCLA rating include its ease of use and the lack of a demonstrable ceiling effect, meaning that the scores in this population were not clustered at or close to the maximum score, which has been demonstrated to occur with other outcome measures after hip and knee arthroplasty [21]. In our patients, it appeared that there were 3 main groups with respect to UCLA scores, representing those participating in relatively low, moderate, and high activities. Whether this truly represents a clustering of patients into several distinct activity groups or a clustering based on the semantics of the UCLA scoring system is not certain.

Several patient factors were related to higher activity, including age younger than 70 years, male sex, BMI less than or equal to 30 kg/m², and the presence of unilateral knee arthroplasty without joint limitations. Although patients older than 70 years had a lower average UCLA score, a substantial subgroup achieved a UCLA score of 8 or higher. It is interesting that despite lower UCLA scores, patients older than 70 years had a higher self-assessment of activity vs peers than younger patients. This likely reflects the relatively high demands and expectations of the younger subgroup of patients studied and may reflect a need for improved procedures, implants, and/or improved preoperative education in this subgroup of patients. With respect to gender, our findings were similar to those found by Zahiri et al [12]. On average, women had lower UCLA scores than men. Similarly, women had lower assessment of their activity level vs their peers than men. There was, however, a subset of highly active women in our study; thus, a general assumption of lower activity in women cannot be made. Regarding the influence of comorbidities, our study population showed similar findings to that of Diduch et al [16] in that patients with unilateral knee arthroplasty who denied other joint limitations had higher activity levels and Knee Society function scores than those with symptoms in other joints. More than half of our patients reported that their activities were limited by symptoms in other joints. Addressing painful conditions in the hip, opposite knee, and foot or ankle may allow for increased activity in these patients. A potential weakness of our study is that we did not assess medical

comorbidities or social circumstances, which likely also affected function and activity levels in some of our patients.

Few scientifically based guidelines exist for activity and sports participation after TKA. Healy et al [9] reported a survey of 54 members of the Knee Society regarding recommendations for athletics and sports participation for their patients. A subset of 13 not recommended activities was identified. Other authors have cautioned against regular participation in activities involving high joint loads, such as might be experienced while performing heavy manual labor [10]. In our study, 187 patients (16%) reported participation in heavy manual labor or sports not recommended by the Knee Society. Although more rigorously tested, scientifically based guidelines for return to activity after TKA are certainly needed, it is clear that a subgroup of TKA patients are participating in activities that involve relatively high knee joint loads. It is unknown whether the current generation of knee arthroplasty implants will withstand such loads over longer term follow-up.

This study represents the largest study to date documenting patient-reported activity level including athletics after TKA. The results can be used as a benchmark for patient activity after primary knee arthroplasty. Further study is warranted to determine the effect of activity level on prosthetic longevity.

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