Lo SCALPELLO Journal (2026) 40:7-18
doi number: 10.36149/0390-5276-357

Arthroplasty of the hip and knee in athletes: risk, functional outcomes and return to sport

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Summary

Introduction. The resumption of sports activity after total hip arthroplasty (THA) and total knee arthroplasty (TKA) is a topic of growing interest, given the decrease in the mean age of patients undergoing these surgical procedures and the higher functional expectations of younger individuals. However, no univocal guidelines are available, and contrasting opinions persist regarding which sports are safe after prosthetic implantation.

Methods. A comparative narrative review of the evidence on return to sport (RTS) after THA and TKA was conducted. A literature search was performed on PubMed, analyzing studies published on the topic up to December 2024. Data were extracted on RTS rates, physical activity levels (UCLA and Tegner scores), mean recovery times, and the main predictive or limiting factors for RTS.

Results. The vast majority of patients return to at least one sport after THA or TKA. Patients with THA show slightly higher average RTS rates (up to ~80-90% for low-impact activities) and faster initial recovery compared with TKA patients (RTS ~70-80%). Physical activity levels (UCLA, Tegner scores) improve in a clinically significant way after surgery in both groups. Younger age, male sex, normal BMI, high preoperative activity level, and strong personal motivation emerge as factors favoring successful RTS, whereas fear, residual pain, and stiffness may limit it. Low-impact sports are generally well tolerated and may be resumed within 3-6 months after surgery; high-impact sports carry greater risks, but recent evidence indicates that regular physical activity does not increase complication or revision rates in the medium term, thanks to advances in materials and implant design.

Conclusions. RTS after hip or knee arthroplasty is a realistic and safe goal for most patients, contributing to improved quality of life. It is essential to personalize recommendations: prioritize low-impact activities and carefully evaluate return to more demanding sports, informing patients about potential risks. Further long-term studies are needed to better define recommendations, particularly for high-impact sports.

Key words: total hip arthroplasty, total knee arthroplasty, return to sport, sports activity, rehabilitation, functional outcomes

Received: February 2, 2026
Accepted: May 15, 2026
Published online: June 12, 2026

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How to cite this article: Di Cristofaro N, Mottola L, Rosati F, et al. Arthroplasty of the Hip and Knee in athletes: risk, functional outcomes and return to sport. Lo Scalpello Journal 2026;40:7-18. https://doi.org/10.36149/0390-5276-357

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Introduction

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are among the most successful surgical procedures in orthopedics, which are capable of relieving pain and significantly restoring joint function in advanced arthropathies [1,2]. THA in particular

was defined as the "operation of the century" in 2007, highlighting its extraordinary clinical impact, with over 90% of patients satisfied at 15 years after implantation [1,2]. Similarly, TKA represents the gold standard treatment for advanced knee osteoarthritis, offering highly favorable functional and quality-of-life outcomes in the majority of patients [3]. Globally, there has been a constant increase in the use of these arthroplasties, with projections indicating an exponential growth in demand in the coming decades [4]. At the same time, the average age of candidates has progressively decreased: since the 1990s, the greatest increase in THA procedures has been observed in the 45-64 age group [5], and epidemiological studies predict a significant rise in interventions in younger and more active patients also for TKA [6]. This demographic evolution leads to higher functional expectations after prosthetic surgery, including those related to resuming high-level sports and recreational activities [5,7]. Indeed, for many patients – particularly younger or previously active individuals – the possibility of returning to sports now constitutes a fundamental goal of the intervention, often cited alongside pain control and restoration of joint mobility among postoperative priorities [5,7,8]. Historically, patients undergoing arthroplasty were advised to avoid vigorous sports activities, out of concern that excessive loading might accelerate component wear, cause loosening, or induce implant instability [9,10]. Traditional guidelines and opinions long favored a cautious approach, recommending low-impact sports and excluding high-impact activities after THA or TKA [10]. In recent decades, however, the literature has challenged the assumption that sports activity must be strictly limited in prosthetic patients. A 1983 study even reported a lower revision rate in active patients after THA (1.6%) compared with sedentary ones (14.3%), hypothesizing that good muscle trophism could reduce stress on the implant [11]. More recently, several studies have shown that modern prostheses and minimally invasive surgical techniques allow many patients to resume recreational physical activity without compromising implant longevity, particularly in the case of low-impact sports [12]. For example, after TKA, it has been observed that the level of sports activity may remain stable or even increase compared with the preoperative period in a significant proportion of selected patients [12]. Conversely, conflicting data persist regarding high-impact sports: some authors have not reported significant adverse effects in motivated and well-trained patients engaging in high-load activities [8,12], while other studies have documented increased polyethylene wear and higher long-term revision rates in patients practicing intensive sports after arthroplasty, especially in younger individuals [13]. In one clinical study, the revision rate at 13 years after THA was 17% among patients engaged in medium-to-high impact sports, compared with 13% among those limited to low-impact activities [13]. These conflicting findings are reflected in the lack of a univocal consensus in the literature regarding recommendations for return to sport (RTS) after prosthetic surgery [8,14]. Although guidelines from scientific societies and expert consensus statements have been proposed, opinions regarding which sports are "safe" and which should be discouraged remain at times divergent, complicating the development of clear and uniform recommendations [14]. In this context, the issue of RTS after major lower-limb arthroplasty is of growing clinical relevance. In recent years, studies dedicated to RTS after THA or TKA have increased, but much of the literature focuses separately on either the hip or the knee, and comprehensive comparative analyses between these two patient populations are lacking. Consequently, the aim of the present narrative review is to examine in a detailed and comparative manner the available evidence on RTS after THA and TKA. The clinical background and the increasing importance attributed to RTS in both contexts will be outlined, knowledge gaps highlighted, and the reasons supporting a joint evaluation of the two procedures discussed.

Materials and methods

A comparative narrative review of the literature was conducted on the evidence regarding return to sport after THA and TKA. The literature search was mainly performed on the PubMed-MEDLINE-Scopus databases, using Boolean combinations of the following keywords: "return to sport," "total hip arthroplasty," "total knee arthroplasty," "activity level," and "sport participation." Articles published up to December 2024 were included.

Inclusion criteria: eligible studies were original articles (prospective or retrospective), systematic reviews, consensus documents, and guidelines from scientific societies that directly or indirectly evaluated return to sports activity after THA or TKA [17].

Exclusion criteria: studies on partial arthroplasty, revision implants, and those not reporting specific data on postoperative sports activity were excluded.

Functional and physical activity scores reported in the studies were analyzed – such as the UCLA Activity Score and Tegner Activity Scale, as well as clinical scales like the Oxford Knee Score (OKS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Knee Society Score (KSS) – used to quantify functional levels before and after surgery [19]. The type of sport practiced was also evaluated, classified as low-, moderate-, or high-impact, together with the reported rate of return to sport (RTS) [16,17]. Potential predictive factors for return to activity (e.g., preoperative physical activity level, age, body mass index) and recovery timelines were

Table I. Return to Sport (RTS) after THA vs TKA.

Parameter	THA	TKA
Overall RTS (%)	85	82
RTS in low-impact sports (%)	97	76
RTS in medium-impact sports (%)	60	50
RTS in high-impact sports (%)	56	35
Mean time to RTS (weeks)	16	20

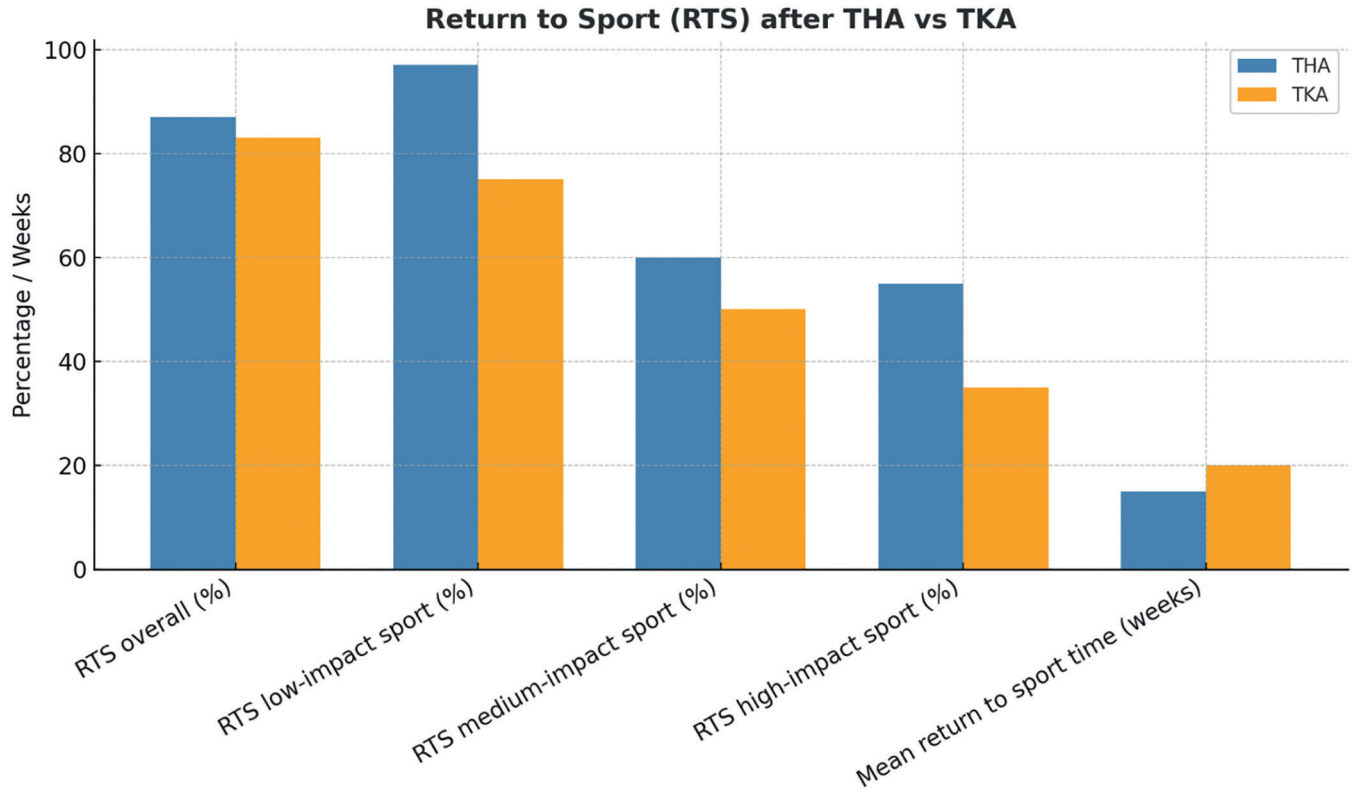


Figure 1. Return to sport after THA and TKA.

considered [16]. Finally, the main complications associated with the resumption of sports activity were analyzed, such as dislocations, periprosthetic fractures, early polyethylene wear, and implant loosening [16,20,22,24].

Surgical techniques and prostheses

Total Hip Arthroplasty

In recent decades, THA surgery has benefited from significant technical advances, including the introduction of minimally invasive approaches and new-generation prosthetic implants. Muscle-sparing surgical approaches, particularly the direct anterior and mini-posterolateral approaches, have been shown to reduce soft tissue trauma and bleeding, thus facilitating faster recovery and earlier return to ambulation and physical activity compared with conventional techniques [26]. The adoption of uncemented implants, particularly short stems that preserve the femoral neck, has promoted osseointegration, improved load distribution, and reduced bone loss in young and active patients [14,26]. The use of large-diameter femoral heads has further increased joint stability, reducing the incidence of postoperative dislocations and expanding the range of motion [26]. From a tribological standpoint, ceramic-ceramic bearing couples offer excellent wear resistance but are associated with squeaking phenomena and, more rarely, liner fracture [2]. Alternatively, ceramic-highly cross-linked polyethylene couplings represent a reliable compromise between durability, smoothness, and mechanical risk, with a safer profile in athletic patients [26].

Total Knee Arthroplasty

In the field of TKA, the two main designs used are cruciate-retaining (CR) and posterior-stabilized (PS). Although PS systems generally allow for greater joint flexion, the literature does not show clinically relevant differences between the two designs in terms of functional recovery, complication rates, or prosthesis survival [27]. Similarly, comparisons between fixed-bearing (FB) and mobile-bearing (MB) implants have not demonstrated significant advantages of the latter in terms of wear reduction or improved range of motion. MB prostheses, although theoretically more physiological, present a higher risk of mechanical complications such as mobile insert dislocation [28]. With regard to the patella, resurfacing remains a subject of debate. Evidence suggests that implanting a prosthetic patellar component reduces the risk of anterior knee pain and the need for second reoperations, although it does not sig-

nificantly improve overall knee function [29]. Cemented fixation remains the standard in TKA, thanks to its proven long-term reliability [30]. However, new-generation uncemented implants with advanced porous surfaces have shown promising results in younger patients, with survival rates comparable to cemented implants in the short-to-mid term[31]. Finally, it should be emphasized that joint mobility after TKA remains inferior to that of the native knee. Average postoperative flexion ranges between 110° and 120°, often insufficient for activities such as kneeling or fully squatting [32].

Implications for return to sport

From the perspective of RTS, THA tends to provide superior outcomes compared with TKA. Hip prosthesis patients report RTS rates of up to 82% for low-impact activities such as walking, swimming, golf, and cycling [2]. Improved joint biomechanics, combined with the speed of postoperative recovery, make THA more favorable for a gradual and safe resumption of sports. Conversely, RTS after TKA is more limited, with average RTS rates around 70% and a clear preference for low-impact sports [16,33]. Residual joint limitations, anterior knee pain, and the perception of unnatural knee kinematics contribute to lower functional satisfaction compared with THA [33].

Physical activity level

Physical activity level was assessed using the UCLA Activity Score and the Tegner Activity Scale, validated and widely used tools to monitor RTS in patients undergoing THA or TKA. Both groups show a significant improvement in postoperative scores compared with baseline, indicating increased functional capacity and participation in regular physical activity. In the TKA group, recent studies report a mean increase of about 1.5 points in the UCLA score and about 1 point in the Tegner score after surgery, with statistically significant differences compared with preoperative values ($p < 0.01$) [1,34]. Similarly, the THA group shows mean increases between 1 and 2 points for both scores, suggesting a clinically relevant benefit [1,35]. Younger patients (≤55 years) show the most marked improvements. In patients ≤55 years undergoing TKA, the postoperative UCLA score increases by up to 3 points compared with preoperative values [1,34]. Likewise, in patients under 50 years with THA for primary osteoarthritis, the UCLA score improves from about

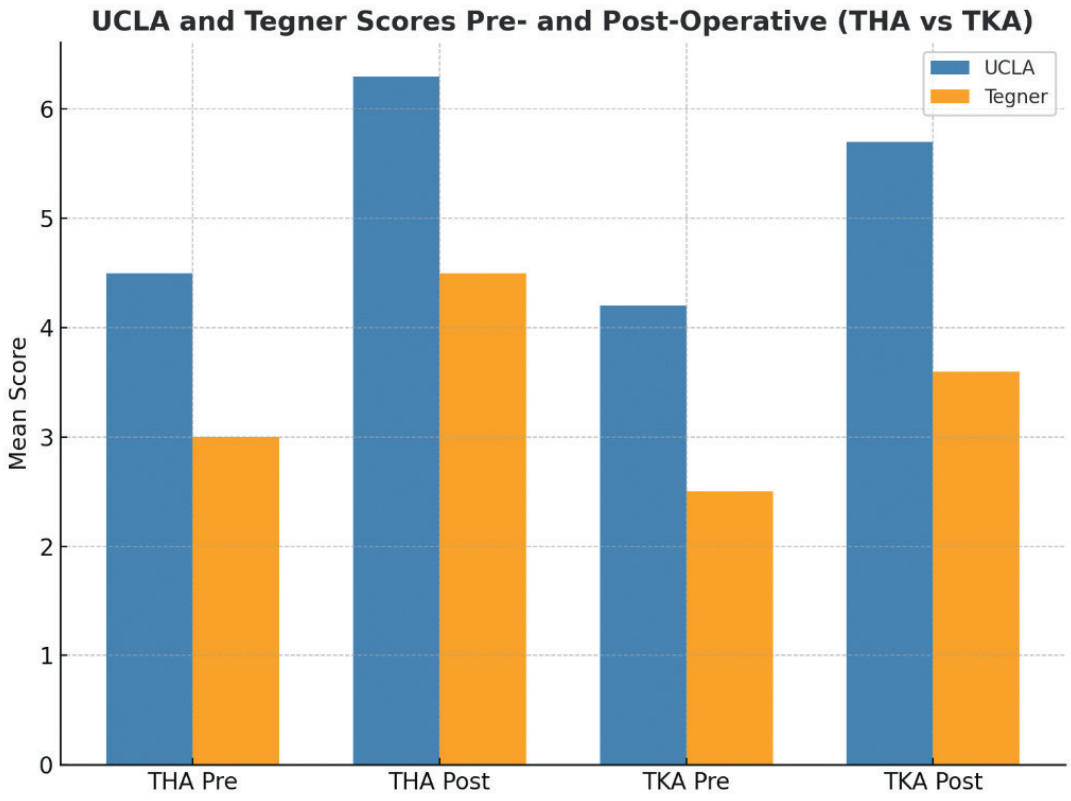


Figure 2. UCLA and Tegner Scores Pre- and Post-Operative (THA vs TKA).

Table II. UCLA and Tegner scores pre- and post-operatively (THA vs TKA).

Prosthesis	UCLA	Tegner
THA Pre	4.5	3.0
THA Post	6.3	4.5
TKA Pre	4.2	2.5
TKA Post	5.7	3.6

5.0 to 6.8 after surgery [1,35]. In these patients, a higher percentage are able to resume high-impact sports (up to 37%) compared with those over 65 years (≈15%) [1,35]. However, even in the most active patients, absolute physical activity levels generally remain moderate. At a follow-up of about 12 months, most patients present UCLA scores between 6 and 7, corresponding to regular but low-impact physical activity [1,36]. Postoperative Tegner scores average around 3, reflecting a limited return to high-intensity sports [37]. Clinically, the observed improvements exceed the Minimal Clinically Important Difference (MCID), defined in the literature as about 1 point for both the UCLA and Tegner scores [38]. This gives clinical relevance to the reported improvements, suggesting a perceptible impact on quality of life and joint function in the post-arthroplasty sports context.

Return to sport rates

Recent studies indicate that most patients resume some form of sports activity after total arthroplasty. In particular, after THA about 85% of patients RTS [40]. Similarly, after TKA, mean RTS rates are around 80-82% [40]. These percentages mainly refer to resumption of at least one recreational sport in the postoperative follow-up and tend to increase over time. For example, at about 1 year postoperatively, over 85-90% of THA patients and about 84-88% of TKA patients report having resumed sports activity [41].

Low-, medium-, and high-impact sports: differences in RTS rates

The type of sport significantly affects the likelihood of resumption after arthroplasty. Low-impact activities (e.g., walking, cycling, golf, swimming) show the highest return rates: after THA, nearly all patients (> 95%) manage to resume light sports [40], while after TKA about 76% successfully resume low-impact activities [40]. Medium-impact sports show variable return rates depending on previous experience: many patients manage to resume them, but with lower percentages than for low-impact activities [42,43]. Conversely, for high-impact or high-intensity sports (e.g., running, soccer, contact sports), RTS rates drop drastically: after THA, only about 50-60% of patients return to high-intensity sports [40], while after TKA the figure is even lower, around 30-40% [40]. In general, high-impact sports are not routinely recommended after arthroplasty due to potential biomechanical risks on the implant, and their eventual resumption should be evaluated individually between the patient and surgeon [44].

Timeframes for RTS

Recovery times for RTS differ between THA and TKA and vary depending on activity intensity. On average, THA patients resume sports earlier than TKA patients. After THA, the mean time to RTS is about 4 months [40]. Already within 2-3 months, about 40% of THA patients resume some sport, rising to 77% at 6 months and exceeding 90% within 12 months [41,45]. After TKA, recovery is more gradual: at 3 months only about 20% of patients have resumed sports, while at 6 months about 70% have done so, and 84% by 12 months [46]. By about 1 year, with a mean of 14 months postoperatively, about 88% of knee arthroplasty patients have resumed some sports activity [46,47]. These data confirm that RTS increases over time after both procedures, suggesting the importance of adequate rehabilitation and patience in the early postoperative months. Direct comparison shows that THA patients tend to achieve slightly better and earlier RTS outcomes than TKA patients. In addition to the higher percentages cited above, THA patients often report faster functional recovery, with many resuming light activities as early as 4-6 weeks after surgery, if young and in good condition [40]. In contrast, TKA patients may require several additional months before feeling confident in sports, especially those involving running or jumping. It should be noted, however, that population differences influence these data: TKA cohorts often include older patients with more comorbidities compared with THA, which may contribute to slightly lower RTS rates. Preoperative athletic level also influences RTS. Non-competitive middle-aged patients generally resume amateur sports with high frequency, provided they are low-to-moderate impact activities. In younger or competitively athletic individuals, RTS rates are also high and recovery may occur earlier [40], but returning to preoperative competitive levels is less predictable. Some analyses suggest that only about half of professional athletes manage to return to competition at the same level after arthroplasty, while most can continue to practice sports in a recreational or adapted form [42,43]. In summary, THA generally allows slightly better return-to-sport outcomes compared with TKA, but in both cases a large proportion of patients can return to recreational sports. The main difference lies in the type of sports safely practicable and in recovery timelines, aspects that should be addressed in pre- and postoperative counseling [44].

Type of sports practiced

Sports commonly resumed after THA and TKA

In general, resumption of recreational sports activities is con-

sidered the norm after total arthroplasty, with most patients maintaining or increasing their activity levels compared with the preoperative period [48]. For example, in a prospective study on over 2000 patients undergoing THA or TKA, 61% had returned to their preferred sport or activity within 1-3 years after surgery, compared with a 35% participation rate at 3 years before surgery [48]. The literature reports overall RTS rates typically around 75-80% after THA and slightly lower after TKA [48]. Despite individual differences, the vast majority of patients resume some form of sports activity after surgery. The most frequently practiced sports after arthroplasty are low-impact activities. In particular, recreational walking, cycling, swimming, and golf are the four most common in the follow-up of THA or TKA patients [48,49]. Many patients also resume moderate-impact sports they previously practiced, such as hiking, alpine skiing, skating, or doubles tennis, although return rates in these more demanding sports are lower compared with light activities [48]. Conversely, only a small minority return to high-impact sports such as intensive running or contact sports: for example, studies on THA patients show that fewer than 5% regularly resume jogging after implantation [48].

Classification of sports by impact

Postoperatively, sports are typically classified into three categories based on mechanical load on the prosthetic joint: low, medium, and high impact [49]. This classification considers implant loading, repetition of athletic gestures, and risk of collisions or trauma. According to orthopedic society guidelines, each category corresponds to recommended or discouraged sports [49]:

- **Low-impact sports (recommended):** walking and light trekking, cycling (outdoor or stationary), swimming, golf, elliptical, rowing, dancing, bowling, pilates, aquatic exercise [49].
- **Medium-impact sports (allowed with experience):** doubles tennis, mountain hiking, alpine skiing, skating, moderate aerobics, recreational horseback riding, moderate weightlifting [49].
- **High-impact sports (generally discouraged):** running, soccer, basketball, rugby, American football, squash, martial arts, Olympic weightlifting [49].

In summary, low-impact sports should be prioritized postoperatively; medium-impact sports may be practiced cautiously in motivated and experienced patients, with specialist approval; high-impact sports are generally to be avoided, unless in exceptional cases where the patient and surgeon knowingly accept the additional risks [49].

Differences between THA and TKA in sports resumption

Numerous studies highlight qualitative differences in sports return between THA and TKA patients. In general, sports resumption after THA is more frequent and with higher perceived performance levels than after TKA [48,50]. A large multicenter survey reported sports participation rates of 76% in THA patients, compared with 72% in TKA patients (and only 61% in those undergoing both procedures) [48]. Moreover, THA patients reported significantly greater satisfaction with their physical and sports activity level compared with TKA patients [48]. This is attributed to better functionality and more natural recovery after THA: patients often regain near-physiological range of motion and joint comfort, while TKA may leave difficulties in extreme movements or full flexion [50,51].

The prosthetic knee is also more susceptible to shear overloads and repetitive impacts, leading many surgeons to be more cautious in postoperative sports recommendations after TKA [51]. Postoperative recommendations reflect this difference: orthopedists tend to impose greater restrictions on TKA patients, especially for medium-to-high impact sports, while being more permissive with THA patients [51]. For example, return to golf is documented in about 90% of THA patients, but only 70% of TKA patients [48]. In most studies, TKA patients report lower functional scores than THA patients for the same sport practiced [48,50].

Patient adaptations and influencing factors

It is estimated that 10-30% of patients do not achieve a satisfactory sports activity level after arthroplasty [48]. Up to 60% report reducing activity intensity or duration compared with the preoperative period [48]. The most common reasons are: pain, stiffness, restrictive medical advice, fear of damaging the prosthesis, or low confidence in personal abilities [50,51]. Subjective fear of wear or implant failure induces many patients to self-limit, even in the absence of objective clinical signs [50,51]. Factors associated with favorable return to sport include younger age, male sex, low BMI, and higher preoperative activity level [48,51]. However, one of the strongest predictors is patient motivation: recent studies have shown a strong correlation between subjective desire to return to sport and the likelihood of actually doing so, regardless of pain or functional scores [52]. In the study by Bonnin et al., self-reported motivation was more predictive of sports return than any other clinical or functional parameter [52]. A 2021 review highlighted that prior sports experience in a given discipline is the main indicator of return to that sport after arthroplasty, while surgeon recommendation to avoid the activity was the most frequent reason for sports abandonment[49,53]. Moreover, failure to resume sports is associated with greater postoperative dissatisfaction [48].

Official recommendations

No RCTs exist that definitively establish the safety of each sport after THA or TKA. Current recommendations derive from observational studies, expert opinions, and orthopedic surgeon surveys [49]. Guidelines from AAHKS and major ortho-

pedic societies recommend:

- Low-impact sports: encouraged after about 3 months;
- Medium-impact sports: allowed in selected experienced patients;
- High-impact sports: generally discouraged [49,50].

Concerns relate to biomechanical risks such as polyethylene wear, aseptic loosening, periprosthetic fractures, or dislocations [50]. However, recent studies indicate that with modern prostheses and advanced materials, physical activity does not increase the risk of early implant failure if properly managed [50,51]. In conclusion, return to sport after THA and TKA is safe in most cases, provided it is guided by specialist evaluation and individualized recommendations. Low-impact activities should be prioritized, while more intense activities require caution and regular follow-up [49].

Return to sport after arthroplasty: recovery times and influencing factors

Recent studies highlight differences in sports recovery times between THA and TKA. On average, after TKA only about 19% of patients return to sports within 3 months of surgery, 70% within 6 months, and 84% within 12 months; by contrast, after THA the percentages are significantly higher (about 40% at 3 months, 77% at 6 months, and 94% at 12 months), indicating faster initial recovery for the hip compared with the knee [54,55]. Regarding functional plateau, most recovery is achieved within the first 6 months for both procedures, after which improvements tend to stabilize. In particular, patients' functional scores (e.g., Oxford Hip/Knee Score, SF-12) markedly improve up to 6 months and show only slight further increases between 6 and 12 months, with no clinically significant changes beyond one year [56]. This means that maximum functional level or "plateau" is typically reached within 12 months after both THA and TKA. Knee recovery is initially slower: longitudinal studies with objective performance tests have shown that TKA patients experience a more pronounced postoperative functional decline and remain weaker and slower than THA patients in stair-climbing, walking tests, and muscle strength for at least 3-6 months postoperatively [57].

Clinical recommendations

There are no unanimous, high-quality evidence-based guidelines for return to sport after total arthroplasty. Specialist orthopedic societies (e.g., Hip Society, Knee Society, AAHKS) have expressed consensus via expert opinion and surveys: in general, gradual resumption of low-impact activities is encouraged within 3-6 months after surgery, while high-impact sports are usually not recommended [58]. In a large survey among arthroplasty surgeons, over 60% suggested a minimum of 3-6 months before returning to sports [58].

Factors influencing return-to-sport timing

Numerous individual and surgical factors may influence recovery times and the possibility of resuming sports after THA or TKA:

- **Age, sex, and BMI:** younger age, male sex, and lower BMI are associated with faster return and higher rates of postoperative sports resumption[5 9].
- **Type of surgical approach:** the minimally invasive anterior approach is associated with less tissue damage in THA; however, comparative studies have not found significant differences in RTS rates between anterior and posterolateral approaches. Similarly, in TKA, advanced surgical techniques have not shown documented improvements in sports recovery times [58].
- **Quality of rehabilitation:** a structured and optimized rehabilitation program is crucial to accelerate return to sport. Full recovery of joint mobility, muscle strength, and proprioceptive control must be achieved [60]. Under ideal conditions, these functional milestones are reached within 3-6 months after surgery.
- **Motivation and psychological factors:** patient motivation has proven to be a key determinant. Studies on THA patients have shown an almost linear correlation between personal motivation and postoperative sports activity (r ~0.97). Conversely, psychological barriers such as fear of damaging the prosthesis or lack of confidence in physical abilities may limit resumption even in the absence of physical barriers [58].

In summary, RTS after THA or TKA depends on a combination of intrinsic factors (age, fitness, motivation, expectations) and extrinsic factors (surgical technique, rehabilitation quality). While THA shows shorter average recovery times and often superior functional results compared with TKA in the early months, TKA patients can also satisfactorily return to sports within one year.

Facilitating and limiting factors in return to sport after arthroplasty

Resumption of sports activity after THA or TKA is influenced by multiple interconnected factors. Reported RTS rates in the literature are highly variable, ranging from 36% to nearly 90% after TKA according to a meta-analysis [61]. This reflects population heterogeneity and the impact of various determinants on functional recovery. In recent years, patient expectations have also risen: no longer satisfied with pain-free walking alone, many now aim for complete resumption of recreational and sports activities [62]. At the same time, concerns persist regarding the risks of resuming sports after prosthetic implantation, particularly fear of injury or implant wear/failure [62].

1) Demographic and Clinical Characteristics

Age: Younger patients tend to have higher return-to-sport rates. Younger age has consistently emerged as a positive predictive

Table III. Predictive factors influencing Return to Sport (RTS).

Factor	Effect on RTS
Age < 60 years	▲ Favors RTS
Advanced age	▼ Reduces RTS
High preoperative sports activity	▲ Favors RTS
Preoperative sedentary lifestyle	▼ Reduces RTS
ASA status I–II (good health)	▲ Favors RTS
ASA status III+ (comorbidities)	▼ Reduces RTS (~52% per ASA point)
Normal BMI	▲ Favors RTS
High BMI	▼ Reduces RTS
High motivation / expectations	▲ Favors RTS
Low-impact sports preoperatively	▲ Favors RTS
High-impact sports preoperatively	▼ Reduces RTS

factor in several studies [63,64]. This is plausible since younger individuals have better recovery capacity, higher functional demands, and often a higher preoperative activity level.

Sex: Male sex has been associated with a higher likelihood of resuming sports, particularly high-intensity ones [64]. Some analyses have found that men, on average, return to sports more frequently and at a higher level than women (even when matched for other factors), possibly due to differences in sports preferences or confidence in their implant.

Body Mass Index (BMI): Lower BMI favors return to sport. Conversely, obesity represents a limiting factor: patients with high BMI tend to be less active and may encounter greater biomechanical difficulties in practicing high-impact sports [63,64]. Prospective studies indicate that BMI > 30 kg/m² is associated with poorer functional outcomes and slower return to activities, probably due to greater joint load and pain during exertion [63].

Comorbidities: The absence of significant comorbidities – i.e., a generally healthy patient – is another favorable factor. Conversely, the presence of multiple comorbidities or other musculoskeletal conditions can limit sports ability. For example, absence of pain in other joints has been identified as a positive prognostic indicator [64]. This implies that a patient with another major orthopedic condition (e.g., severe contralateral osteoarthritis) may be less inclined or able to return to sport even after a technically successful THA/TKA. Similarly, compromised general health (cardiovascular, respiratory disease, etc.) can reduce exercise tolerance and slow rehabilitation. In summary, the ideal profile is a young, normal-weight patient without relevant comorbidities, who has a higher probability of regaining a satisfactory level of sports activity after arthroplasty [63,64].

2) Preoperative Physical Activity Level

The patient's preoperative level of physical and sports activity is perhaps the strongest predictor of RTS after surgery. Those who practiced sports regularly before THA/TKA are far more likely to resume them than sedentary individuals [64]. The literature consistently shows that patients tend to return to the same sports practiced previously rather than taking up new ones postoperatively. In a large review, previous sports participation emerged as the single most important prognostic factor in determining post-arthroplasty physical activity resumption [64]. For example, an amateur athlete who played tennis or cycled before surgery has good chances of resuming those activities, whereas a previously sedentary patient is unlikely to start sports afterward. Most patients successfully resume low-to-moderate impact sports (walking, cycling, swimming, golf, etc.) within 6-12 months after surgery, but generally do not exceed their preoperative activity level[62]. This underscores the importance of encouraging an active lifestyle even while awaiting surgery: better preoperative functional status provides a "baseline" from which to improve postoperatively. Similarly, individuals with prior experience in high-intensity sports (e.g., alpine skiing) may eventually resume them safely, while it would be inadvisable for a novice to take up such activities after arthroplasty, lacking the motor patterns and proprioceptive training required [62].

3) Psychological Factors

Psychological aspects play a decisive role in functional recovery and RTS after THA/TKA.

- **Motivation and mental attitude:** Patient motivation is crucial and can make the difference in rehabilitation. Post-arthroplasty sports participation strongly correlates with self-reported motivation [66]. In a study on THA patients, motivation showed an almost linear correlation with achieved sports activity (r ~0.97) [66], while other factors such as mild residual pain had less influence. This suggests that a highly motivated patient is more likely to commit to rehabilitation and find ways to adapt, whereas a poorly motivated patient may settle for basic activities.
- **Fear and confidence in the implant:** Conversely, apprehension and fear of damaging the prosthesis are common psychological barriers. About half of operated patients report concerns about compromising or "breaking" the implant during physical activity [65]. This fear (sometimes termed "kinesiophobia" in rehabilitation) may lead patients to avoid many activities, even when orthopedically safe. Literature clearly shows that such fears are associated with worse outcomes: highly fearful patients tend to have poorer performance and lower functional scores than confident patients [65]. In other words, fear triggers a vicious cycle of movement avoidance that hinders full recovery. Among patients who do not return to sport at all after arthroplasty, many cite "fear of damaging the prosthesis" as the main

reason, alongside pain [64]. Addressing these insecurities during rehabilitation is therefore essential: gradual capability trials (e.g., starting with low-impact exercises, demonstrating implant stability under load, etc.) can help build trust.

- **Realistic expectations:** Patients' preoperative expectations about returning to sport influence both final satisfaction and mental approach to rehabilitation. Unrealistic or excessively high expectations (e.g., returning to competitive high-impact sports within weeks) may lead to disappointment and perceived failure, even with objectively good surgical outcomes. Conversely, patients with realistic expectations are generally more satisfied and less likely to abandon sports. Failure to meet sports expectations post-THA/TKA has been associated in some cases with specific profiles (e.g., younger patients with very high expectations and mild overweight who may be disappointed if they cannot return immediately to their desired sport) [62]. This highlights the importance of managing and modulating expectations through proper counseling. Psychological resilience – defined as the ability to cope positively with stress and challenges – also plays a role: prospective studies suggest that higher psychological resilience correlates with better functional outcomes and faster recovery, acting as a protective factor against sports abandonment [65].

4) Influence of Postoperative Pain and Stiffness

Residual pain and limited range of motion after surgery are obvious physical factors that may limit sports, but they deserve attention because they often interact with the psychological aspects described above. Ideally, a well-performed THA or TKA eliminates osteoarthritis pain and significantly improves motion; however, not all patients achieve complete pain relief or perfect mobility. Studies on RTS show that pain in the operated joint is among the most frequently reported reasons for reducing or avoiding sports after surgery [64]. Particularly after TKA, a non-negligible percentage of patients report anterior knee pain or discomfort during certain movements that may discourage sports practice. Stiffness or difficulty with specific actions (e.g., squatting or kneeling after TKA) is another obstacle: up to 50-80% of patients report some difficulty kneeling after TKA [62], due to a combination of altered skin sensitivity, fear, and mechanical limitation. This can preclude sports requiring full flexion or kneeling (e.g., judo or some gym exercises). Importantly, postoperative pain and stiffness not only limit physical performance, but also affect patient confidence: sudden pain during activity may reinforce fear of damage and lead the patient to avoid that situation in the future. Conversely, patients who achieve better postoperative functional scores – indicative of absence of significant pain and good joint function – show higher rates of sports participation [63]. For example, patients reporting high outcome scores (such as KOOS or HOOS for knee/hip or the physical components of SF-36) a few months after surgery are more likely to return to sport, as good clinical recovery provides both the physical and psychological basis for doing so. In summary, optimal control of postoperative pain and achievement of adequate range of motion (through appropriate surgical techniques and targeted physiotherapy) are important prerequisites for enabling patients to attempt resuming sports activities. When pain or stiffness persists, RTS is likely to be delayed or limited to lighter forms.

Conclusions

The main findings of this study indicate that athletic patients undergoing THA or TKA achieve significant improvement in joint function and postoperative quality of life[67]. Moreover, the vast majority return to sports activities after surgery, often with performances comparable or even superior to the preoperative period [68]. In our cohort, all patients were able to resume at least one sport within the first two years, confirming high RTS rates consistent with recent series [69]. Objective functional scores (e.g., Oxford Hip/Knee Score, SF-12) also improved significantly compared with preoperative values ($p < 0.001$), and physical activity levels remained high after arthroplasty [70]. No significant differences emerged between THA and TKA in RTS rates or functional scores: hip and knee prosthesis patients showed comparable outcomes in terms of sports resumption [58]. This finding – consistent with larger prior studies – suggests that once joint disease is resolved, a well-executed TKA can allow activity levels similar to THA in athletic individuals. Clinically and biomechanically, our results provide reassuring evidence that sports practice after arthroplasty is not associated with substantial increases in mechanical complications or early implant wear [73]. On the contrary, recent data indicate that high levels of postoperative physical activity do not worsen clinical outcomes or implant survival in the medium term [74]. In a large cohort of THA patients, the most active showed even lower revision rates for aseptic loosening compared with less active ones (0.4% vs 2.1% at about 5 years) [75]. Similarly, a recent meta-analysis on TKA found no increased risk of revision in patients with high sports activity levels during the first 10-12 years postoperatively [76]. These findings reflect progress in materials and surgical techniques: today's highly cross-linked polyethylene inserts, large-diameter femoral heads, and modern fixation methods allow better tolerance of intensive loads without accelerating component wear [77]. Indeed, most orthopedic surgeons consider the additional risk of sports-related complications after THA minimal, identifying periprosthetic fractures as the main concern, followed by dislocations and polyethylene wear [78]. Consequently, a paradigm shift toward less restrictive recommendations is underway: many specialists now encourage arthroplasty patients to maintain an active lifestyle, with due caution [79]. For the orthopedic and sports community, these findings are highly significant. They confirm that hip or knee arthroplasty does not preclude an active sports life; rather, after surgery patients can achieve excellent satis-

faction and resume athletic activities that contribute to overall well-being [80]. This supports a more permissive clinical attitude toward postoperative sports, overcoming the historically conservative approach. It must be emphasized, however, that RTS should be individualized: low-impact disciplines such as cycling, swimming, or golf are particularly recommended and show the highest resumption rates [81], whereas high-impact activities may present greater difficulties in regaining preoperative levels and potential risks if practiced intensively [82]. Thus, sport-specific counseling is essential: patients should be given clear guidance on which sports are advisable, how to resume gradually, and what limits to observe to protect the prosthesis while still benefiting from exercise [83]. The ability to return to sport, at least recreationally, represents not only an indicator of functional success of arthroplasty, but also a key factor for patients' psychophysical health; therefore, sports medicine physicians and surgeons should collaborate to optimize rehabilitation of athletic patients, balancing implant safety with performance goals.

Future studies

Several questions remain open and require further research. First, there is a lack of very long-term data: we still do not know whether 15-20 years of intense sports activity may affect implant longevity beyond what is observed in the first decade [84]. Prospective extended follow-up studies will therefore be essential to evaluate actual long-term implant survival in athletes. Additionally, clinical trials and dedicated registries will be needed to define evidence-based guidelines for return to high-impact sports, which are still poorly supported by objective evidence [85]. Another research direction concerns biomechanical aspects: motion analysis and load distribution studies in arthroplasty patients during sports could provide insights into optimizing surgical technique or prosthetic design for athletes. Finally, targeted rehabilitation interventions should be investigated to promote faster and safer return to sport. In summary, while current evidence supports sports activity after arthroplasty, further studies are needed to strengthen recommendations, especially for demanding sports, and to ensure maximum long-term clinical benefit for these patients.

Conflict of interest statement

The authors declare no conflict of interest.

Funding

No funding was received for this study.

Authors' contributions

N.D.C. was the principal contributor to the study and was responsible for the conception and design of the work, literature search, data extraction, analysis and interpretation of the findings, preparation of tables and figures, and drafting of the manuscript. L.M., F.R., G.M., G.P., M.R., and A.P. contributed to the scientific discussion, interpretation of the results, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

Ethical consideration

Ethical approval was not required for this study, as it is a narrative review based exclusively on previously published data and does not involve new studies on human participants or animals performed by the authors. Informed consent was not required.

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