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A Bibliometric Review: Global Sport Injury Research in Adolescent Athletes

Alzenna Amalia Putri[1]✉, Kuston Sultoni[2], Yati Ruhayati[3], Jajat[4]

Sport Science Study Program, Faculty of Sport and Health Education, Indonesian University of Education, Indonesia[1234]

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Abstract

Sports injury in adolescent athletes is an important issue that can impact their physical and mental development and future performance. This study analyzed research trends related to injury in adolescent athletes using bibliometric methods based on publications in the Scopus database during the period 2018-2025. The analysis showed that the number of publications has increased significantly since 2018, with a peak in 2024. The United States, the United Kingdom and Australia are the countries with the largest contributions to this research, as well as building extensive international collaborations. Keyword mapping revealed that factors such as age, injury history, body mass index (BMI) and training intensity play a role in increasing injury. Additionally, the study identified research challenges, including language bias and publication selectivity, indicating the need for further exploration with a more diverse range of literature sources. The findings provide insight into sports injury research trends and may guide future studies to increase awareness and injury prevention efforts in adolescent athletes.

How to Cite

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✉ Correspondence address :
E-mail: jenamp3@upi.edu

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INTRODUCTION

Adolescence is crucial for mental and physical growth, especially for people who are active in sports (Brewer & Chatterton, 2024). To become athletes, they must increase the intensity and duration of their training (Ekenros et al., 2023). But behind the passion and enthusiasm of teenage athletes, there are many to be aware of, and the most important is the of injury. Injury is defined as any physical problem that occurs during training or competition (Rejeb et al., 2019). Sports injuries can occur anywhere and at any time, which is detrimental to athletes as well as their clubs (de Azevedo Sodré Silva et al., 2023). Sports injuries will have a negative impact on physical and mental conditions, as they can affect quality of life, and serious long-term effects on the body's health (Werner et al., 2023). Examples of sports injuries include physical collisions with opponents or excessive training. The term Adolescent Motor Awkwardness (AMA), refers to a temporary decline in motor control during adolescence. Many factors influence developmental challenges in youth sport, such as speed, training intensity and play, which are generally based on chronological age, but often do not consider the different timing of the physical onset of AMA (Clarke et al., 2024). Although most athletes are able to return to sport, few are able to regain their pre-injury objective performance. Ongoing problems, such as pain and limitations in subjective range of motion, are common (Raisch et al., 2024).

In a case study, young athletes aged 7-18 years practiced regularly every week. Athletes at this age were significantly more likely to be injured (Shigematsu et al., 2021). In addition to the high rate of injury in adolescent athletes, the of burnout has also increased. Burnout is defined as a condition when an athlete stops participating in a sport they used to enjoy, due to chronic stress (Temm et al., 2022). The imbalance between physical load and functional ability of the body in adolescents is a major factor that triggers chronic physical fatigue and increases the of sports injuries (Shakhlina et al., 2023). Athletes who experience a lot of stress have a 70% higher of injury (Ekenros et al., 2023). Injuries at this age can affect an athlete's future development and performance, especially due to the high frequency of competition and training (de Azevedo Sodré Silva et al., 2023).

Over the past five years, a great deal of research has been done on injuries among adolescent athletes. One study involved 372 students in 16 different sports throughout Europe. According to research, approximately 40% of injuries were brought on by excessive training, and 20% of injuries resulted in absences longer than four weeks (Temm et al., 2022). It is impossible to ignore young athletes' intense training regimens, as research indicates that over one-third of them suffer from overtraining (Mitic et al., 2020). According to research, the location most frequently injured is the lower back (25%), which is followed by the knee (21%), elbow/hand (18%), other anatomical regions (18%), shoulder (7%), neck (4%), hip (4%), and ankle (4%). These results are consistent with a study by (Bult et al., 2018), which likewise found that the majority of injuries (85.2%) happen in the lower extremities, with the ankle (19.5%), thigh (17.1%), knee (16.6%), and hip/groin (16.5%) having the highest prevalence. Additionally, (Mallada et al., 2024) supported these findings by stating that the most commonly damaged body parts are the head or face (14.2%), knee (17.3%), and ankle (19%). Interestingly, the most common injuries, which can happen during practice or competition, are to the ankle. Because of their increased training loads, teenage athletes are therefore at a heightened of injury (Ekenros et al., 2023). According to the aforementioned research, over one-third of teenage athletes experience overtraining, which puts them at serious for damage from intense training. Ankle, knee, and lower back injuries are the most common, with the ankle being the most commonly injured during training and competition.

There is one analysis technique that can be used to analyze references to related articles, namely bibliometric analysis. In this study, the bibliometric analysis method was used to summarize and evaluate various articles on the topic of "Injury in Adolescent Athletes." Previous research often assesses the impact of a study based on the number of citations, as done by (Tagge et al., 2018) in their study on brain injury in young athletes. Through bibliometric analysis, we can identify high-impact articles based on the number of citations and how they relate to other studies, helping researchers understand key contributions to the field.

The main purpose of this article is to contribute to identifying key research, thematic clusters, and collaborative networks, and to provide readers with a thorough understanding of the topic of sports injuries. Bibliometric analysis provides insight into valuable research topics regarding research directions, major themes, qualitative and quantitative assessment of author, institution, and country collaborations (Wang et al., 2023).

This method is useful for examining the development of scientific production in a particular field, especially in sports. In short, with the increase of scientific production and the contribution of research progress in the development of the topic, this analysis technique can provide a comprehensive insight into the views on sports injuries (Ventaja-Cruz et al., 2024). Moreover, this method has been instrumental in tracing the development of sports injury research, over time (Pamboris et al., 2024). This study was conducted to help researchers and readers gain a deeper understanding and identify relevant studies in this field.

METHODS

This article is based on research published in Scopus indexed journals, using bibliometric analysis to collect references from related studies over the past eight years, i.e. from 2018 to 2025 (https://www.scopus.com). This method produces a bibliometric visualization of the journal, which includes author collaboration mapping, citation linkages, the emergence of frequently shared keywords, and interconnected bibliographic patterns and networks (Tran & Ha, 2023). By examining the most frequently cited articles and commonly discussed topics, bibliometric analysis can identify emerging research trends and key themes within a journal (Ansorge, 2024).

This analysis applied the BOOLEAN search method using a set of keywords (Yang et al., 2024);(Pamboris et al., 2024). Therefore, the syntax used to search the data found in Scopus was ("injury" OR "trauma") AND ("athlete" OR "sport" OR "player") AND ("young" OR "adolescent").

Scopus search results from 2018 to 2025 were processed using the VOSviewer application (1.6.20) as CSV files. All study designs were included without qualification, and analysis was based on graphs, descriptive frequencies, and bubble visualizations. VOSviewer is free software used to build, visualize and analyze bibliometric networks, and is particularly useful in displaying the thematic structure of a discipline (Pamboris et al., 2024).

RESULTS AND DISCUSSION

Published documents

In total, 15,582 articles were identified on the topic of sports injuries in adolescents between 1932 and 2025 **Figure 1**. Research on this topic started to trend and become more widely studied from 2018 to 2025, with the most publications in 2024 **Figure 2**.

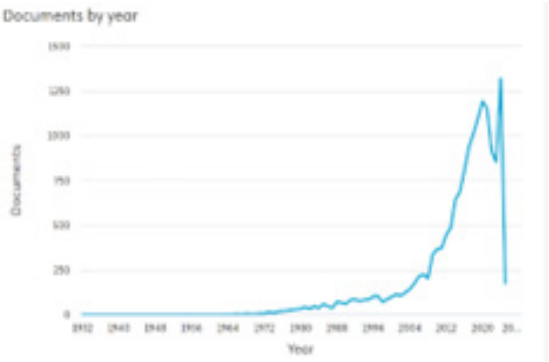

Figure 1. Number of documents from 1932 to 2025 citations

From 2018 to 2025, there are 223 countries that have articles related to injury of youth athletes. Fig 2, Analysis based on the Scopus database, shows that in 2018, there were 1,011 articles published. In 2019 the number of published articles rose to 1,097. In 2020, the number of articles published also rose to 1,191. However, in 2021, there was a slight decrease in the number of articles published, namely to 1,149. In the following two years, the number of articles published also decreased very significantly, namely 910 articles in 2022 and 852 articles in 2023. In 2024 the number of published articles increased very rapidly, and became the year that published the most articles with related research topics, namely 1,318 articles. And at the beginning of 2025, 174 articles have been published. The decline in publications related to Injury in Adolescent Athletes suggests the need for investigation into underlying factors.

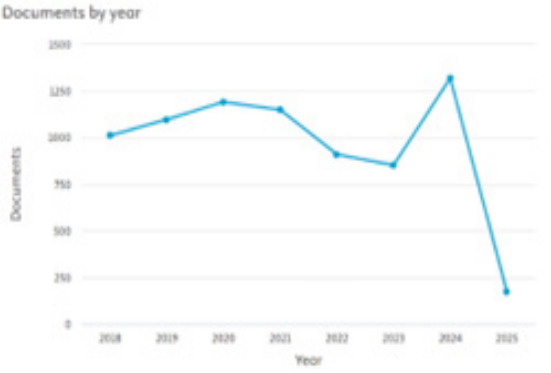

Figure 2. Document count of citations from 2018 to 2025

Table 1 shows the top 10 authors with the most influential articles in the research on Injury of Youth Athletes listed. First place is taken by the article published by Leddy et al., with a total of 307 citations. In second place was Tagge et al., with a total of 229 citations. Then the article published by Musahl et al., occupies the third po-

sition with a total of 227 citations. In the fourth and fifth positions there are Martinez et al., and Malone et al with the same number of citations, namely 215 citations. This table shows the most influential articles in terms of citations to topics related to Youth Athlete Injury, offering insight into the significant research contributions of various authors.

Table 1. Top 10 most-cited articles on Scopus

Rank	Document Title	
1.	Early Subthreshold Aerobic Exercise for Sport-Related Concussion: A Randomized Clinical Trial	307
2.	Concussion, microvascular injury, and early tauopathy in young athletes after impact head injury and an impact concussion mouse model	229
3.	Anterior cruciate ligament tear	227
4.	Prevalence of Inflammatory Heart Disease among Professional Athletes with Prior COVID-19 Infection Who Received Systematic Return-to-Play Cardiac Screening	215
5.	High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk?	215
6.	Team sport athletes may be less likely to suffer anxiety or depression than individual sport athletes	213
7.	Low energy availability is difficult to assess but outcomes have large impact on bone injury rates in elite distance athletes	212
8.	Determinants of anxiety in elite athletes: a systematic review and meta-analysis	191
9.	Factors Associated With Psychological Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction Surgery	188
10.	Anterior cruciate ligament injury in sport: A systematic review and meta-analysis of injury incidence by sex and sport classification	186

Scientific mapping

Figure 3 shows that some of the top 10 researchers have made significant contributions through the publication of their work. **Table 2** shows that Myer, G.D., Webster, K.E., Howell, D.R., Hewett, T.E., and Kerr, Z.Y., have made significant contributions, with between 67 and 23 publications that provide deep insights into sports injuries. This is followed by Bahr, R., Broglio, S.P., Meehan, W.P., Buckley, T.A., Mccrea, M.A., who have also contributed significantly, publishing between 57 and 38 articles highlighting important aspects of sports injury research. Among them, Myer, G.D. stands out with outstanding productivity, accumulating 1,424 citations from his articles.

Figure 3. Co-authorship by number of publications and citations

Table 2. Authors, Publications, and Citations

Rank	Author	Pub	Cit
1	Myer, Gregory D.	67	1.424
2	Webster, Kate E.	23	1.078
3	Howell, David R.	74	1.026
4	Hewett, Timothy E.	31	1.010
5	Kerr, Zachary Y.	44	994
7	Broglio, Steven P.	57	985
8	Meehan, William P.	54	974
9	Buckley, Thomas A.	41	883
10	Mccrea, Michael A.	50	837

Table 3 shows the top 10 countries by articles published on related topics. The US leads with 3,215 articles and 40,729 total citations, followed by the UK with 713 articles and 9,439 total citations. Then there is Australia, which published 547 articles with a total citation of 8,231, followed by Canada and Germany, which published 510,366 articles each, with a total citation of 7,261 for Canada and 4,516 for Germany. **Figure 4** shows the collaboration network with the United States as the main center, followed by the United Kingdom, Australia, Canada and finally Germany. These countries have strong collabora-

tions and significant influence in adolescent athlete injury research.

Figure 4. Countries with the highest productivity by number of publications and citations

Table 3. Countries, Publications, and Citations

Rank	Countrie	Pub	Cit
1	United States	3.215	40.729
2	United Kingdom	713	9.439
3	Australia	547	8.231
4	Canada	510	7.261
5	Germany	366	4.516
6	Spain	390	4.494
7	Netherlands	216	3.618
8	Sweden	207	3.601
9	Japan	469	3.384
10	Italy	319	3.116

Figure 5. Keyword Analysis

Figure 5 present the prevalence of 916 shared keywords, which appeared in our search results, using Scopus. Direct and co-citation analysis can be used in networks to reveal publication relationships, identify related research topics, and assess the impact of articles on related topics (Gong et al., 2019);(Sugandh et al., 2023). Even in sports, shared keyword analysis can be used to recognize current research trends and monitor the development of related topics (Rinanda et al., 2023). In this study, we used VOSviewer to map keyword associations, apply fractional calculations with a minimum occurrence threshold, and analyze the keywords used by authors. Frequently co-used keywords are grouped with the same color, while the distance reflects the degree of relatedness, and the line indicates the co-occurrence of keywords (Sugandh et al., 2023).

The principle of keyword clustering analysis is to identify how often keywords appear in the same article and apply statistical methods to group closely related keywords (Gong et al., 2019). VOSviewer uses the VOS (Visualization of Similarities) algorithm to automatically cluster keywords based on their degree of relatedness in the analyzed data. Words that appear more frequently have higher relevance than others and play an important role in determining the themes in each cluster (Ventaja-Cruz et al., 2024);(Gong et al., 2019). Clustering based on the close relationship between the keywords combined is divided into 6 clusters, namely:

1) Cluster 1: Achilles tendon, acl reconstruction, acromioclavicular joint, adolescent athlete, adverse event, allograft, analgesia, analgesic agent, anamnesis, anterior cruciate ligament,arm pain, arthralgia, arthrography, arthroscopic surgery, arthroscopy, articular cartilage, asymptomatic disease, athletic rehabilitation, autotransplantation, avulsion fracture, avulsion injury, backache, bankart lesion, baseball, baseball player, basketball player, biceps brachii muscle, bone graft, bone marrow edema, bone patellar tendon, bone radiography, bone transplantation, cartilage, cartilage, articular, case report, case series, case study, chronic pain, clinical article, clinical decision making, clinical evaluation, clinical examination, clinical feature, clinical outcome, collateral ligament, ulnar, computer assisted tomography, conservative treatment, daily life activity, debnidement, diagnosis, differential, diagnostic imaging, differential diagnosis, disability, disease classification, disease course, disease duration, disease exacerbation, dislocation, echography, edema, elastography, elbow, elbow flexion, elbow injury, elbow joint, electronic medical record, falling, femoracetabular imping, femoral condyle, femur fluoroscopy, follow-up studies, forearm fracture, fracture focation, fracture healing, fracture nonunion, fractures bone, fractures stress, functional status, general anesthesia, graft failure, grip strength, gymnast, hamstring tendons, hematoma, hip pain, hospital discharge, humerus, ibuprofen, image analysis, imaging, immobilization, informed consent, inguinal

pain, instability, intermethod comparison, international knee documentation committee scale, interrater reliability, jogging, joint dislocation, joint effusion, joint instability, joint laxity, joint ligament, joint stability, knee arthroscopy, knee injuries, knee injury, knee injury and osteoarthritis outcome score, knee instability, knee ligament injury, knee meniscus, knee meniscus rupture, knee osteoarthritis, knee pain, knee radiography, leg pain, ligament, ligament injury, ligament surgery, lysholm score, magnetic resonance imaging, medial collateral ligament, medical record review, meniscal repair, meniscectomy, meniscus, metatarsal bones, middle aged, military personnel, mri, muscle atrophy, muscle training, muscle weakness, musculoskeletal disease assessment, musculoskeletal pain, nonsteroid anti-inflammatory agent, nuclear magnetic resonance imaging, numeric rating scale, open reduction (procedure), orthopedic procedures, orthopedic surgeon, orthopedic surgery, orthopedics, osteoarthritis, osteochondritis dissecans, osteolysis, osteosynthesis, outcome assessment, pain, pain assessment, pain intensity, pain measurement, pain severity, palpation, paresthesia, patella, patellar ligament, patellofemoral joint, pathology, patient reported outcome measures, patient satisfaction, patient-reported outcome, pediatric, pediatric patient, physical examination, physical therapy modalities, physiotherapy, pitching, postoperative care, postoperative complications, postoperative pain, postoperative period, preoperative evaluation, preoperative period, priority journal, procedures, professional athlete, prognosis, quality of life, radiography, range of motion, reconstruction, reconstructive surgery, recurrence, recurrence, recurrent disease, recurrent shoulder dislocation, rehabilitation care, reoperation, rest, retrospective studies, return to play, return to sports, rotator cuff, rotator cuff injuries, rotator cuff injury, rotator cuff rupture, rupture, scapula, school child, shoulder, shoulder arthroscopy, shoulder impingement, shoulder injuries, shoulder injury, shoulder instability, shoulder joint, shoulder pain, shoulder surgery, softball player, stress fracture, subluxation, supine position, surgery, surgical approach, surgical technique, swelling synovitis, systematic review, t2 weighted imaging, tegner activity score, tendinitis, tendon, tendon graft, tendong injury, tendong rescontruction, tendon repture, tendons, tenodesis, thrombocyte rich plasma, tibia, tibia facture, tomography, x-ray computed, transplantitation, autologous, treatment duration, treatment failure, treatment outcome, treatment study, ulnar collateral ligament, ulnar collateral ligament (elbow), ulnar collateral ligament reconstruction, ultrasonography, ultrasound, visual analog scale, weight bearing, weight lifting, x-ray, x-ray computed tomography.

2) Cluster 2: Acceleration, accelerometry, acute disease, adolescent, adolescent athletes, age, age factors, algorithm, amnesia, anxiety, anxiety disorder, area under the curve, assessment, athletes, athletic injuries, athletic trainer, attention, attention deficit disorder, attention deficit hyperactive, attitude, attitude to health, awareness behavior, brain, brain concussion, brain function, brain injures, traumatic, brain injury, career, caucasian, child parent relation, chronic traumatic encephalopathy, clinical assessment, clinical practice, clinical trial, cognition, cognition assessment, cognitive defect, cognitive dysfunction, cohort analysis, cohort studies, college, college student, collision sport, comorbidity, complication, concussions, confidence interval, contact athlete, contact sport, contact sports, convalescence, corpus callosum, correlation analysis, correlational study, craniocerebral trauma, cross-sectional study, data analysis, decision making, demography, depression, descriptive research, devices, diagnosis, diagnostic accuracy, diagnostic test accuracy study, diffusion tensor imaging, diffusion weighted imaging, disease assessment, disease association, disease burden, disease severity, dizziness, education, educational status, electroencephalogram, electroencephalography, emotion, equipment design, ethnicity, etiology, executive function, exposure, fear, feasibility study, female, finite element analysis, football, football player, fractional anisotropy, functional connectivity, functional magnetic resonance imagic, game, gender, head, head impact, head injury, head movement, head protective devices, headache, health care personnel, health education, health knowledge, health survey, helmet, high school, high school student, hippocampus, hockey, hockey player, ice hockey, image processing, impact, information processing, interpersonal communication, interview, juvenile, knowledge, lacrosse (sport), learning, learning disorder, likert scale, linear regression analysis, logistic models, logistic regression analysis, longitudinal studies, machine learning, major clinical study, male, mass screening, medical history, memory, mental disease, mental health, mental performance, migraine, mild traumatic brain injuries, motivation, mouth protectors, mbti, multicenter study, nausea, neck, neck pain, neuroimaging, neurologic examination, neuropsychological assessment, neuropsychological test, non-contact sport, observational study, odds ratio, parents, patient care, pediatric

sports medicine, pediatrics, perception, personal experience, physician, post-concussion syndrome, practice guideline, prediction, predictive value, predictive value of tests, primary prevention, processing speed, psychological aspect, psychology, psychometrics, psychomotor performal, qualitative research, quantitative analysis, questionnaire, race, reaction time, receiver operating charactertistic, recovery of function, reference values regression analysis, reproducibility, reproducibility of results, assessment, rugby, saccadic eye movement, safety, school, scoring system, screening test, secondary analysis, self concept, self report, semi structured interview, sensitivity analysis, sensitivity and specification, severity of illness index, sex, sex characteristics, sex difference, sex factor, sexual characteristics, skill, sleep, sleep disorder, sleep quality, sleep time, sport, sport injury, sport related concussions, sports, sports medicine, sports-related concussicons, statistical model, student, student athlete, surveys and questionnaires, symptom, symptom assessment, tau protein, time, traffic accident, trauma, traumatic brain injury, unconsciousness, universities, university student, validation study, validity, verbal memory, video recording, vision, visual memory, vomiting, wearable electronic device, wellbeing, white matter, working memory, wresling, youth sport.

3) Cluster 3: Abduction, accident prevention, acl, acl injury, adduction, agility, analysis of variance, ankle, ankle injuries, ankle instability, ankle joint, ankle sprain, anterior cruciate ligament, anterior cruciate ligament injury, asymmetry, athletic tape, balance, ball sport, ball sports athlete, biceps femoris muscle, biomechanical phenomena, biomechanics, body equilibrium, body movement, body position, chronic ankle instability, chronic disease, clinical effectiveness, clinical protocol, comparative study, controlled clinical trial, controlled study, core stability, correlation coefficient, data analysis software, deceleration, dynamic balance, dynamometer, dynamometry, eccentric muscle contraction, effect size, electromyography,, evaluation study, exercise therapy, female, athletes, flexibility, flexor muscle, foot, football players, force, functional assessment, functional movement screen, gait, gastrocnemius muscle, goniometry, ground reaction force, hamstrings, hamstring muscles, handball, height, hemispheric dominance, hip, hip joint, hip muscle, injury prevention, injury, intervention study, intrarater reliability, isokinetic, isokinetic exercise, isometric contraction, joint characteristics and function, joint function, joint mobility, joints (anatomy), jumping, kinematics, kinesiotherapy, kinetics, knee, knee function, knee joint, landing, leg, leg muscle, limb, locomotion, lower extremity, lower limb, measurement, mechanical stress, mechanics, motion, motion analysis, motor control, motor performance, motor skills, movement, movement (physiology), muscle contraction, muscle function, muscle isometric contraction, muscle rigidity, muscle strength, muscle strength dynamometer, muscle stretching exercises, musculoskeletal function, musculoskeletal system parameters, neuromuscular function, neuromuscular training, pathophysiology, pelvis, physical functional performance, physical parameters, physiology, plyometric exercise, plyometrics, postural balance, postural control, postural stability, posture, pressure, prevention, prevention and control, principal component analysis, proprioception, quadriceps femoris muscle, quadriceps muscle, range of motion, articular, rectus femoris muscle, rehabilitation, reliability, nisk reduction, rotation, screening, semitendinous muscle, single blind procedure, standing, strength, stretching, stretching exercise, task performance, task performance and analysis, team sports, test retest reliability, therapy, three-dimensional imaging, time and motion studies, torque, torso, trunk, valgus knee, vastus lateralis muscle, velocity, walking, walking speed, warm up, warm-up exercise, weight-bearing, young athletes.

4) Cluster 4: Absorptiometry, photon, adaptation, adaptation physiological, adolescence, adult, aerobic exercise, anatomy and histology, animals, animal experiment, anthropometric parameters, anthropometry, athletic performance, biological marker, biomarkers, blood, blood pressure, blood sampling, body composition, body fat, body height, body mass, body mass index, body weight, bone, bone density, c reactive protein, competitive behavior, coronavirus disease 2019, countermovement jump, covid-19, creatine kinase, creatine kinase blood level, creatinine, cross-over studies, crossover procedure, cryotherapy, cycling, dietary supplement, disabled sport, double blind procedure, double blind method, drug effect, dual energy x-ray absorptiometry, electrocardiography, endurance, endurance training, enzyme linked immunosorbent assay, exercise, exercise intensity, exercise test, fatigue, fitness, genetics, genotype, geographic informations system, hand strength, health, health status, healthy volunteers, heart rate, heat, heat injury, heat stress disorders, high intensity interval training, hot temperature, human, human cell, human experiment, human tissue, humans, hydrocor-

tisone, inflammation, interleukin 6, lactate dehydrogenase, lactic acid, maturation, menstrual cycle, mental stress, metabolism, monitoring, muscle, muscle damage, muscle fatigue, muscle injury, muscle mass, muscle, skeletal, myalgia, nonhuman, normal human, nutrition, obesity, oxidative stress, oxygen consumption, pandemic, para-athletes, performance, photon absorptiometry, physical activity, physical conditioning, human, physical endurance, physical exertion, physical fitness, physical performance, physiological stress, pilot projects, pilot study, placebo, post hoc analysis, protein blood level, public health, randomized controlled trial, recovery, resistance training, runner, running, simulation, skeletal muscle, soccer, soccer player, spinal cord injuries, spinal cord injury, sports for persons with disabilities, stress, psychological, team sport, testosterone, therapy effect, time factor, training, training load, treadmill exercise, tumor necrosis factor, unclassified drug, vitamin d, wheelchairs, workload, young adult, young population.

5) Cluster 5: Age distribution, aged, 80 and over, ankle injury, arm, arm injuries, arm injury, athletic injury, athletics, badminton, basketball, blunt trauma, bone injury, bone stress, boxing, cervical spine, child, preschool, children, classification, competition, contusion, cricket (sport), cumulative trauma disorder, dancing, disease surveillance, elite athlete, emergency service, hospital, emergency ward, epidemiology, face injury, female athlete, finger injury, foot injury, golf, groin, groin pain, groups by age, gymnastics hand, hand injury, high population, hip injury, hospital admission, hospital emergency service, hospitalization, incidence, infant, inguinal region, injuries, injury, injury scale, injury severity, injury severity score, injury surveillance, internet, joint injury, judo, laceration, leg injuries, leg injury,limb injury, low back pain, lumbar spine, lumbar vertebra, martial art, morbidity, muscle strain, musculoskeletal disease, musculoskeletal injury, musculoskeletal system, neck injury, overuse injury, physical education, physiotherapist, preschool child, prevalence, prospective studies, racquet sport, recreation, factors, rowing, season, seasonal variation, seasons, sex ratio, skating, skier, skiing, soft tissue injuries, softball, specialization, spine, spine injury, spondylolysis,s sport specialization, sporting injuries, sports and sport related phenomenal, sports injury, sprain, sprains and strains, statistical analysis, statistics and numerical data, sudden cardiac death, swimming, taekwondo, tennis, thigh, thorax injury, tooth injury, track and field, trauma severity indices, upper extremity, upper limb, very elderly, volleyball, water sports, wounds and injuries, wrist, wrist injury, youth, youth athletes, youth sport.

6) Cluster 6: Case-control studies, case control study, reinjuries.

The results identified several important insights into research trends and contributions related to Injury in Youth Athletes from 1932 to 2024. Analysis of publication trends showed a significant increase since 2018, and peaked in 2024, signaling a growing interest in the field. The article with the most significant influence based on the most citations was written by Leddy et al., (2019), titled "Early Subthreshold Aerobic Exercise for Sport-Related Concussion: A Randomized Clinical Trial" with 307 citations.

Figure 3 shows the notable contributions of 10 of the most influential researchers, including Myer, G.D., Webster, K.E., Howell, D.R., Hewett, T.E., and Kerr, Z.Y., who together have produced many valuable publications on related topics. Table 3 provides an overview of research productivity and impact at the global level, with the United States topping the list in both number of published articles and number of citations. Then, figure 5 and table 4 show the shared keywords divided into 6 clusters. The occurrence of key terms confirms that the topic of sports injuries is an exciting area of exploration. Words such as "human," "adolescent," and "injury" are closely related to scientific production, which is directly related to the process of professionalism experienced by adolescent athletes.

Bibliometric studies are in high demand in these countries, suggesting that this method is an effective publication strategy (Ansorge, 2024). The topic of injury in adolescent athletes led to a discussion of the strategies and approaches used by researchers on sports injuries. More detailed information can be seen in **Figure 4**, which shows the network of collaboration between countries. The United States, along with the United Kingdom, Australia, Canada and Germany, has a central role. This confirms that research on injury in adolescent athletes is global and involves international cooperation. The increasing trend of article publications is in line with institutional initiatives to promote sports injury research, while encouraging the development of research in related fields. The increase in research on injury in adolescent athletes since 2018, reflects the importance of sports injuries as a platform for their empowerment. This topic is not only relevant in a sporting context, but also from a psychological

and social aspect, as in adolescence, maintaining motivation to exercise can be challenging.

The high injury rate is influenced by several factors, including older age, history of musculoskeletal injuries, high posture, greater body mass and body mass index (BMI), and more intense levels of participation in sports activities throughout the year (de Azevedo Sodré Silva et al., 2023). Based on the results of the above discussion, there are various of injury experienced by adolescent athletes. The most common injuries are knee and ankle injuries, especially in sports that involve a lot of jumping and fast movement. Furthermore, musculoskeletal injuries often occur due to overtraining or the use of improper techniques, which affect the muscles, ligaments and bones. Another is overuse injuries, caused by repetitive use without sufficient recovery time, such as tendinitis or stress fractures. In addition, head injuries and concussions are also a major concern, especially in contact sports like soccer and basketball. Finally, lack of recovery and overtraining can increase the of injury while causing chronic fatigue. By mapping clusters of interconnected keywords, this research enriches and expands the academic discussion on sports injuries. Despite this wealth of research, there are still aspects that have not been explored in depth or require further study, particularly regarding the effectiveness of different approaches in reducing the impact of injuries in adolescent athletes. Overall, this in-depth analysis provides valuable insights into the developments, trends and dynamics of collaboration in injury research. The findings not only enrich existing studies, but also serve as a guide for future research, with the aim of increasing awareness of injury among athletes, particularly adolescent athletes.

This study has several limitations, namely the reliance on Scopus-indexed English publications may lead to language bias, ignoring research in other languages. In addition, the use of Scopus could potentially lead to publication bias as it does not cover all relevant literature. While bibliometric analysis provides quantitative insights, it falls short of capturing the qualitative aspects and context of individual studies. Therefore, careful interpretation and further research are needed to overcome these limitations and deepen the understanding of sports injuries to adolescent athletes among university students.

CONCLUSION

This study analyzed trends and collaborations in Injury in Youth Athletes research (1932-2024). Publications increased significantly in 2018 and peaked in 2024, reflecting great interest. Adolescent athletes' injury has been the subject of an increasing number of research, indicating a high level of scholarly interest in this area. The most often researched injuries are those brought on by acute trauma and overuse. Biomechanical, physiological, and psychosocial elements are among the many factors that contribute to injury occurrence, as are the effects of training regimens and environmental circumstances.

The United States, the United Kingdom, and Australia are the nations that have contributed the most to this study. In order to better understand injury and create efficient preventative techniques, cooperation between academic institutions and sports organizations is essential. This study emphasizes the value of a multidisciplinary strategy in reducing young athletes' of injury. It is advised that future studies concentrate on creating evidence-based treatments and creating more potent injury prevention regulations.

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