Health effects of tennis participation: benefits, injury patterns, and implications for lifelong physical activity – a narrative review

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Abstract

Introduction and purpose: Tennis is widely recognized as a lifelong form of physical activity that combines intermittent high-intensity effort, repeated directional changes, weight-bearing loading, and complex motor coordination. The purpose of this narrative review was to summarize current evidence on the cardiovascular, metabolic, musculoskeletal, and longevity-related effects of regular tennis participation, while also considering its injury profile.

Brief description of the state of knowledge: The reviewed literature indicates that regular tennis participation is associated with favorable cardiorespiratory and metabolic effects, including improved aerobic fitness, lower body fat, and beneficial effects on selected health indicators. Tennis also appears to support bone health, particularly in loaded skeletal regions. Observational evidence suggests that tennis and other racket sports are associated with lower all-cause and cardio-

vascular mortality, although these findings are based mainly on cohort studies and remain vulnerable to residual confounding. At the same time, tennis is linked to acute and overuse injuries, especially involving the shoulder, elbow, and lower extremities.

Summary (conclusions): Tennis appears to be a valuable component of lifelong health promotion, but its overall health value depends on technique, training load, conditioning, recovery, and injury-prevention strategies. Further prospective and interventional studies are needed to clarify dose-response relationships and distinguish tennis-specific effects from broader racket-sport associations.

Keywords (MeSH): Tennis; Exercise; Cardiovascular Diseases; Bone Density; Sports Injuries

1. Introduction and purpose

Regular physical activity is one of the most important modifiable determinants of health. A large body of evidence indicates that exercise contributes to the prevention of cardiovascular disease, type 2 diabetes, obesity, and selected musculoskeletal disorders, while higher cardiorespiratory fitness is consistently associated with lower morbidity and mortality [1-4]. Against this background, sports that combine endurance, speed, coordination, and repeated loading may offer especially broad health benefits.

Tennis is a globally popular sport characterized by intermittent high-intensity effort, repeated accelerations and decelerations, multidirectional movement, and complex motor coordination [5-8]. Owing to these characteristics, tennis engages both aerobic and anaerobic energy systems and can be regarded as a multidimensional form of exercise with substantial physiological demands [5-8].

In recent years, increasing attention has been given to participation in tennis and other racket sports as a potential contributor to healthy aging and long-term health outcomes [4,9-13]. In addition to its cardiovascular and metabolic demands, tennis is a weight-bearing activity that may support bone health, muscular performance, balance, and functional capacity across the lifespan [14-16].

At the same time, tennis is associated with a distinct profile of acute and overuse injuries. Common problems include lateral epicondylitis, shoulder dysfunction related to repeated overhead motion, and lower-limb injuries associated with abrupt directional changes, braking, and repetitive loading [17-29]. For this reason, the health effects of tennis should be considered in a balanced way, taking into account both its benefits and its risks. Where direct tennis-specific evidence was

limited, selected findings from broader research on racket sports were discussed as supportive contextual evidence, with cautious interpretation.

The aim of this narrative review was to summarize current evidence on the health benefits and potential risks associated with tennis participation, with particular attention to cardiovascular, metabolic, musculoskeletal, and longevity-related outcomes.

1.1. Literature search strategy

This article was prepared as a narrative review based on a structured, targeted search of the literature addressing the health effects of tennis participation. The objective of the search was to identify clinically and scientifically relevant publications concerning the cardiovascular, metabolic, musculoskeletal, and long-term health implications of tennis, as well as the epidemiology and mechanisms of tennis-related injuries.

The literature search was conducted using PubMed/MEDLINE and Web of Science as the primary databases. Additional sources were identified through supplementary searches in Google Scholar and by manually screening the reference lists of relevant reviews and original articles. The final search update was performed in April 2026.

The search strategy included combinations of keywords and Medical Subject Headings (MeSH), where applicable, such as: “tennis AND health”, “tennis AND cardiovascular health”, “tennis AND metabolic health”, “tennis AND bone mineral density”, “tennis AND mortality”, “tennis AND longevity”, “tennis injuries”, “tennis elbow”, “tennis serve AND injury”, and “racket sports AND health benefits”. Additional records were retrieved through citation tracking of key review articles and primary studies.

Publications from January 2018 to April 2026 were prioritized in order to reflect the most recent evidence. Earlier studies were included selectively when they were considered landmark or foundational contributions to the understanding of tennis physiology, biomechanics, injury epidemiology, or clinical management. Preference was given to systematic reviews, meta-analyses, cohort studies, and clinically relevant observational studies. English-language full-text articles were considered eligible. Conference abstracts without accessible full text, non-peer-reviewed materials, and studies not directly relevant to the health effects, injury burden, or long-term implications of tennis participation were excluded.

Study selection was based on relevance to the predefined thematic domains of the review: (1) cardiovascular and metabolic effects, (2) musculoskeletal adaptation and bone health, (3) longevity-related and overall health outcomes, and (4) injury epidemiology, mechanisms, and prevention. The identified literature was assessed qualitatively, and studies considered most informative for the clinical and public-health interpretation of tennis participation were included in the narrative synthesis. Particular attention was paid to studies involving adult and aging populations, long-term participation, bone-related outcomes, and biomechanical mechanisms specific to tennis.

Where direct tennis-specific evidence was limited, selected studies concerning racket sports more broadly were included to provide contextual support. Such evidence was interpreted cautiously and is discussed in the manuscript as indirect rather than strictly tennis-specific.

Because this work was designed as a narrative review rather than a formal systematic review, no PRISMA flow diagram, quantitative meta-analysis, or formal risk-of-bias assessment was performed. Accordingly, the conclusions should be interpreted as an evidence-informed narrative synthesis rather than as pooled quantitative estimates. The purpose of the review was to provide a clinically oriented and conceptually structured overview of the multidimensional health effects of tennis participation rather than an exhaustive systematic synthesis of all available publications. Key studies included in the narrative synthesis are presented in Tables 1 and 2.

2. Description of the state of knowledge

2.1. Cardiovascular and metabolic benefits of tennis participation

Tennis is an intermittent high-intensity sport that imposes a considerable cardiovascular load through repeated running, rapid changes of direction, stroke production, and short recovery intervals between rallies [5-8]. These demands make tennis a potentially effective stimulus for improving cardiorespiratory fitness.

Cardiorespiratory fitness is a strong and consistent predictor of both cardiovascular and all-cause mortality [2,3]. In this context, participation in sports that improve aerobic fitness may contribute substantially to long-term health. Available reviews suggest that tennis and other racket sports are associated with favorable effects on cardiorespiratory fitness and broader physical-health outcomes [4-6].

From a metabolic perspective, regular tennis participation may contribute to body-weight control, improved glucose regulation, and better overall metabolic health through repeated bouts of

moderate-to-vigorous activity and relatively high total energy expenditure [1,4-6]. These observations are consistent with the broader literature on physical activity and chronic disease prevention [1,4].

Observational studies further indicate that participation in tennis and racket sports is associated with lower all-cause and cardiovascular mortality [10-13]. In large cohorts, racket sports have repeatedly ranked among the leisure-time disciplines most strongly associated with improved survival. However, these findings are derived mainly from observational data and should not be interpreted as definitive proof of causality [10-13].

Overall, the current literature supports the view that tennis may be a useful form of physical activity for improving cardiovascular fitness and supporting metabolic health, especially when practiced regularly over many years [4-6,9-13].

2.2. Musculoskeletal benefits of tennis participation

Tennis is a weight-bearing sport that exposes the musculoskeletal system to repeated mechanical loading. Such loading is an important stimulus for bone remodeling and may contribute to the development and maintenance of bone strength [14-16].

Recent reviews and meta-analyses indicate that tennis participation is associated with higher bone mineral density, particularly in the dominant upper extremity and in skeletal regions exposed to repeated impact and muscular loading [14-16]. These findings are relevant from the perspective of osteoporosis prevention and healthy aging.

Beyond bone health, tennis requires repeated sprinting, braking, lunging, trunk rotation, and overhead motion. Together, these tasks may contribute to muscular strength, coordination, balance, and functional performance [5,6,14-16]. Such adaptations may be beneficial not only in competitive players, but also in recreational participants and older adults who maintain regular practice.

Because tennis is a unilateral sport, some adaptations are asymmetrical. Nevertheless, these sport-specific changes also provide a useful model of osteogenic and neuromuscular adaptation to long-term physical activity [14-16]. The asymmetrical nature of tennis should not automatically be interpreted as harmful; rather, it highlights the need for balanced conditioning and technique-focused training.

Table 1. Selected studies included in the narrative synthesis on the cardiovascular, metabolic, musculoskeletal, and longevity-related effects of tennis participation.

Study	Study design	Population / scope	Main findings	Contribution to the present review
Oja et al., 2024 [4]	Systematic review and meta-analysis	2.6 million adult participants across different sports	Different sports may confer different health benefits; racket sports were among the disciplines associated with favorable health outcomes	Provides a broad public-health context for tennis and other racket sports
Cádiz Gallardo et al., 2023 [5]	Systematic review	Participants in racket sports	Racket sports involve substantial physiological demands engaging both aerobic and anaerobic energy systems	Supports the interpretation of tennis as a multidimensional form of exercise
Pluim et al., 2023 [6]	Systematic review with meta-analysis	Tennis players across court surfaces, sexes, and levels of play	Tennis imposes considerable physical demands, with differences according to performance level, sex, and playing conditions	Supports the discussion of cardiorespiratory and functional demands of tennis
Lang et al., 2024 [2]	Overview of meta-analyses	General adult populations	Cardiorespiratory fitness is a strong predictor of morbidity and mortality	Provides indirect mechanistic support for the long-term health relevance of tennis participation
Oja et al., 2017 [10]	Cohort study	80,306 British adults	Participation in racket sports was associated with lower all-cause and cardiovascular mortality	Key evidence for the longevity-related section, although not limited to tennis alone
Schnohr et al., 2021 [11]	Cohort study	Copenhagen City Heart Study participants	Duration of sports participation showed a U-shaped relationship with mortality; racket sports remained among activities with favorable outcomes	Supports cautious interpretation of long-term associations
Ko et al., 2025 [12]	Prospective cohort study	Older US men	Long-term tennis participation was associated with lower mortality risk	Strengthens the tennis-specific component of the longevity discussion

Study	Study design	Population / scope	Main findings	Contribution to the present review
Spring et al., 2020 [13]	Observational study	Adults reporting lifetime activity patterns	Long-term tennis participation was associated with favorable health outcomes	Supports the concept of tennis as a lifelong form of physical activity
Huang et al., 2025 [14]	Meta-analysis	Male tennis players	Tennis participation was associated with higher bone mineral density	Key evidence for musculoskeletal and osteogenic benefits
Chapelle et al., 2019 [15]	Systematic review and meta-analysis	Tennis players	Upper-extremity bone mineral content asymmetries were observed in tennis players	Supports the discussion of sport-specific skeletal adaptation
Nicol and Sammut, 2026 [16]	Narrative review	Paediatric to young adult tennis players	Tennis may positively influence bone mineral density during growth and young adulthood	Adds age-specific context for bone-related adaptation

2.3. Longevity and overall health outcomes

Longevity is one of the most clinically meaningful indicators of the long-term effects of physical activity on health. In recent years, evidence has accumulated suggesting that not all sport disciplines are associated with the same magnitude of mortality reduction [4,9-13].

Among commonly practiced sports, tennis and other racket sports have repeatedly been identified as disciplines associated with particularly favorable long-term outcomes [10-13]. Population-based cohort studies from the United Kingdom, Denmark, and the United States suggest that participation in racket sports may be linked to lower all-cause mortality and, in some analyses, to one of the largest survival benefits among leisure-time sports [10-13].

The mechanisms underlying this association are likely multifactorial and may include improvements in cardiorespiratory fitness, body composition, metabolic regulation, long-term adherence to physical activity, and the social dimension of sport participation [1-6]. Nevertheless, residual confounding remains a major limitation of the available evidence. Individuals who play tennis regularly may differ from non-participants in ways that are difficult to fully adjust for, including socioeconomic status, healthcare access, and other health-related behaviors.

Taken together, the available data support the hypothesis that tennis may be especially beneficial from a public-health perspective, while also underscoring the need for cautious interpretation of observational associations [4,9-13]. This interpretation is also consistent with recent narrative work emphasizing the broad health and longevity-related potential of racket sports as a category of lifelong physical activity [9].

2.4. Risks and injuries associated with tennis

Table 2. Selected studies included in the narrative synthesis on injury patterns, injury mechanisms, and preventive implications in tennis.

Study	Study design	Population / scope	Main findings	Relevance
Bradley et al., 2025 [17]	Systematic review and meta-analysis	Tennis players, with emphasis on the serve	The tennis serve is associated with specific injury risk factors, especially involving the shoulder	Key evidence for serve-related injury mechanisms
Oosterhoff et al., 2019 [18]	Systematic review	Elite junior tennis players	Identified risk factors for musculoskeletal injuries in elite junior players	Supports the epidemiological discussion of injury risk
Pluim et al., 2006 [19]	Review	Tennis players	Described injury occurrence, aetiology, and prevention in tennis	Foundational reference for general tennis injury patterns
Kibler and Safran, 2005 [20]	Review	Tennis players	Summarized common tennis injuries and their mechanisms	Supports the clinical overview of limb injuries
Maquirriain and Baglione, 2016 [21]	Epidemiological review	Davis Cup retirements over eight years	Documented the epidemiology of injuries in high-level tennis competition	Adds competitive-level injury data
Tłoczek et al., 2026 [22]	Multifactorial review	Tennis injuries across mechanisms and player factors	Tennis injuries arise from the interaction of repetitive loading, biomechanics, training exposure, and player characteristics	Supports the multifactorial interpretation of injury burden
Garret et al., 2024 [23]	Systematic review and meta-analysis	Competitive tennis players	Competitive players demonstrate characteristic shoulder range-of-motion adaptations	Supports the discussion of shoulder overuse and adaptation

Study	Study design	Population / scope	Main findings	Relevance
Jacquier-Bret and Gorce, 2024 [24]	Systematic review and meta-analysis	Tennis serve biomechanics	Key kinematic features of the serve may contribute to both performance and injury risk	Supports the biomechanical explanation of shoulder stress
Lambrich and Muehlbauer, 2023 [25]	Systematic scoping review	Serve and groundstroke biomechanics	Different stroke techniques are associated with distinct biomechanical demands	Supports technique-related prevention strategies
Abrams et al., 2011 [26]	Biomechanical review	Tennis serve motion analysis	Different serve types are associated with different loading patterns and injury implications	Adds mechanistic depth to the serve-related section
Cutts et al., 2020 [27]	Clinical review	Patients with lateral epicondylitis / tennis elbow	Summarized the mechanisms, presentation, and management of tennis elbow	Supports the section on overuse disorders of the elbow
Ollivierre and Nirschl, 1996 [28]	Clinical review	Tennis elbow	Presented classical treatment and rehabilitation concepts	Provides historical clinical background
Dziegciarczyk et al., 2024 [29]	Review	Tennis elbow treatment	Compared conservative and surgical approaches	Supports the practical clinical management perspective
Szewczyk et al., 2024 [30]	Literature review	Athletes across sports	Strength training may reduce orthopedic injury risk	Supports practical prevention recommendations
Chodkowski, 2024 [31]	Review	Athletes across sports	Adequate nutrition and hydration may support recovery and reduce injury risk	Supports the recovery and prevention perspective

Despite its health benefits, tennis is also associated with acute and chronic musculoskeletal injuries [17-29]. The sport's repetitive, high-speed, and asymmetrical movement patterns create substantial mechanical stress, particularly on the upper extremities, trunk, and lower limbs. Recent

review literature further emphasizes the multifactorial nature of tennis injuries, including the interaction between repetitive loading, stroke mechanics, player characteristics, and training exposure [22].

One of the best recognized overuse conditions in tennis is lateral epicondylitis, commonly referred to as tennis elbow [27-29]. This disorder is linked to repetitive wrist extension and forearm loading and may be aggravated by poor technique, excessive training volume, or inappropriate equipment. From a clinical standpoint, management may include both conservative and procedural approaches depending on symptom duration, functional limitation, and response to initial treatment [29].

Shoulder disorders are another major concern in tennis players, especially because of the serve and other overhead strokes [17,23-26]. Repetitive serving exposes the shoulder to high rotational loads and may contribute to altered range of motion, impingement symptoms, rotator cuff dysfunction, and other overuse conditions [17,23-26].

Lower-limb injuries are also common in tennis and are related to acceleration, deceleration, landing, and multidirectional court movement [17-21]. Epidemiological and review data indicate that both acute and overuse injuries occur, with the exact distribution varying according to age, training load, level of play, movement quality, and playing surface [17-21].

These observations emphasize the practical importance of progressive loading, adequate recovery, technical coaching, and preventive conditioning. Strength training, movement preparation, and structured rehabilitation awareness are likely to reduce injury burden and improve the overall risk-benefit balance of tennis participation [17-25,30]. In addition, appropriate nutritional support and hydration may contribute to recovery capacity and injury-risk reduction, particularly in athletes exposed to repeated training sessions or competition in demanding environmental conditions [31].

2.5. Discussion

The findings summarized in this review suggest that tennis may be regarded as a multidimensional form of physical activity rather than merely a leisure sport. Its physiological profile combines intermittent aerobic effort, repeated high-intensity actions, impact loading, coordination, and complex technical skills. This combination may help explain why tennis has been linked to favorable outcomes across several domains, including cardiovascular fitness, musculoskeletal adaptation, and long-term functional health.

One of the most interesting observations in the available literature is the recurrent association between participation in tennis and other racket sports and lower mortality risk. However, this point requires careful interpretation. Most studies addressing mortality and long-term health outcomes are observational, which means that residual confounding cannot be excluded. Individuals who play tennis regularly may differ from non-participants not only in physical activity level, but also in socioeconomic status, diet, healthcare access, educational background, and other health-related behaviors. For this reason, the available evidence should be interpreted as indicating an association rather than proving a direct causal effect of tennis participation on longevity.

The strength of evidence also differs across outcome domains. The literature on physiological demands, sport-specific biomechanics, and selected musculoskeletal adaptations is supported by systematic reviews and meta-analyses, whereas evidence linking tennis participation with lower all-cause or cardiovascular mortality is based mainly on cohort studies. Consequently, confidence is higher for conclusions related to cardiorespiratory demands, movement characteristics, and bone-related adaptation than for conclusions regarding causal effects on long-term survival or chronic disease prevention.

From a musculoskeletal perspective, tennis appears to offer a distinctive combination of osteogenic loading, neuromuscular coordination, sprinting, braking, and repeated directional changes. These features may support bone health, balance, and functional performance, which is particularly relevant in the context of healthy aging. At the same time, the unilateral and repetitive nature of tennis creates a characteristic injury profile involving especially the shoulder, elbow, and lower extremities. Therefore, the health value of tennis depends not only on participation itself, but also on how the sport is practiced, including technical proficiency, training volume, recovery, and preventive conditioning.

An important methodological issue is that part of the available evidence concerns racket sports as a broader category rather than tennis alone. Although tennis is one of the most representative disciplines within this group, direct extrapolation from broader racket-sport data to tennis-specific outcomes should be made cautiously. This applies particularly to studies addressing mortality, general health outcomes, and long-term participation patterns, where the exposure is not always limited to tennis as a single sport.

From a practical point of view, injury-prevention strategies in tennis should include gradual increases in training load, technique-oriented coaching, shoulder and trunk strengthening, lower-

limb neuromuscular conditioning, appropriate warm-up, and adequate recovery between sessions. In recreational and older players, particular attention should be paid to load tolerance, movement quality, and balance. In competitive players, by contrast, repetitive overhead exposure, cumulative serving volume, and high training density may require closer monitoring. This practical dimension is important because the overall risk-benefit balance of tennis is likely to depend strongly on age, training status, frequency of play, and playing level.

The public-health relevance of tennis lies partly in its potential to be practiced recreationally across many decades of life. Unlike short-term exercise interventions, tennis may promote long-term adherence by combining physical effort with skill development, social interaction, and enjoyment. This multidimensional character may partly explain why racket sports have repeatedly been associated with favorable long-term outcomes in observational studies. Nevertheless, the apparent advantage of tennis over other forms of leisure-time activity should not be overstated, because direct between-sport comparisons remain vulnerable to confounding and differences in participant characteristics.

This review has several limitations. First, it was conducted as a narrative review and therefore does not provide a formal systematic synthesis or pooled quantitative effect estimates. Second, the evidence base is heterogeneous with respect to age, sex, training status, competitive level, exposure definitions, and outcome measures. Third, long-term outcomes such as mortality and chronic disease risk are documented primarily in observational studies and remain vulnerable to residual confounding. Finally, some of the literature discussed in this review derives from broader studies on racket sports rather than tennis alone, which limits the precision of tennis-specific conclusions. These limitations should be considered when interpreting the practical and public-health implications of the current evidence.

Despite these limitations, the available literature supports the view that tennis may be positioned not only as a sport, but also as a potentially useful component of lifelong health promotion. Future prospective and interventional studies should clarify dose-response relationships, distinguish tennis-specific effects from broader racket-sport associations, and identify the most effective strategies for preserving health benefits while reducing injury burden across different age groups and levels of participation.

3. Summary

Tennis appears to be a valuable form of lifelong physical activity with potential benefits across cardiovascular, metabolic, musculoskeletal, and functional domains. The available literature also suggests that regular participation in tennis and other racket sports may be associated with favorable long-term health outcomes, including lower mortality risk, although the evidence in this area is based predominantly on observational studies and does not establish causality.

At the same time, tennis is associated with a characteristic injury profile, particularly involving the shoulder, elbow, and lower extremities. Therefore, the most favorable risk-benefit profile is likely to be achieved when tennis participation is accompanied by appropriate technique, progressive load management, conditioning, recovery, and injury-prevention strategies.

Further prospective and interventional studies are needed to clarify dose-response relationships, distinguish tennis-specific effects from broader racket-sport associations, and identify the most effective preventive approaches across different age groups and levels of play.

Disclosure section

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Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this work, the authors used ChatGPT (OpenAI) to improve grammar, language clarity, and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

References

1. Ding D, Mutrie N, Bauman A, Pratt M, Hallal PRC, Powell KE. Physical activity guidelines 2020: comprehensive and inclusive recommendations to activate populations. Lancet. 2020;396(10265):1780-1782. https://doi.org/10.1016/S0140-6736(20)32229-7
2. Lang JJ, Prince SA, Merucci K, et al. Cardiorespiratory fitness is a strong and consistent predictor of morbidity and mortality among adults: an overview of meta-analyses representing over 20.9 million observations from 199 unique cohort studies. Br J Sports Med. 2024;58(10):556-566. https://doi.org/10.1136/bjsports-2023-107849
3. Kodama S, Saito K, Tanaka S, et al. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. JAMA. 2009;301(19):2024-2035. https://doi.org/10.1001/jama.2009.681
4. Oja P, Memon AR, Titze S, et al. Health benefits of different sports: a systematic review and meta-analysis of longitudinal and intervention studies including 2.6 million adult participants. Sports Med Open. 2024;10(1):46. https://doi.org/10.1186/s40798-024-00692-x
5. Cádiz Gallardo MP, Pradas de la Fuente F, Moreno-Azze A, Carrasco Páez L. Physiological demands of racket sports: a systematic review. Front Psychol. 2023;14:1149295. https://doi.org/10.3389/fpsyg.2023.1149295
6. Pluim BM, Jansen MGT, Williamson S, et al. Physical demands of tennis across the different court surfaces, performance levels and sexes: a systematic review with meta-analysis. Sports Med. 2023;53(4):807-836. https://doi.org/10.1007/s40279-022-01807-8

7. Baiget E, Fernández-Fernández J, Iglesias X, Rodríguez FA. Tennis play intensity distribution and relation with aerobic fitness in competitive players. PLoS One. 2015;10(6):e0131304. https://doi.org/10.1371/journal.pone.0131304
8. Bergeron MF, Maresh CM, Kraemer WJ, Abraham A, Conroy B, Gabaree C. Tennis: a physiological profile during match play. Int J Sports Med. 1991;12(5):474-479. https://doi.org/10.1055/s-2007-1024716
9. Dylik A, Krawczak Ł, Gulaczyk H, Spychalska M, Spychalski J, Musiał M, Kaczmarek M, Grochowska W, Gryczyńska W. The Influence of Racket Sports on Longevity and Comprehensive Health Benefits. Qual Sport. 2025;39:58953. https://doi.org/10.12775/QS.2025.39.58953
10. Oja P, Kelly P, Pedisic Z, et al. Associations of specific types of sports and exercise with all-cause and cardiovascular-disease mortality: a cohort study of 80 306 British adults. Br J Sports Med. 2017;51(10):812-817. https://doi.org/10.1136/bjsports-2016-096822
11. Schnohr P, O'Keefe JH, Lavie CJ, Holtermann A, Lange P, Marott JL. U-shaped association between duration of sports activities and mortality: Copenhagen City Heart Study. Mayo Clin Proc. 2021;96(12):3012-3020. https://doi.org/10.1016/j.mayocp.2021.05.028
12. Ko A, Zhang Y, Giovannucci E. Long-term intensity and volume of biking, swimming, and tennis: associations with mortality risk in US older men. Prev Med. 2025;198:108350. https://doi.org/10.1016/j.ypmed.2025.108350
13. Spring KE, Holmes ME, Smith JW. Long-term tennis participation and health outcomes: an investigation of “lifetime” activities. Int J Exerc Sci. 2020;13(7):1251-1261. https://doi.org/10.70252/BAHT9366
14. Huang H, Huang J, Fu D, Fu Y, Wang T. The effect of tennis on male bone mineral density: a meta-analysis. PLoS One. 2025;20(8):e0328636. https://doi.org/10.1371/journal.pone.0328636
15. Chapelle L, Rommers N, Clarys P, D'Hondt E, Taeymans J. Upper extremity bone mineral content asymmetries in tennis players: a systematic review and meta-analysis. J Sports Sci. 2019;37(9):988-997. https://doi.org/10.1080/02640414.2018.1537173
16. Nicol G, Sammut L. Bone mineral density in paediatric to young adult tennis players: a narrative review. Osteoporos Int. Published online March 9, 2026. https://doi.org/10.1007/s00198-026-07905-x

17. Bradley J, Langdown BL, Bowmaker D, Kerr S. Injury risk factors of the tennis serve: a systematic review and meta-analysis. Adv Rehabil Sci Pract. 2025;14:27536351251374616. https://doi.org/10.1177/27536351251374616
18. Oosterhoff JH, Gouttebarge V, Moen M, et al. Risk factors for musculoskeletal injuries in elite junior tennis players: a systematic review. J Sports Sci. 2019;37(2):131-137. https://doi.org/10.1080/02640414.2018.1485620
19. Pluim BM, Staal JB, Windler GE, Jayanthi N. Tennis injuries: occurrence, aetiology, and prevention. Br J Sports Med. 2006;40(5):415-423. https://doi.org/10.1136/bjsm.2005.023184
20. Kibler WB, Safran M. Tennis injuries. Med Sport Sci. 2005;48:120-137. https://doi.org/10.1159/000084285
21. Maquirriain J, Baglione R. Epidemiology of tennis injuries: an eight-year review of Davis Cup retirements. Eur J Sport Sci. 2016;16(2):266-270. https://doi.org/10.1080/17461391.2015.1009493
22. Tłoczek W, Twardowska D, Śliwa W, Szlachta W, Kret D, Zdziebko A, Dziuk K. Beyond the Baseline: A Multifactorial Review of Tennis Injuries. Qual Sport. 2026;52:69033. https://doi.org/10.12775/QS.2026.52.69033
23. Garret J, Cuinet T, Guillard V, Montalvan B. Shoulder range of motion in competitive tennis players: systematic review and meta-analysis. JSES Int. 2024;8(3):551-569. https://doi.org/10.1016/j.jseint.2024.01.017
24. Jacquier-Bret J, Gorce P. Kinematics characteristics of key point of interest during tennis serve among tennis players: a systematic review and meta-analysis. Front Sports Act Living. 2024;6:1432030. https://doi.org/10.3389/fspor.2024.1432030
25. Lambrich J, Muehlbauer T. Biomechanical analyses of different serve and groundstroke techniques in tennis: a systematic scoping review. PLoS One. 2023;18(8):e0290320. https://doi.org/10.1371/journal.pone.0290320
26. Abrams GD, Sheets AL, Andriacchi TP, Safran MR. Review of tennis serve motion analysis and the biomechanics of three serve types with implications for injury. Sports Biomech. 2011;10(4):378-390. https://doi.org/10.1080/14763141.2011.629302
27. Cutts S, Gangoo S, Modi N, Pasapula C. Tennis elbow: a clinical review article. J Orthop. 2020;17:203-207. https://doi.org/10.1016/j.jor.2019.08.005

28. Ollivierre CO, Nirschl RP. Tennis elbow. Current concepts of treatment and rehabilitation. Sports Med. 1996;22(2):133-139. https://doi.org/10.2165/00007256-199622020-00006
29. Dziegciarczyk A, Banyś F, Wiak I, Bochen K, Czyżewski F, Górska W, Jasiński F, Łukawski A, Szałajska J, Wojtach K. Approaches to Treating Tennis Elbow: Surgical vs. Conservative Treatment. Qual Sport. 2024;34:56235. https://doi.org/10.12775/QS.2024.34.56235
30. Szewczyk J, Świta M, Szuciak A. The impact of strength training on the prevention of orthopedic injuries in sports: a literature review. Qual Sport. 2024;31:1-12. https://doi.org/10.12775/QS.2024.31.55268
31. Chodkowski J. The Role of Nutrition and Hydration in Injury Prevention and Recovery: A Review. J Educ Health Sport. 2024;71:56117. https://doi.org/10.12775/JEHS.2024.71.56117