Recommended Guidelines for Physical Activity and Athletics After Knee Arthroplasty

10

Sue Barber-Westin and Frank R. Noyes

10.1 Introduction

In 2013, Weinstein et al. [1] calculated that 655,800 total knee arthroplasty (TKA) recipients in the USA were 50–59 years old and 984,700 patients were 60–69 years old, indicating a large number of individuals that were expected to be active in fitness and recreational activities. Subsequent studies showed a disproportionate increase in the percentage of younger individuals (under the age of 60 years) requiring TKA [2, 3]. This appears to be especially true in individuals that participate in recreational activities over their lifetime who developed knee osteoarthritis (OA) [4–6] and in patients who sustain athletic injuries such as anterior cruciate ligament (ACL) ruptures that underwent meniscectomy [7–12].

TKA is performed in many athletes, as well as individuals who wish to resume a physically active lifestyle after surgery. These patients have high preoperative expectations [13–15] that correlate strongly with postoperative patient satisfaction [14, 16, 17], as detailed in Chap. 12. Therefore, the assessment of which recreational activities are resumed postoperatively is important to determine for preoperative patient counseling and a goal-oriented rehabilitation program to accomplish patient expectations. In addition, objective measurement of the level of physical activity (PA) using validated activity monitors provides realistic data regarding changes in parameters such as percent of time spent in sedentary behaviors compared with light, moderate, or vigorous activities; step counts; time spent walking; distance achieved; and so on. Finally, the determination of whether symptoms of

S. Barber-Westin (✉)
Noyes Knee Institute, Cincinnati, OH, USA
e-mail: sbwestin@csmref.org

F. R. Noyes
Cincinnati SportsMedicine and Orthopaedic Center, The Noyes Knee Institute, Cincinnati, OH, USA

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pain and/or swelling occur with recreational activities is also important to assess the ability of TKA to return patients to an active lifestyle, including aerobic fitness, and achieve high levels of satisfaction. This chapter represents an update of the authors' previous systematic review [18] of this topic in published literature through October 2020.

10.2 Current Physical Activity Guidelines for Healthy Adults

In 2018, the American Heart Association (AHA) updated its guidelines for OA for healthy individuals (Table 10.1) [19, 20]. The guidelines were based on the work of a 17-member advisory committee that extensively reviewed the literature on PA and health [21]. Evidence was rated as strong, moderate, limited, or not assignable and was based on risk factors for cardiovascular disease that can be modified by PA, including blood pressure, blood glucose, blood lipids, and body weight.

Recommendations for substantial health benefits for all healthy adults (aged ≥18) were at least 150–300 minutes of moderate-intensity PA a week, or 75–150 minutes of vigorous-intensity activity, or an equivalent combination of moderate- and vigorous-intensity activity. During moderate-intensity activity, a person can talk but not sing. During vigorous-intensity activity, a person cannot say more than a few words without pausing to catch their breath. In addition, muscle-strengthening exercises of moderate or greater intensity that involve all major muscle groups should be performed at least 2 days a week. Adults aged ≥65 years were also encouraged to do multicomponent PA that includes balance training. They were advised to determine their level of effort for PA according to their level of fitness and whether any chronic conditions were present.

The guidelines allow for a cumulative effect of PA throughout the week. Therefore, the first recommendation was that "adults should move more and sit less throughout the day. Some physical activity is better than none." Therefore, sedentary patients who begin to perform some PA, such as taking the stairs or parking further from a store, could be expected to achieve some benefits.

The 2018 CDC Physical Activity Guidelines [22] further defined activity in terms of metabolic equivalents (METs), which is the most commonly used unit to measure PA. One MET is the rate of energy expenditure while sitting at rest, 1.3 for sitting and reading, 2.0 for walking slowly, 3.3 for walking at 3 miles per hour, and 8.3 for running at 5 miles per hour. Vigorous-intensity activity requires >6.0 METs; moderate-intensity activity, 3.0 to <6.0; light-intensity activity, 1.6 to <3.0; and sedentary activity ≤1.5. PA is also reported in terms of frequency (sessions of moderate-to-vigorous PA per day or week), duration (length of each session), and intensity (in METs). Volume is calculated in MET minutes or MET hours per day or week. The use of personal devices (pedometers and accelerometers) to measure PA allows for volume to be expressed as activity counts or step counts during a period of time.

Table 10.1 Examples of aerobic physical activities and intensities for adults[a]

Adults aged 18–64	
Moderate intensity (person can talk, but not sing, during activity)	Walking briskly (≥2.5 miles per hour) Recreational swimming Bicycling on level terrain (<10 miles per hour) Doubles tennis Active yoga Ballroom or line dancing General yard work and home repair work Exercise classes such as water aerobics
Vigorous intensity (person cannot say more than a few words without pausing for a breath)	Jogging or running Swimming laps Singles tennis Vigorous dancing Bicycling (>10 miles per hour) Jumping rope Heavy yard work (digging or shoveling, with heart rate increases) Hiking uphill or with a heavy backpack High-intensity interval training Exercise classes such as step aerobics or kickboxing
Adults aged ≥65	
Either moderate or vigorous intensity (depending upon the level of fitness and chronic conditions) Moderate intensity: On a scale of 0–10 (0 = sitting, 10 = greatest effort possible), levels 5–6 and produces noticeable increases in breathing and heart rate Vigorous intensity: levels ≥7 and produces large increases in breathing and heart rate	Walking or hiking Dancing Swimming Water aerobics Jogging or running Aerobic exercise classes Some forms of yoga Bicycle riding Some yard work (raking, pushing a lawn mower) Tennis or basketball Walking as part of golf

[a]From Physical Activity Guidelines for Americans, 2nd edition, 2018; U.S. Department of Health and Human Services

10.3 Sports and Recreational Activities After TKA

We assessed data from 21 studies that detailed recreational and sports activities patients participated in postoperatively (Table 10.2) [23–43]. The studies reported a wide range of patients that returned to recreational activities (25–100%, Fig. 10.1). The mean percentages of patients that participated in the most common activities

Table 10.2 Studies that determined sports and recreational activity after TKA

Study	No. of knees	Age mean	F.U. yr mean	Activity monitor	Sports/physical activity rating instruments
Naylor et al. [23]	718	67.8	3	None	Authors' own questionnaire
Rocha Da Silva et al. [24]	59	69.5	>0.5	None	IPAQ
Hepperger et al. [25]	200	72.2	2.0	None	Tegner
Vielgut et al. [26]	260	62.7	14.9	None	Tegner, authors' own questionnaire
Bercovy et al. [27]	494	70.6	7.5	None	UCLA Activity Score
Mayr et al. [28]	81	71.8	6.4	None	Authors' own questionnaire
Chang et al. [29]	369	68.8	2	None	UCLA Activity Score, authors' own questionnaire
Long et al. [30]	108	All ≤55	25.1	None	Tegner
Argenson et al. [31]	104	69.0	10.6	None	UCLA Activity Score
Jones et al. [32]	83	66.5	1	None	Self-Efficacy for Exercise, Historical Leisure Activity
Kersten et al. [33]	830	72.0	3	None	SQUASH
Meding et al. [34]	98	NA	21.1	None	UCLA Activity Score
Bonnin et al. [35]	141	66.4	3.7	None	Knee Function Survey
Jackson et al. [36]	93	66.0	8.7	None	UCLA Activity Score, authors' own questionnaire
Dahm et al. [37]	1206	67.0	5.7	None	UCLA Activity Score, authors' own questionnaire
Hopper et al. [38]	76	62.1	1.8	None	Authors' own questionnaire
Mont et al. [39]	33	66.0	4.1	None	Authors' own questionnaire
Mont et al. [40]	114	70.0	7	None	Authors' own questionnaire
Walton et al. [41]	122	71.5	1	None	Grimby, authors' own questionnaire
Chatterji et al. [42]	144	70.8	1.5	None	Authors' own questionnaire
Huch et al. [43]	312	66.0	5	None	Authors' own questionnaire

F.U. follow-up, *IPAQ* International Physical Activity Questionnaire, *SQUASH* Short Questionnaire to Assess Health-Enhancing Physical Activity, *UCLA* University of California at Los Angeles

including walking, bicycling (stationary or road), hiking, swimming, dancing, fitness training or classes such as aerobic or aquatic, and golf are shown in Fig. 10.2. Evidence was not routinely available regarding the number of sports patients participated in on a weekly basis, although some studies indicated patients took part in more than one sports activity [27, 38, 40]. Frequency of participation was highly variable due to the differing methods reported that included the number of days/week [25, 38], number of days/month [36], mean hours/week [28, 32, 43], mean minutes/week [33], and mean number of times per week any activity was performed [39, 40] (Table 10.3).

Only a few studies described symptoms or limitations that occurred with activity [36, 38, 43, 44]. A "major limitation" during participation was found in 14% in one study [44]. Pain in the knee was reported during activity in 16% in one study [43] and in 17% in another (while golfing) [36]. One investigation [38] reported that 26% of patients had pain in their knee and 26% had a feeling of instability during

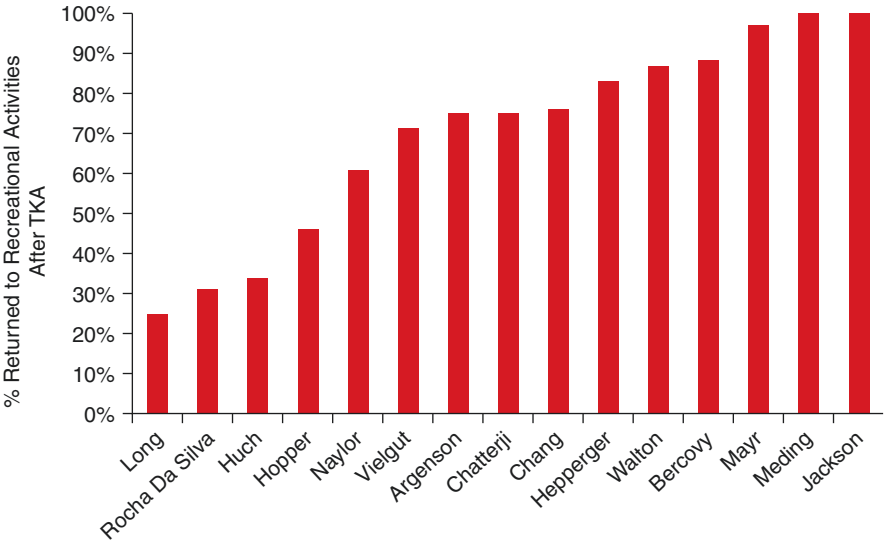
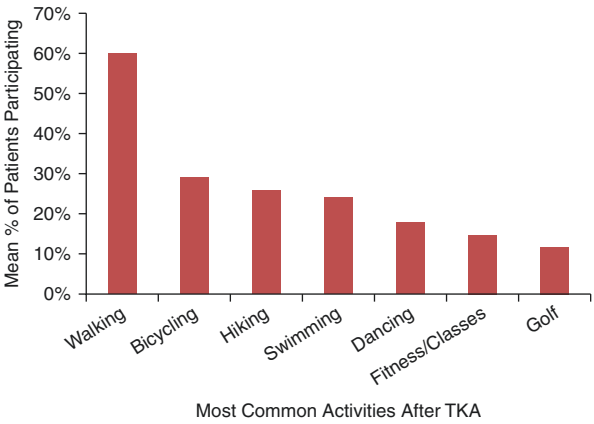


Fig. 10.1 The overall percent of TKA patients that returned to sports and recreational activities per study. These data were not available for five of the 20 studies

Fig. 10.2 The most common sports and recreational activities reported after TKA. Only studies that reported multiple activities were included. The number of studies for each activity was: walking 8, bicycling 13, hiking 8, swimming 13, dancing 7, fitness/classes 8, and golf 9



participation. Factors responsible for the inability to return to PA were usually other musculoskeletal problems or persistent pain in the TKA joint [23, 31, 37, 38, 43].

Factors that influenced return to recreational activities included higher preoperative levels of activity [23, 26, 27], higher educational level [24], male gender [37], and body mass index less than 30 [37]. Most studies found that younger patient age at TKA led to higher postoperative activity levels (<70 years [37], <65 years [33], or "younger" age [26]). There were significant correlations found between University of California at Los Angeles (UCLA) activity scores and SF-36 and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores in one study

Table 10.3 Sports and recreational activities after TKA

Study	% Postoperative participation in sports and recreational activities	Sports and recreational activities	Other results
Naylor et al. [23]	61%	Walking 46%, swimming 9%, fitness exercise 8%, cycling 6%, golf 5%, lawn bowling 4%, tai chi 2%, tennis 1%	Significant factors return to PA: regular PA 1 year preop ($P < 0.001$). Main reasons not able to participate in PA: other musculoskeletal problems 10%, problem with TKA 5%, other medical problem 5%
Rocha Da Silva et al. [24]	34%	Low impact (water aerobics, walking, cycling, weight lifting, pilates) 26%, gymnastics 5%	Significant factors return to PA: older age ($P < 0.001$), lower pain VAS ($P < 0.001$), educational level ($P < 0.05$)
Hepperger et al. [25]	83%	Hiking 74%, skiing 70%, cycling 55%, swimming 38%, cross-country skiing 17%	Frequency of PA (all sports combined): 13% >5 days/week, 57% 2–3 x/week, 13% occasionally
Vielgut et al. [26]	71%	Cycling 26%, hiking 26%, nordic walking 22%, gymnastics 22%, swimming 20%, dancing 9%, fitness training 3%, bowling 3%, badminton 3%, golf 2%, jogging 2%, soccer 2%	Significant factors return to PA: preop Tegner score ($P < 0.001$), younger age ($P < 0.05$)
Bercovy et al. [27]	88%	88% had UCLA score $\geq$ 7 points 30% had UCLA score $\geq$ 8 points 21% participated in more than 1 activity	Significant factors UCLA score: pre-disease UCLA score, age (unknown older or younger age; $P = 0.001$)
Mayr et al. [28]	97%	Cycling 94%, swimming 76%, hiking 70%, fitness training 33%, nordic walking 31%, cross-country skiing 27%, water aerobics 26%, dancing 26%, alpine skiing 25%, tennis 20%, golf 11%, rock climbing 9%	All patients >60 years age. Mean frequency participation (all sports combined): 5.3 hours/week. Significant correlation level PA activity and KOOS sports score ($P = 0.02$), KOOS quality of life score ($P = 0.04$), WOMAC score ($P = 0.03$)
Chang et al. [29]	76%	Walking 60%, swimming 23%, cycling 22%, hiking 6%, gymnastics 5%, <2% badminton, running, golf, table tennis	Regular PA associated higher satisfaction. Postop UCLA scores significantly correlated with SF-36 and WOMAC function scores. No effects in sociodemographic factors, pain relief, postoperative range of motion on PA levels

Study	% Postoperative participation in sports and recreational activities	Sports and recreational activities	Other results
Long et al. [30]	25%	Tegner scores: 4 (8%), 5 (3%), 6 (11%), 7 (3%)	NA
Argenson et al. [31]	75%	75% involved in sports or recreation; most frequent walking, hiking, gardening, swimming, exercising, cycling, and golfing	Mean time to return to PA 6 ± 3 mos. Limitations with PA: 71% none, 23% mild, 6% major. No PA: reasons not related to TKA 19%
Jones et al. [32]	NA	Walking 64%, fitness exercising 32%, weight lifting 31%, gardening 30%, bicycling 24%, swimming 7%, hiking 4%, golfing 4%	Mean frequency of PA: 19.6 hours/week (range, 0–125.6)
Kersten et al. [33]	NA 51% met PA guidelines (≥30 min. moderate-intensity aerobic PA ≥5 days/week or ≥20 min. vigorous-intensity PA ≥3 days/week)	Mean frequency of PA: 1347 minutes/week; 167 ± 135 minutes/week for walking, 122 ± 242 minutes/week for cycling, 52 ± 140 minutes/week for sports. Patients < 65 years of age had greater mean PA per week than those > 65 years ($P < 0.001$)
Meding et al. [34]	100%	36% impact activities such as jogging, volleyball, and singles tennis	All patients participated in moderate activity (UCLA scores ≥5)
Bonnin et al. [35]	NA	Gardening 52%, hiking 35%, stationary cycling 31%, swimming 31%, gymnastics 16%, downhill skiing 8%, dancing 6%, cross-country skiing 5%	Correlation between participation in PA and patient motivation ($P = 0.0001$)
Jackson et al. [36]	100%	Studied only patients who returned to golf	Frequency: 33% 1 x/mo, 36% 2–7 x/mo, 31% >7 ×/mo. Time to return: 3 mos in 13%, 4–6 mos in 44%, 7–9 mos in 20%, 10–12 mos in 8%, >12 mos in 15% Pain while golfing: 17%
Dahm et al. [37]	NA	Walking 67%, stationary cycling 45%, swimming 29%, dancing 25%, hiking 24%, golfing 21%, low-impact aerobics 17%, road cycling 15%, weight lifting 15%, speed walking 10%, croquet 7%, canoeing 6%, bowling 6%	Significant factors higher UCLA score: age < 70 years ($P < 0.001$), male gender ($P < 0.0001$)
Hopper and Leach [38]	46%	1 sport 28%, 2 sports 17%, >2 sports 3%. Swimming 30%, dancing 14%, cycling 9%, bowling 9%, golfing 6%	Mean frequency of PA 2 x/wk, minimum 37.5 mins/session; mean time to return to PA 4.1 mos.

(continued)

Table 10.3 (continued)

Study	% Postoperative participation in sports and recreational activities	Sports and recreational activities	Other results
Mont et al. [39]	100%	All high-impact sports such as jogging, tennis (singles), racquetball, and high-impact aerobics	Mean frequency 4 x/week, 3.5 hours
Mont et al. [40]	NA	High activity group: walking 89%, swimming 53%, weight training 46%, gardening 44%	Mean frequency of PA: high activity group 11 x/week, low activity group 4 x/week
Walton et al. [41]	87%	Walking 66%, swimming 11%, green bowls 11%, fishing 6%, gym work 6%, golfing 5%, cycling 4%	NA
Chatterji et al. [42]	75%	Walking 72%, swimming 15%, bowling 12%, water aerobics 8%, fishing 8%, golfing 6%, exercise class 6%	Mean time to return: 5–6 weeks aqua aerobics, 8 weeks exercise walking, 12–13 weeks exercise class, cycling, golf, 18 weeks bowling
Huch et al. [43]	34%	Swimming ~35%, cycling ~31%, hiking 29%, gymnastics ~8%, dancing ~4%	Frequencies of all PA: 15% <1 hour/week, 15% 1–2 hours/week, 5% >2 hours/week, 65% none

KOOS Knee Injury and Osteoarthritis Outcome Score, *NA* not available, *PA* physical activity, *UCLA* University of California at Los Angeles, *VAS* visual analogue scale, *WOMAC* Western Ontario and McMaster Universities Osteoarthritis Index

[29], and between patient activity levels (high, medium, and low impact) and Knee Injury and Osteoarthritis Outcome Score (KOOS) sports, KOOS quality of life, and WOMAC scores in another study [28].

Although the majority of studies that reported return to activity data following TKA found the majority participated in low-impact activities [45], a few described patients who returned to high-impact sports. However, an analysis of symptoms or limitations with these activities has not been rigorously conducted to our knowledge. For instance, Mont et al. [39] followed a cohort of 31 patients (who represented 4% of their TKA population) that returned to sports that involved running and other high-impact activities a mean of 4 years postoperatively. All but one had excellent clinical outcomes and were satisfied with the result of the operation. The authors stressed their opinion that these types of activities were not appropriate for the majority of patients. However, with a small percentage choosing to return, surgeons should work closely to individualize recommendations. Mayr et al. [28] found that 25% of 81 patients who lived in an Alpine area returned to high-impact activities such as downhill skiing and tennis, and 47% returned to medium-impact sports such as mountain hiking and cross-country skiing. All but one patient had been involved in sports during their lifetime. While most patients were participating in low-impact activities at the 1-year evaluation, the evaluation at 6 years showed increased involvement in higher-impact sports. Hepperger et al. [25] reported that 74% of 200 patients from Austria returned to hiking and 70% returned to downhill skiing 2 years postoperatively. These authors attributed the results to living in the Alpine region and noted that the home geographic environment plays an important role in activities resumed postoperatively.

10.4 Objective Measured Physical Activity After TKA

Eight studies measured movement-related activity, three of which determined the percent of patients who achieved AHA recommended PA guidelines (Table 10.4) [46–53]. At 6 months postoperatively, two studies reported that 0% [47] to 18% [46] met the guidelines, and at 12 months postoperatively, one study [48] found that 16.5% met the guidelines. There was wide variability in study conclusions regarding time spent in sedentary behavior compared with preoperative data, as four studies reported no change [47–49, 51] and three studies reporting a significant decrease [46, 50, 52]. Postoperative PA levels were considerably lower than those of healthy controls in one study [48] and were lower than previously published data in another study [50].

It is important to note that in normal adult populations, investigators have shown that only a small percentage of adults meet AHA guidelines. Whether the data from TKA studies and those from control populations regarding problems achieving PA guidelines are strictly related to aging or are due to other factors such as socioeconomic status and motivation is unclear and worthy of future study. One investigation that measured PA in 2450 healthy adults aged 70–93 years reported that only 15% of men and 10% of women achieved >150 minutes a week of PA [54]. Another

Table 10.4 Studies that determined physical activity after TKA

Study	No. of knees, age mean	Activity monitor, time measured	% Met PA guidelines[a]	Results
Frimpong et al. [46]	45, 63.8	ActiGraph Preoperative, 6 months postop	18%	Sedentary behavior: decreased from 70% preop to 64% at 6 mos postop (~56 mins/day; $P = 0.009$). Proportion time spent in light PA increased from 29% preop to 35% at 6 mos postop (~50 min/day; $P = 0.008$). No change in time spent in moderate to vigorous PA. Significant improvements in UCLA activity scores ($P < 0.001$)
Harding et al. [47]	25, 69.0	ActiGraph Preoperative, 6 months postop	0%	No patient met American PA guidelines. No change in measured PA. Proportion of time in sedentary behavior: 82% preop, 83% postop. Significant improvements in UCLA activity scores ($P < 0.001$)
Lutzner et al. [48]	97, 68.9	activPAL Preoperative, 12 months postop	16.5%	16.5% met PA guidelines. Moderate to vigorous steps/day increased from 1150 ± 982 to 1935 ± 1728 ($P < 0.001$). Time spent in sedentary behavior did not change. Patients took significantly fewer steps/day than age-matched controls
Vissers et al. [49]	21[b], NA	Activity Monitor Preoperative, 6 months, 4 years postop	NA	No significant improvement in either time period: all movement-related activity/24 hour period, % time walking/24 hour period, % time standing/24 hour period, number of sit-to-stand movements/24 hour period. No significant improvement in KOOS Sport and Recreation score
Brandes et al. [50]	44, 65.8	SAM Preoperative, 2, 6, 12 months postop	NA	Gait cycles: significant increase 6 ($P < 0.05$) and 12 ($P = 0.003$) mos postop Significant increase in time spent in moderate and high-intensity walking (>50 gait cycles/minute) 12 mos postop ($P = 0.01$)
de Groot et al. [51]	42, 62.1	Activity Monitor Preoperative, 3, 6 months postop	NA	No significant improvement in all movement-related activity/24 hour period, % time walking/24 hour period, % time standing/24 hour period, number of sit-to-stand movements/24 hour period
Walker et al. [52]	19, 69.0	Numact Preoperative, 1, 3, 6 months postop	NA	Significant increase in total overall ambulatory activity (79%, $P = 0.02$, effect size 1.66), total time standing/24 hour period (64 min. longer, $P = 0.01$), energy expenditure in longest continuous walk ($P = 0.03$). No change in mean amplitude steps/24 hour period

(continued)

Table 10.4 (continued)

Study	No. of knees, age mean	Activity monitor, time measured	% Met PA guidelines[a]	Results
Hoorntge et al. [53]	52 58.4	Activ8 Preoperative, 6 months postop	NA	Small improvement in total waking active time (0.7 ± 0.6%), standing time (1.0 ± 0.9%), and sedentary time (−2.5 ± 1.3%). No improvement with use of an individualized rehabilitation program based on preoperative goal setting

[a]≥150 minutes of moderate to vigorous PA per week
[b]21/42 patients from de Groot et al.'s [51] study

study of 3459 US adults aged 49–85 years measured PA for 7 days and reported that only 2.5% achieved adherence of PA guidelines of ≥30 min/day of moderate-to-vigorous movement intensity [55].

In a systematic review of 26 studies that measured PA levels after total joint (hip and knee) arthroplasty (using either objective instruments or recall questionnaires), Naal and Impellizzeri [56] reported noteworthy heterogeneity and provided recommendations to standardize future studies. They noted patients undergoing total joint arthroplasty were less active than recommended AHA levels. Accelerometers provide realistic data of all types of activity (light, moderate, and vigorous) and give feedback and motivation to patients [57]. Total daily step count is a beneficial motivator, and Garber et al. [58] recommended ≥7000 steps/day, which could be achieved by increasing step counts by ≥2000 as necessary to achieve this level. In 2018, Hammett et al. [59] systematically reviewed the literature for studies that only used accelerometers from preoperative to postoperative from inception of the PubMed database to January 2016 for TKA and total hip arthroscopy. Seven studies were included, four of which focused on TKA, and the authors found no significant increase in PA at 6 months (compared with preoperative) and only a small to moderate effect at 12 months.

Clinical studies usually employ patient self-reporting of activity levels with questionnaires such as the UCLA activity scale [60]. These data are not always reliable, may be subject to recall bias [51, 61], and may overestimate PA compared with objective activity measurements [47, 50, 51]. For example, Harding et al. [47] reported no change in PA parameters 6 months after TKA measured with an accelerometer in 25 patients. However, there was a significant increase in the UCLA activity scores between the preoperative and follow-up evaluations (3 ± 1 and 5 ± 3, respectively; $P < 0.001$). Brandes et al. [50] also reported no correlation between PA and clinical outcomes as measured with the Knee Society Score and SF-36.

10.5 Recommended Sports and Recreational Activities

At the time of writing, the most recent activity recommendations following TKA by the American Association of Hip and Knee Surgeons were published in 2009 (Table 10.5) [62]. Based on the results of 139 completed surveys from the 2007 annual meeting, consensus was reached for low-impact activities such as walking, climbing stairs, bicycling on level surfaces, swimming, doubles tennis, and golfing. Activities that were consistently discouraged included jogging, sprinting, skiing on difficult terrain, and singles tennis. A survey of 94 surgeons from the Netherland Orthopaedic Association included 40 sports, of which the surgeons indicated whether they were allowed, allowed with experience, discouraged, or no opinion [63]. The results for patients <65 years of age are shown in Table 10.5. For patients >65 years of age, the same activities achieved consensus for allowed and not allowed as the younger group. Two additional activities reached consensus for allowed with

Table 10.5 Survey activity recommendations after TKA

Society, study	Activities allowed all patients	Activities allowed with experience	Activities not allowed
American Association of Hip and Knee Surgeons, 2009 [62]	Walking Climbing Bicycling on level surfaces Swimming Doubles tennis Golfing	NA	Jogging Sprinting Skiing on difficult terrain Singles tennis
Netherland Orthopaedic Association, 2018 [63]	*For patients < 65 years:* Aqua fitness Bicycling Dancing Fitness/fysiofitness Golf Game of bowls Nordic walking Swimming Walking	*For patients < 65 years:* Aerobics Canoeing Cross-country skiing Cycling Ice skating Horseback riding Sailing Surfing Table tennis Doubles tennis Yoga	Basketball Football Handball Hockey Korfball Martial arts Running Snowboarding Volleyball
Systematic review 21 studies [64]	Low-impact aerobics Bowling Golf Dancing Walking Swimming	Cycling Hiking Rowing Cross-country skiing Stationary skiing Speed walking Doubles tennis Ice skating	Racquetball/squash Contact sports (football, hockey, soccer) Rock climbing Jogging/running Singles tennis Waterskiing Baseball/softball Handball Martial arts

experience (cross-walking and rowing). A systematic review of 21 studies published from 1986 through 2010 by Vogel et al. [64] provided advice regarding the most appropriate activities after TKA. These authors stressed the avoidance of sports that create high-impact loads and noted that rehabilitation may take at least 3 months to allow low-impact activities.

10.6 Authors' Discussion

Important goals of TKA in younger active patients include maintaining a healthy lifestyle and returning to desired realistic recreational or sports activities. However, in patients who wish to resume moderate- or high-intensity recreational and sports activities after TKA, the high loads placed on the knee joint may result in chronic effusions and muscle dysfunction.

There was a wide range of patients that resumed mostly light, low-impact recreational activities after TKA (25–100%). There are many potential reasons for lack of postoperative participation in recreational activities or PA, including lingering effects of the operation (pain or swelling), the natural aging process, income, educational status, area of residency, personal barriers and beliefs, self-efficacy, and social support [65–68]. The reasons patients elect not to participate in recreational activities after TKA are important to determine, especially in studies in which return to PA is a main focus. Five studies reported that the factors most commonly responsible for the inability to return to PA were other musculoskeletal problems or persistent pain in the TKA joint [23, 31, 37, 38, 43].

Few studies provided data regarding symptoms or functional limitations that occurred during recreational or sports activities. For patient counseling purposes, future studies should provide these data to ensure that preoperative patient expectations are realistic in terms of activities that are resumed after surgery. Finally, no study provided detail regarding the postoperative rehabilitation program. This book describes in detail the role of the physical therapist in guiding a patient back to recreational or fitness activities. Rehabilitation programs that incorporate strength, balance, flexibility, and neuromuscular function have been recommended to safely resume PA [69–71]. Objective assessment of muscular and neuromuscular function prior to release to activities is also recommended [72–75]. A careful balance of joint loads must be managed to reduce chronic knee joint effusions (which is an indicator of the need to reduce activities) and chronic muscle weakness.

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