Lower-Extremity Injuries in Adolescent Tennis Players: A Review of Epidemiology, Maturation-Related Risk, Rehabilitation, and Return to Sport

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Received August 10, 2026
Accepted October 14, 2026
Electronic access November 15, 2026

Tennis requires repeated accelerations and decelerations, lateral movements, and rotations on a planted foot, which can make tendons and ligaments especially injury-prone in adolescents, as their skeletons and tendon attachments are still maturing. Published studies show conflicting results about which injuries dominate in this age group, and much of the treatment advice is extrapolated from studies of other sports. This review examines lower-extremity (LE) injury patterns, risk factors, and return-to-sport (RTS) practices in competitive tennis players, focusing on ages 10 to 18, and explores which recommendations rest on tennis data and which are extrapolated. A comprehensive search was conducted using PubMed, Google Scholar, and the reference lists of key reviews and consensus statements. Across studies, injury patterns varied with the population and surveillance method: ankle and knee injuries were prominent in several adolescent datasets, whereas an elite junior program identified lumbar-spine and shoulder injuries most often, and emergency-department samples differed again from school training-room data. A 15-year study reported that overall injury incidence and burden peaked around peak height velocity in boys and after it in girls. It is not yet clear whether lower-extremity injuries specifically follow the same pattern. The majority of the interventions detailed in this review rely on data extrapolated from different athletic disciplines and populations. Return-to-sport decisions should rest on functional criteria rather than a calendar-based approach; training load deserves attention, especially around the growth spurt; and this review identified the need for rehabilitation research specifically in adolescent tennis players to develop more targeted guidelines.

Keywords: tennis, adolescent athlete, lower extremity injury, biological maturation, return to sport, injury epidemiology, sport specialization, rehabilitation

Introduction

The International Tennis Federation's 2024 Global Tennis Report, compiled from 199 national associations, reported that approximately 106 million people play tennis worldwide, a 25.6% increase over five years[1] (Tier 3; contextual mixed-age tennis evidence). Injuries can occur at every level of play, and young competitive players are no exception[2] (Tier 2; adolescent-specific findings). In this review, adolescence refers to roughly ages 10 to 18, and the terms youth and junior are used interchangeably; studies of mixed child-and-adolescent samples were included when their findings could not be separated by age, and this is noted where it applies.

What makes tennis distinctive is how it is played. A single point can demand hard accelerations and sudden stops, lateral movement, rotation over a planted foot, and overhead loading during the serve[3] (Tier 3; contextual mixed-age tennis evidence). Each of these actions stresses the ankle, knee, hip, and groin. In an adolescent, that stress lands on a growing skeleton: during the pubertal growth spurt, the apophyses and physes are mechanically weak, and tendons pull on attachment sites that have not finished ossifying[4] (Tier 2; adolescent-specific findings).

Published studies report different injury patterns. In one United States high-school surveillance study, the ankle (25.6%) and knee (12.5%) were the most commonly injured sites[5] (Tier 1). In an elite Australian junior program, however, the lumbar spine and shoulder had the highest incidence of injury, and knee injuries were notable mainly in boys[6] (Tier 1). A 2025 systematic review combining adolescent and adult high-performance tennis studies reported seasonal injury prevalence of 46–54% in juniors and 30–54% in professionals, with lower-limb trauma prominent; it also identified workload spikes as a potentially modifiable risk factor[7] (Tier 2; adolescent-specific findings). Because that review combined age groups, it did not isolate which recommendations were supported by adolescent tennis data. A 2026 narrative review of racket-sport injuries in young athletes included 60 studies and found that lower-extremity injuries, particularly

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knee and ankle injuries, were reported most often, while pediatric sport-specific evidence remained limited[8] (Tier 4; extrapolated). This review narrows the question to adolescent tennis and distinguishes direct tennis evidence from extrapolation.

This review examines lower-extremity injury patterns, risk factors, and rehabilitation and RTS criteria among competitive tennis players aged about 10 to 18 years. It asks which recommendations rest on direct tennis evidence and which are extrapolated from studies of other sports or age groups. The scope is limited to the lower extremity; injuries of the trunk and upper limb appear only as points of comparison.

Methods

Search Strategy

This is a structured narrative review conducted without a prospectively registered protocol. The full PubMed strategy, reproduced verbatim in Supplementary Methods S1, combined tennis with adolescent, youth, or junior terms; lower-extremity and anatomic-site terms; and injury, epidemiology, rehabilitation, and return-to-sport terms. No lower publication-date limit was applied. The original search was completed on August 8, 2026; the identical strategy was rerun on September 4, 2026 (the most recent search date), returning 117 records; thirteen reports from that search that had not been cited in the original submission were added during revision, including one adult tennis prevention study used only as context.

An initial literature search was conducted via Google Scholar in August 2026 and updated on September 4, 2026, utilizing three predefined search strings: [youth tennis lower extremity injury epidemiology], [junior tennis ankle knee hip rehabilitation], and [adolescent tennis return to sport growth]. The first 200 results from each query were exported, yielding 600 initial Google Scholar records. Following the removal of 115 duplicates (73 internal to Google Scholar and 42 shared with PubMed), 602 unique database records were screened by title and abstract.

The screening process varied by database: PubMed records were screened independently by the author and a physician mentor, with any disagreements resolved through discussion, whereas Google Scholar records were screened by the author alone. The author also independently performed the full-text assessments of all records retained after the initial screening. Ultimately, 32 database reports were selected for inclusion (26 initially retrieved via PubMed and 6 via Google Scholar). The record-level disposition for PubMed is detailed in Supplementary Table S2, the Google Scholar data and duplicate-removal logs are available in Supplementary Table S3, the complete screening workflow is illustrated in Supplementary Figure S1, and the source routes and population tiers are outlined in Supplementary Table S5. To ensure data integrity, separate reports originating from the same cohort or dataset were excluded if they duplicated findings, but were retained if they evaluated distinct outcomes. Final selection decisions were updated during the peer-review revision stage.

An additional 32 sources—predominantly consensus statements—were subsequently identified through manual reference checks of included reviews, guidelines, and consensus statements, alongside targeted PubMed and Google Scholar searches (not logged at the record level). These targeted queries paired maturation-related terms with specific conditions (including ankle sprain, patellofemoral pain, Osgood-Schlatter disease, hamstring and calf injury, Achilles tendinopathy, bone stress injury, and femoroacetabular impingement) and terms related to rehabilitation, return-to-sport, prevention, and clinical guidelines.

Selection Criteria

Evidence was prioritized from English-language, peer-reviewed studies focused on adolescent tennis players aged approximately 10 to 18 years. When adolescent tennis-specific data were lacking, the search was expanded to include mixed-age tennis cohorts, adolescent athletes in other disciplines, and adult populations. Eligible literature addressed lower-extremity injury epidemiology, risk factors, prevention, rehabilitation, or return-to-sport metrics. Crucially, adult and other-sport data were utilized solely to provide biomechanical or clinical context, or to inform explicitly extrapolated recommendations; they were not treated as direct evidence of injury patterns or treatment efficacy in pediatric cohorts.

Consensus statements and clinical practice guidelines—many derived from mixed-age or adult data—were incorporated to outline current management and return-to-sport frameworks. Conversely, the non-peer-reviewed International Tennis Federation (ITF) participation report was used strictly for global demographic context. Exclusion criteria comprised studies restricted to upper-extremity injuries and single case reports. For mixed-age cohorts, the author documented the full age range and noted whether adolescent-specific sub-analyses were available. Ultimately, 64 sources were included. Because contextual adult and other-sport literature was selected specifically to support the clinical topics discussed, this narrative review did not intend to capture a comprehensive synthesis of those external fields.

For each included study, the reviewer extracted the design, setting, sample size and age range, injury definition, surveillance method, anatomic distribution, incidence or prevalence measures, and principal limitations into a structured worksheet. The physician mentor reviewed the inclusion decisions. No formal risk-of-bias tool was applied; these points are ac-

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knowledged as limitations in the Discussion.

Population-Applicability Tiers

Each included source was categorized into one of five hierarchical population-applicability tiers based on its relevance to competitive tennis players aged approximately 10 to 18 years:

- Tier 1: Adolescent tennis cohorts exclusively;
- Tier 2: Mixed-age tennis cohorts with isolated adolescent findings;
- Tier 3: Mixed-age tennis cohorts without distinct adolescent data;
- Tier 4: Adolescent data from non-tennis sports;
- Tier 5: Adult cohorts.

Mixed-age, multi-sport samples lacking isolated adolescent data were conservatively grouped into Tier 5 and explicitly designated as mixed-age context. Critically, these tiers reflect population directness rather than study quality or risk of bias. Non-empirical sources—such as reports, reviews, consensus statements, and clinical practice guidelines—were tiered based on the specific populations backing their relevant assertions or guidelines. Sources with ambiguous demographic reporting were classified conservatively.

While Tier 1 data and adolescent-specific subsets from Tier 2 directly informed conclusions about young tennis players, Tier 3 evidence served strictly as mixed-age tennis context. Tier 4 and Tier 5 evidence was treated as extrapolated. The specific population tier supporting each finding or clinical recommendation is highlighted at its point of use in the text, with complete source-to-tier mappings detailed in Supplementary Table S5.

Synthesis Method

This review keeps incidence (new cases per unit of exposure), prevalence (proportion affected at or over a period), and burden (a function of both frequency and severity, often expressed as days lost) separate because they measure different aspects of injury, consistent with the 2020 International Olympic Committee consensus statement on recording and reporting epidemiological data in sport[9] and its tennis-specific extension[10]. Where original studies used differing injury definitions, this is noted, in keeping with the consensus statement on epidemiological studies in tennis[11]. Findings were grouped by epidemiology, risk factors, body region, rehabilitation, and prevention. At each point of use, the population-applicability tier supporting a result or management recommendation is stated. When a statement draws on more than one tier, each citation is paired with its corresponding tier. Evidence from Tiers 3 through 5 is described as contextual or extrapolated and is not used to establish injury patterns or treatment effectiveness in adolescent tennis players.

Results

Epidemiology

Lower-extremity injuries are frequent in adolescent tennis, but their reported prominence varies across studies. The apparent distribution depends on the age and competitive level of the sample, the injury definition, the surveillance method, and whether non-time-loss overuse complaints are captured.

A one-season prospective study of 73 elite Dutch juniors aged 11 to 14 years, followed for 32 weeks using the Oslo Sports Trauma Research Center method, reported an average weekly prevalence of all health problems of 21.3% (95% CI, 19.2–22.9), an overuse-injury prevalence of 12.1% (10.9–13.3), and an illness prevalence of 5.8%[12] (Tier 1). In that cohort, 56 players reported 88 overuse injuries, and the knee was the single most common overuse site[12] (Tier 1). These figures illustrate how a surveillance method sensitive to overuse and non-time-loss problems yields a different picture than one restricted to time-loss injury.

In a large survey of 861 United States competitive juniors, 41% reported at least one injury per year, with a clear age gradient: 11% in the 12-and-under group, 28% in the 14-and-under group, and 36% in the 16-and-under group[13] (Tier 1). Players who sustained a first injury had approximately a one-in-three likelihood of a subsequent injury; this is reported here as an association rather than a causal effect[13] (Tier 1).

Elite cohorts show a different regional profile. In nationally supported Australian juniors, the lumbar spine was the most common and most severe injury region in both sexes, the shoulder was second, and knee injuries were common particularly in boys[6] (Tier 1). Injury incidence rose with age, from 2.0 at 13 years to 2.9 at 18 years per 1000 exposure hours, and there was no overall sex difference in incidence, although male injuries were more severe[6] (Tier 1). In an elite Irish national program covering under-10 through senior groups, injury rates over two years were highest in the under-16 group (12.93 per 1000 athletic exposures); across the whole mixed-age cohort, 54% of players were injured and lower-limb injuries were the largest regional category (49.5%)[14] (Tier 2; under-16 rate adolescent-specific). In a cross-sectional analysis of 237 elite junior and professional players (mean age, 14.6 years; range, 9–27 years) from a United States Tennis Association high-performance database, self-reported injury prevalence and injury location differed by age group and sex[15] (Tier 2; adolescent-specific findings).

High-school and club studies show a different pattern, with

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more lower-extremity injuries. In 176 high-school tennis injuries captured in the High School Reporting Information Online system between 2014 and 2018, the ankle accounted for 25.6%, the knee 12.5%, and the wrist 9.7%; ligament sprains (35.2%) and muscle strains (17.6%) were the leading injury types, and 28.7% resulted from rotation about a planted foot or inversion of the foot[5] (Tier 1). In 256 competitive Tunisian youth players aged 5 to 18 years—a cross-sectional, questionnaire-based sample that included children as well as adolescents—53.5% reported a total of 366 injuries; the lower limb was most affected (58.5%), with the knee (23.2%) and ankle (17.5%) predominating, and subsequent injury occurred in 54.6% of injured players, in a higher proportion of those with incomplete rehabilitation, again reported as an association[16] (Tier 3; contextual mixed-age tennis evidence).

More recent national data complicate the high-school picture. In a National Athletic Treatment, Injury and Outcomes Network analysis of 147 U.S. high schools in 26 states from 2011 to 2014, hand/wrist injuries were most common in both boys and girls; girls had a higher overall injury rate than boys (rate ratio, 1.55; 95% confidence limits [CL], 1.23–1.96) and a higher ankle-injury rate (rate ratio, 2.11; 95% CL, 1.14–3.92)[17] (Tier 1). A separate 2014–2023 analysis of National Electronic Injury Surveillance System emergency-department data for patients aged 2 to 18 years estimated 48,378 U.S. tennis injuries from 1,672 sampled cases; sprains and strains were the most common diagnosis and the ankle was the most common site[18] (Tier 3; contextual mixed-age tennis evidence). A companion analysis of the same NEISS window reported sex-specific patterns: girls sustained more ankle injuries and sprains or strains and more injuries in the high-school years, whereas boys had more fractures and upper-extremity injuries and peaked at age 14[19] (Tier 3; contextual mixed-age tennis evidence). These studies broaden the evidence but do not establish one adolescent-tennis injury profile: the first used athletic-trainer reports from participating schools, whereas the NEISS analyses included younger children and recorded emergency-care presentations rather than athlete exposures.

The surveillance source itself changes what is seen. For ankle injuries specifically, athletes captured in United States emergency departments differ from those captured in school athletic training settings in both severity and diagnosis mix[20] (Tier 4; extrapolated), so emergency-department datasets describe presentations for acute care rather than participation-based injury rates. Historical and tournament data are consistent with LE prominence in some settings: a six-year surveillance study at the United States Tennis Association Boys' Championships reported more LE than upper-extremity injuries in tournament adolescents[21] (Tier 1), a one-year prospective study of the Brazilian national junior circuit recorded 6.9 medical treatments per 1000 games played, with muscle complaints the leading reason for on-site care[22] (Tier 1), and a two-year prospective study of Swedish juniors described sex-specific patterns, with ankle injuries prominent in boys[23] (Tier 1). Adult data provide context but are not generalizable to adolescents: among recreational players presenting for acute care (449 patients, mean age 43.6 years), 59% of injuries involved the LE, with twisting and falling the common mechanisms[24] (Tier 3; contextual mixed-age tennis evidence). Broader background on tennis injury patterns and playing-surface mechanics is available in earlier reviews and biomechanical work[2,25] (Tiers 2 and 5; Tier 2 limited to adolescent-specific findings; Tier 5 extrapolated).

Risk Factors

Previous injury. A prior injury was among the most consistently reported correlates of future injury, both in the roughly one-in-three subsequent-injury likelihood after a first injury among United States juniors[13] (Tier 1) and in the 54.6% subsequent-injury proportion among Tunisian youth[16] (Tier 3; contextual mixed-age tennis evidence). In a two-year prospective cohort of 55 Swedish junior players, a previous injury at any site was a risk factor for new injury, injured players played more singles matches per week and more tennis hours per year than uninjured players, and lower-extremity injuries accounted for 51% of the 100 recorded injuries[26] (Tier 1). These are associations, not demonstrations of cause.

Training load and specialization. In a clinical case-control study of young athletes from multiple sports, sports-specialized training was independently associated with injury (odds ratio [OR], 1.27; 95% CI, 1.07–1.52) and with serious overuse injury (OR, 1.36; 95% CI, 1.08–1.72) after accounting for age and weekly sports-activity hours[27] (Tier 4; extrapolated). Young athletes who trained more hours per week than their age in years had higher odds of serious overuse injury (OR, 2.07; 95% CI, 1.40–3.05)[27] (Tier 4; extrapolated). This multisport association has not been validated as a tennis-specific training threshold.

Multifactorial risk, including practice environment and psychology. In a study of youth athletes aged 10 to 15 years that recorded 1575 LE complaints and 328 complaints at other sites, weekly practice time was significantly shorter in the LE group (OR, 0.98; 95% CI, 0.963–0.999), and athletes whose stated goal was recreational had a lower incidence of new injuries after an LE injury; the authors concluded that practice environments and psychological factors deserve greater attention[28] (Tier 4; extrapolated). This was a multisport cohort and is cited here as evidence that LE injury risk in the young is multifactorial rather than as tennis-specific data.

Biological maturation—direct tennis evidence. A 15-year retrospective analysis of 100 junior tennis athletes (50 boys, 50 girls) recorded 256 injuries and assessed maturation by age

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at peak height velocity (APHV), which averaged 13.2 years in boys and 11.5 years in girls[29] (Tier 1). In boys, the highest overall injury incidence (1.34 per year; 95% CI, 0.57–1.84) and burden (16.4 days per year) occurred in the phase around APHV; in girls, the highest overall incidence (0.98 per year; 95% CI, 0.75–1.32) and burden (7.2 days per year) occurred more than 18 months after APHV[29] (Tier 1). The study provides direct tennis-specific evidence that overall injury incidence and burden varied across maturation phases and by sex, but its analyses combined all recorded injuries and did not report lower-extremity incidence or burden separately. It is not yet clear whether lower-extremity injuries specifically follow the same pattern. The overall pattern is consistent with soccer data, in which talented pubertal players sustained more traumatic injuries in the year of peak height velocity (1.41 per player per year) than in the preceding year (0.81)[30] (Tier 4; extrapolated). The growth plate is also vulnerable to repetitive load: a 2022 systematic review of primary periphyseal stress injuries in young athletes across sports, including tennis, found knee, ankle, and foot involvement, no prospective incidence data, frequently asymptomatic imaging changes, and growth disturbance in 12.7% of 448 case-reported injuries[31] (Tier 4; extrapolated).

Table 1 summarizes the population applicability and methods of the primary tennis injury studies discussed in this and the preceding section.

Playing-surface biomechanics. Plantar pressures differ by surface[35] (Tier 5; extrapolated), and clay-court friction influences turning kinematics[36] (Tier 5; extrapolated). These studies demonstrate differences in loading and movement, not differences in injury incidence, so surface should be treated as a plausible modifier rather than a proven risk factor. Tennis injury data based on court surface are limited to self-reports: in a mixed-age questionnaire study of 218 players aged 9 to 72 years, more frequent clay-court training was associated with higher odds of injury (odds ratio, 4.11; 95% CI, 1.46–11.55), as were training three or more times per week and elite status[32] (Tier 3; contextual mixed-age tennis evidence).

Region-Specific Injuries and Management Evidence

Ankle: The ankle is a leading LE injury site in high-school and club samples, and the inversion or planted-foot mechanism is well documented[5,16] (Tiers 1 and 3; Tier 3 contextual). The lateral ligament complex—the anterior talofibular, calcaneofibular, and posterior talofibular ligaments—resists inversion, and sprains are graded I to III by the extent of ligamentous disruption[3] (Tier 3; contextual mixed-age tennis evidence). Most first-time lateral ankle sprains are treated without surgery: the 2021 clinical practice guideline supports external support, early progressive loading, and exercise and balance training, and routine acute surgery is not recommended[37] (Tier 5; extrapolated). Return-to-sport decisions may be structured with the PAASS framework (pain, ankle impairments, athlete perception, sensorimotor control, and sport/functional performance)[38] (Tier 5; extrapolated).

Knee: Anterior knee pain in adolescents requires distinguishing patellofemoral pain from patellar tendinopathy, because their management differs. Anterior knee pain is common in this age group: among 197 athletes aged 11 to 15 years from basketball, volleyball, Australian football, and tennis programs, point prevalence on a provocation test was 39%, with no statistically significant association with maturation status, age, sex, or sport in this sample[39] (Tier 4; adolescent multi-sport cohort including tennis players). The skewed distribution of maturation status limits interpretation of these findings. Patellofemoral pain is managed with combined hip- and knee-targeted exercise therapy[40] (Tier 5; extrapolated). Patellar tendinopathy also occurs in young athletes: in a three-year prospective study of 1553 youth elite athletes across six sports, including tennis, 100 lower-limb tendinopathies were recorded, and the patellar tendon was the most frequent site (79%)[41] (Tier 4; extrapolated).

Osgood-Schlatter disease, a traction apophysitis of the tibial tubercle, often improves with nonoperative care, but symptoms may persist. In 28 competitive junior tennis players aged 10.6 to 15.3 years imaged twice over 12 months, the ultrasound appearance classically attributed to Osgood-Schlatter disease was present in eight players, seven of them pain free, and 62% of the least mature attachments progressed toward more mature stages within a year, so imaging alone should not define the diagnosis[42] (Tier 1). In a prospective cohort of 51 adolescents, activity modification and progressive knee strengthening were associated with favorable outcomes[43] (Tier 4; extrapolated). A 2026 systematic review of 15 studies and 712 patients found that nonoperative treatments were generally effective; surgery was uncommon and generally reserved for persistent symptoms after physeal closure, while the authors called for stronger comparative evidence[44] (Tier 4; extrapolated). Meniscal and anterior cruciate ligament injuries can occur through the planted-foot rotation intrinsic to tennis, but the literature does not support a claim that tennis carries a higher rate of these injuries than other cutting sports.

Thigh and leg: Hamstring strain rehabilitation favors lengthening-based loading. In a randomized trial in elite football, a lengthening (L-) protocol returned players in a mean of 28 days versus 51 days for a conventional (C-) protocol, with a single reinjury over 12 months[45] (Tier 5; extrapolated). Meta-analytic evidence supports rehabilitation exercise while finding no added benefit from platelet-rich plasma injection[46] (Tier 5; extrapolated), and a graded evidence statement summarizes management of common LE muscle injuries[47] (Tier 5; extrapolated). For prevention, adding the Nordic hamstring exercise to injury-prevention programs approximately halved

Table 1A Population and applicability of primary tennis injury studies

Study and tier	Design and setting	Sample and actual age range	Tennis level	Adolescent results extractable?
Tier 1 — Llanes 2023 [5]	Retrospective HS RIO surveillance, 2014–2018	176 injury reports; exact ages NR	U.S. high-school varsity and junior varsity	Yes—entire high-school cohort; exact ages NR
Tier 1 — Gescheit 2019 [6]	Prospective national-program surveillance, 2012–2016	101 players; 13–18 years	Elite Australian national juniors	Yes
Tier 2 — O'Connor 2020 [14]	Two-year prospective national-program surveillance	82 players; under-10 through senior age groups	Elite Irish national program (juniors and seniors)	Yes—age-group rates reported separately
Tier 1 — Pluim 2016 [12]	32-week prospective cohort using OSTRC surveillance	73 players; 11–14 years	Elite Dutch national-program juniors	Yes
Tier 1 — Kovacs 2014 [13]	Retrospective prior-year survey	861 players; approximately 10–17 years	Competitive U.S. juniors (12U–16U)	Yes
Tier 2 — Rice 2022 [15]	USTA High Performance Profile database, 2014–2015	237 players; 9–27 years; mean 14.6 years	Elite U.S. juniors and professionals	Yes—age-group results reported
Tier 3 — Layouni 2025 [16]	Cross-sectional questionnaire	256 players; 5–18 years; median 9 years	Competitive Tunisian club players	No—10–18-year results were not isolated
Tier 1 — Upshaw 2026 [17]	Retrospective NATION surveillance, 2011–2014	Players at 147 high schools; exact ages NR	U.S. high-school tennis	Yes—entire high-school cohort; exact ages NR
Tier 3 — Docters 2026 [18]	NEISS emergency-department analysis, 2014–2023	1,672 sampled cases; 2–18 years	Pediatric recreational tennis injuries presenting to U.S. emergency departments	No—no stand-alone 10–18-year denominator
Tier 3 — Mysore 2026 [19]	NEISS emergency-department analysis, 2014–2023	1,679 sampled cases; under 18 years	Pediatric emergency-department tennis injuries	No—no stand-alone 10–18-year profile
Tier 1 — Hutchinson 1995 [21]	Six-year tournament surveillance	1,440 athlete-participations; exact ages NR	USTA National Boys' Championships	Entire junior tournament cohort; exact ages NR
Tier 1 — Silva 2003 [22]	One-year prospective tournament surveillance	151 treated players; under-12 to under-18 categories	Brazilian national junior circuit	Yes—entire junior cohort
Tier 1 — Hjelm 2010 [23]	Two-year prospective cohort	55 players; 12–18 years	Swedish junior club players training more than twice weekly	Yes
Tier 1 — Hjelm 2012 [26]	Prospective 2-year cohort (same as Hjelm 2010)	55 players; 12–18 years	Swedish junior club players	Yes
Tier 3 — Kaiser 2021 [24]	Retrospective hospital case series, 2013–2018	449 patients; 8.2–84.4 years; mean 43.6 years	Recreational tennis players	No—adolescent results were not reported separately
Tier 3 — Minghelli 2019 [32]	Cross-sectional questionnaire (12-month recall)	218 players; 9–72 years	Recreational to elite tennis players	No—adolescent results not reported separately
Tier 1 — Saigo 2026 [29]	Fifteen-season retrospective academy analysis	100 players; chronological age range NR	Japanese junior tennis academy	Entire junior cohort; chronological ages NR
Tier 5 — Acquaye 2020 [33]	Cross-sectional injury questionnaire	142 players; 18–59 years; mean 37.5 years	Club and stadium players in Accra, Ghana	No—adult evidence
Tier 5 — Render 2026 [34]	One-year observational program cohort	317 enrolled; 18–75 years; mean 48 years	Adult recreational league and competitive players	No—adult evidence

hamstring injury rates (risk ratio, 0.49; 95% CI, 0.32–0.74) [48] (Tier 5; extrapolated). "Tennis leg" denotes an acute calf strain, most often involving the medial gastrocnemius—soleus complex [49] (Tier 5; extrapolated); ultrasound helps characterize the injury and evaluate alternatives, including soleus injury and, when indicated, deep vein thrombosis [50] (Tier 5; extrapolated). Achilles tendinopathy—correctly termed a tendinopathy rather than a tendonitis—is managed with progressive tendon loading in line with the Dutch multidisciplinary guideline [51] (Tier 5; extrapolated); the 2024 clinical practice guideline revision likewise recommends tendon-loading exercise at as high a load as tolerated, at least three times per week, as first-line treatment [52] (Tier 5; extrapolated).

Foot and bone stress injuries: Bone stress injuries are classified by anatomic site into high-risk and low-risk categories, a distinction that governs both imaging and management [53] (Tier 5; extrapolated). The tarsal navicular is a high-risk site. In a multicenter case series of adolescent athletes (mean age 14.7 years, 65% female), nonoperative management with protected or non-weight-bearing immobilization succeeded in 94 of 110 patients (85%), whereas 16 (15%) required screw fixation; healing took months, and the operative subgroup returned to sport a median of approximately five months after fixation [54] (Tier 4; extrapolated). Low-risk sites are managed with graded, progressive loading [55] (Tier 5; extrapolated), and RTS timelines differ accordingly by risk class [56] (Tier 5; extrapolated). Minor foot conditions described in young tennis players—plantar fasciitis, blisters, and sub-

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Table 1B Injury definitions, denominators, findings, and interpretive limits of primary tennis injury studies

Study	Injury definition	Denominator	Principal finding	Key limitation
Llanes 2023 [5]	Athletic-trainer-reported HS RIO injury; the article did not restate a complete operational threshold	176 injury reports; no total athlete or exposure denominator	Ankle 25.6% and knee 12.5%; sprains and strains predominated	Athletic-trainer reporting; exact ages and total exposure NR
Gescheit 2019 [6]	Physical complaint arising from tennis that interrupted training or match participation and was assessed by program clinicians	Injuries per 1,000 exposure hours	Lumbar spine and shoulder had the highest incidence; knee injuries were notable in boys	Single elite national program
O'Connor 2020 [14]	Injury leading to missed tennis training or match play	Injuries per 1,000 athletic exposures	Under-16s had the highest rate (12.93/1,000 AE); whole cohort: 54% injured	Single program; includes children and seniors
Pluim 2016 [12]	OSTRC health problem, including overuse and non-time-loss complaints	Player-weeks for prevalence; tennis hours for acute incidence	Average weekly overuse-injury prevalence 12.1%; knee was the leading overuse site	Elite cohort; one season
Kovacs 2014 [13]	Self-reported injury during the preceding year	Players; no exposure-time denominator	Forty-one percent reported at least one injury; subsequent injury was commonly reported	Recall-based self-report
Rice 2022 [15]	Self-reported injury history (HPP questionnaire)	Players; no exposure-time denominator	Injury prevalence and location differed by age group and sex	Cross-sectional; retrospective self-report
Layouni 2025 [16]	Any physical injury during training or competition, regardless of diagnostic testing or time loss	Respondents and reported injuries; no exposure-time denominator	Lower limb 58.5%; higher subsequent reported injury proportion with incomplete rehabilitation	Self-report; ages 5–18 combined; cross-sectional association
Upshaw 2026 [17]	Athletic-trainer-recorded time-loss or non-time-loss injury in NATION	Athlete-exposures	Hand/wrist was most common overall; girls had a higher ankle-injury rate	Participating schools only; older seasons; exact ages NR
Docters 2026 [18]	Tennis injury treated in a participating emergency department and coded in NEISS	Sampled and weighted emergency-department cases; no athletic-exposure denominator	Sprains and strains were most common; ankle was the leading site	Ages 2–18 combined; emergency-care presentations only
Mysore 2026 [19]	Tennis injury treated in a NEISS emergency department	Sampled and weighted cases; no exposure denominator	Girls: more ankle sprains/strains; boys: more fractures and upper-extremity injuries	Same NEISS window as Docters 2026; ages under 18 combined
Hutchinson 1995 [21]	Any medical problem requiring physical or medical assistance	Athletic exposures and participating athletes	Lower-extremity injuries exceeded upper-extremity injuries	Tournament-only setting; older data; exact ages NR
Silva 2003 [22]	Medical treatment provided during circuit tournaments	Treatments per 1,000 games played	6.9 treatments per 1,000 games; muscle complaints led	Treatment-seeking sample; no training exposure
Hjelm 2010 [23]	Inability to participate in regular tennis training or a match on at least one occasion	Tennis hours	Sex-specific patterns; ankle injuries were prominent in boys	Small, single-club cohort
Hjelm 2012 [26]	Time-loss injury (as Hjelm 2010)	Players; tennis hours for exposure	Lower extremity 51% of injuries; prior injury and play volume associated with new injury	Small single-club cohort
Kaiser 2021 [24]	Acute-onset tennis injury treated at one university hospital	Injured patients and injury cases; no participation or exposure denominator	Fifty-nine percent involved the lower extremity; twisting and falling were common mechanisms	Broad mixed-age sample dominated by adults; acute-care selection
Minghelli 2019 [32]	Self-reported injury in the preceding 12 months	Players and reported training hours	Ankle most common site (20%); clay-court training associated with higher injury odds	Mixed ages combined; self-report
Saigo 2026 [29]	Academy-recorded injury; burden measured using days lost per year	Injuries per player-year and days lost per year; no exposure-hour denominator	Overall injury incidence and burden varied across APHV-based maturation phases	Retrospective single academy; chronological age range and lower-extremity-specific maturation results not reported
Acquaye 2020 [33]	Self-reported injury using a standardized tennis injury report form	142 respondents and 170 reported injuries; no exposure-time denominator	Knee and shoulder injuries predominated; many injuries received no professional treatment	Adult cross-sectional sample; self-report
Render 2026 [34]	Self-reported tennis-related injuries at baseline and follow-up surveys	Respondents at each survey; no exposure-time denominator	No consistent injury association with compliance; fewer overuse injuries at 12 months in the high-compliance group	Nonrandomized; self-report; loss to follow-up (149 respondents at 12 months); adult context

Note: NR indicates not reported. Population tiers describe applicability to adolescent tennis, not study quality or risk of bias.

ungual hematoma ("tennis toe")—are generally self-limiting[4] (Tier 2; adolescent-specific findings).

Hip and groin: The adolescent differential for hip and groin pain is broad and includes pelvic apophyseal avulsion injuries, femoroacetabular impingement, and labral pathology[4,57,58] (Tiers 2 and 4; Tier 2 limited to adolescent-specific findings; Tier 4 extrapolated). In the immature skeleton, tennis-related avulsion injuries particularly involve the apophyses of the ischial tuberosity, the anterior inferior or superior iliac spine, and the iliac crest[57] (Tier 4; extrapolated). The rotational demands of tennis strokes load the hip repeatedly, and femoroacetabular impingement is increasingly recognized in active adolescents[58] (Tier 4; extrapolated). Load management is central to conservative care of apophyseal problems[4] (Tier 2; adolescent-specific findings).

Rehabilitation Frameworks and Return to Sport

Acute soft-tissue management has evolved from RICE (rest, ice, compression, elevation) to PRICE (protection, rest, ice, compression, elevation) and then POLICE (protection, optimal loading, ice, compression, elevation), reflecting a shift toward optimal loading rather than prolonged rest[59] (Tier 5; extrapolated). The more recent PEACE & LOVE framework (protection, elevation, avoid anti-inflammatories, compression, education, followed by load, optimism, vascularization, and exercise), proposed in a 2020 editorial, emphasizes patient education and progressive loading while advising against routine early use of anti-inflammatory medication; evidence on ice remains mixed rather than settled[60] (Tier 5; extrapolated). The unifying principle across these frameworks is that tissue capacity is rebuilt through progressive loading.

A staged return progresses from restoring strength, power, balance, and change-of-direction capacity to tennis-specific movement, including multidirectional work, graded serve and groundstroke loading, and progressive match play. Psychological readiness is a component of the decision: in 50 athletes aged 14 to 22 years (mean age, 16.8 years) in the return-to-sport phase of rehabilitation, most after lower-extremity injury, stronger athletic identity was associated with lower fear-avoidance scores[61] (Tier 5; mixed-age multisport evidence, extrapolated). Decisions should be criteria-based rather than time-based, structured by the return-to-sport continuum described in the 2016 Bern consensus[62] (Tier 5; extrapolated), which frames recovery as three phases (return to participation, return to sport, and return to performance) rather than a single pass/fail clearance, by the Strategic Assessment of Risk and Risk Tolerance framework[63] (Tier 5; extrapolated), and, for the ankle, by PAASS[38] (Tier 5; extrapolated).

The Strategic Assessment of Risk and Risk Tolerance (StARRT) framework[63] (Tier 5; extrapolated) is a three-step decision tool developed by Shrier: Step 1 assesses tissue health (injury site, symptoms, and objective testing), Step 2 assesses the tissue stresses the sport will impose (sport type, level of competition, and environment), and Step 3 weighs risk-tolerance modifiers such as the timing of the season and athlete, family, and external pressures; clearance is supported when the estimated risk falls below the accepted tolerance.

The PAASS framework[38] (Tier 5; extrapolated) is an injury-specific consensus framework, published in 2021 by Smith et al., for return-to-sport decisions after an acute lateral ankle sprain; rather than relying on a single measure, it identifies five assessment domains: pain, ankle impairments, athlete perception, sensorimotor control, and sport/functional performance. None of these frameworks provides validated pass/fail thresholds for adolescent tennis players; PAASS identifies domains to assess rather than cutoff scores, so the specific criteria applied remain clinician-selected.

No eligible trials of rehabilitation or return to sport after lower-extremity injury in adolescent tennis players were identified in the reported searches; the criteria above are extrapolated from other sports and populations.

Injury Prevention

Adult tennis evidence provides additional context. A one-year observational study of the Tennis 10+ warm-up and cool-down program enrolled 317 recreational players aged 18–75 years (mean, 48 years). Higher compliance was not consistently associated with fewer injuries; an association with fewer overuse injuries was reported at 12 months[34] (Tier 5; extrapolated). Self-report, loss to follow-up, and the nonrandomized design limit interpretation. These findings do not establish injury prevention in adolescent tennis.

Exercise-based neuromuscular prevention reduces injury in youth sport. A meta-analysis of child and adolescent sport reported an overall risk ratio of 0.54 (95% CI, 0.45–0.67), with a larger effect for programs that included plyometric content (risk ratio, 0.45; 0.35–0.57)[64] (Tier 4; extrapolated). Adding the Nordic hamstring exercise halves hamstring injury rates[48] (Tier 5; extrapolated). Moderating early specialization and weekly training hours is suggested by the observed associations in the specialization data above[27] (Tier 4; extrapolated), and paying attention to load around the growth spurt is suggested by the maturation-phase associations in the tennis data[29] (Tier 1) and the soccer data[30] (Tier 4; extrapolated). Current medical evidence, however, does not prove that reducing training loads during growth spurts prevents injuries. There was no trial identified in this review that tested that hypothesis; at present this remains a reasonable inference rather than an evidence-based strategy. The maturation studies describe injury associations rather than tested prevention effects; prevention guidance for adolescents remains extrapolated from other sports and adult populations.

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Discussion

The aim of this review is to identify the most common lower extremity injuries in adolescent tennis, explore the current evidence for return to sport after injury, and examine direct tennis-specific evidence for the epidemiology of injury in adolescent tennis and indirect evidence that has been derived from other sports and age groups. Three main points emerged from this review. Firstly, the current evidence regarding the epidemiology of injury in adolescent tennis does not provide clear and consistent patterns. Some high-school- and club-based surveillance studies report high numbers of ankle and knee injuries in young tennis players[5,16] (Tiers 1 and 3; Tier 3 contextual), whilst another reports the hand/wrist as the most commonly injured region in young players[17] (Tier 1); the lumbar spine and shoulder led in an elite junior program[6] (Tier 1); another elite national program reported lower-limb injuries as the largest regional category across a mixed-age cohort[14] (Tier 2; whole-cohort finding, contextual), and, in contrast, emergency-department studies report a wide variety of different injuries in young tennis players[18–20] (Tiers 3 and 4; Tier 3 contextual; Tier 4 extrapolated). The balance shifts with age, competitive level, injury definition, and surveillance method. Secondly, direct tennis-specific evidence indicates that overall injury incidence and burden varied across maturation phases. In the Saigo study, these measures were highest in boys around APHV and in girls after APHV[29] (Tier 1). However, the analysis combined all recorded injuries and did not report maturation patterns separately for lower-extremity injuries. It is not yet clear whether lower-extremity injuries specifically follow the same pattern. Lastly, there is a paucity of direct tennis-specific evidence for rehabilitation and return-to-sport after injury. Most rehabilitation and RTS guidance has been derived from studies of other sports involving different populations of athletes, not specifically tennis players or adolescents.

While the implications are practical, they currently rely on clinical inferences rather than direct evidence. Individualizing training load during growth-spurt periods by maturation status rather than chronological age is a reasonable approach, although it has not been shown to prevent injury in adolescent tennis. The Jayanthi study found that young athletes from multiple sports who trained more hours per week than their age in years had higher odds of serious overuse injury[27] (Tier 4; extrapolated). Because this study combined data across multiple sports and did not isolate tennis-specific on-court hours, this training-to-age ratio should be treated as an extrapolated association rather than a validated clinical cut-off for tennis populations. For acute soft-tissue injuries, the PEACE & LOVE framework offers a useful shift in emphasis from the traditional RICE approach[59,60] (Tier 5; extrapolated): This emphasizes the utilization of progressive loading rather than prolonged immobilization during early-stage rehabilitation. However, definitive treatment standards for adolescent tennis players remain elusive due to conflicting or low-tier evidence regarding standard modalities: the editorial proposes avoiding routine early anti-inflammatory medication, which has not yet been validated or established as a treatment standard for adolescent tennis players, although the evidence on ice remains mixed[60] (Tier 5; extrapolated). For ankle sprains, early progressive weight-bearing[37] (Tier 5; extrapolated) and, for Achilles tendinopathy, progressive tendon loading[51] (Tier 5; extrapolated) are crucial to optimal recovery.

Previous injury and suboptimal rehabilitation may be considered warning signs for future injury. A prior history of injury remains a consistently documented correlate of subsequent injury, with incomplete rehabilitation further compounding this risk. Data from multiple youth-tennis cohorts confirm a significantly higher likelihood of recurrent injury following an initial injury[13,16,26] (Tiers 1 and 3; Tier 3 contextual). Current guidelines recommend that athletes successfully complete a criteria-based, sport-specific rehabilitation program prior to resuming full competitive match play[62] (Tier 5; extrapolated). Cross-sectional data from mixed-age tennis populations support this framework, demonstrating that a higher proportion of players who underwent incomplete rehabilitation reported subsequent injuries[16] (Tier 3; contextual mixed-age tennis evidence). While these findings align with current consensus guidance, the cross-sectional design of the available literature identifies only a statistical association; it does not empirically demonstrate that completing a standardized rehabilitation protocol prevents reinjury. Return-to-sport decisions should follow criteria rather than fixed calendars, using the Bern continuum[62] (Tier 5; extrapolated), the StARRT framework[63] (Tier 5; extrapolated), and, for ankle sprains, the PAASS framework[38] (Tier 5; extrapolated), progressing only when strength, balance, change-of-direction capacity, sport-specific loading, and psychological readiness are restored, judged against clinician-selected criteria because validated adolescent-tennis thresholds do not exist. High-risk bone stress injuries of the foot need to be distinguished from their lower-risk counterparts early in the diagnostic process. Patients with persistent activity-related dorsal midfoot pain associated with focal tenderness of the navicular bone may require advanced imaging for a suspected navicular bone stress injury. Management may include protected weight-bearing and months of recovery[53,54] (Tiers 5 and 4, respectively; extrapolated). Finally, the use of a neuromuscular training program that includes elements of plyometric and eccentric exercise has been shown to decrease injuries across youth sport[64] (Tier 4; extrapolated) and hamstring injuries specifically[48] (Tier 5; extrapolated), though its effectiveness in adolescent tennis has not been tested.

This review has several limitations. This narrative review was not conducted under a registered systematic-review pro-

tocol; independent duplicate screening was applied to the updated PubMed search but not to the Google Scholar or hand-searched sources; and no formal quality appraisal was applied, so selection and reporting bias cannot be excluded. Full texts were assessed by the author alone, targeted searches were not logged at the record level, and contextual adult and other-sport literature was selectively cited. The primary studies used heterogeneous injury definitions and denominators, which limits direct comparison of incidence, prevalence, and burden figures. Tennis-specific adolescent rehabilitation evidence is scarce, and much of the management guidance is therefore extrapolated. Only English-language sources were used. Finally, access-to-care disparities affect which injuries are recorded and treated; in one survey, many injured players received no professional treatment, a finding cited here only as access-to-care context and not as evidence of treatment efficacy [33] (Tier 5; extrapolated).

Further research into the area of rehabilitation and return to full sport for the adolescent tennis player is warranted. In the interim, the recommendations for the young tennis player and his or her team of clinicians, coaches, and family members will be based on studies focused mainly on sports other than tennis.

Acknowledgments

The author thanks research mentor Leesi George-Komi for teaching literature-review methods through the Lumiere Research Scholar Program and for encouraging further exploration of this topic. The review was motivated in part by the author's own tennis injury and rehabilitation experience. The author also thanks Surabhi Khanna, MD, a board-certified rheumatologist, who served as physician mentor for the revision, critically reviewed the revised manuscript and the selection of the added references, and independently screened the PubMed records.

AI-assisted tools: ChatGPT (OpenAI) and Claude (Anthropic) were used in preparing this article and its revision, within the journal's AI Usage Policy, for the following tasks: (1) literature-search support: re-running the PubMed strategy and the three Google Scholar queries on September 4, 2026, exporting the records, identifying duplicates by title matching, and compiling the record-level screening logs, the source-route and population-tier table, and the flow diagram in the Supplementary Material; (2) compiling the study characteristics shown in Tables 1A and 1B from the included papers, which the author verified against the original articles; (3) reference management: numbering references in order of first appearance, checking every in-text citation against the reference list, converting citations to the journal's online format, and formatting the reference list; (4) checking the revised manuscript, tables, and supplement for numerical inconsistencies and for spelling, grammar, and punctuation errors, which the author then corrected; (5) critiquing drafts of the response to reviewers; and (6) preparing the tracked-change and clean submission files. No sentence of the manuscript was drafted, paraphrased, or rewritten by an AI tool. The author read the cited sources, made all decisions about study selection and interpretation, composed all text, verified all citations and figures, and accepts responsibility for the final work.

Funding and competing interests: No external research funding supported this review. The author declares no competing interests.

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Supplementary information

The online version contains supplementary material available at https://nhsjs.com/?p=61357

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