STUDIA UBB EDUCATIO ARTIS GYMN., LXXI, 2, 2026, pp. 17-30
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.71(2).12

Prevalence and Factors Associated with Growth Plate Injuries in Children and Adolescent Basketball Players in Malang City

Sekar Ayu Putri WINANTI[1*], Ahmad ABDULLAH[1]

Article history: Received 2026 March 03 Revised 2026 April 18. Accepted 2026 May 19; Available online 2026 June 30; Available print 2026 July 30

ABSTRACT. This study aims to determine the prevalence of growth plate injuries and factors associated with injury in children and adolescent basketball players in Malang City. The study used a quantitative descriptive design with a cross-sectional approach in 80 basketball players aged 8-17 years. Data collection was conducted using a Reported Condition Inquiry questionnaire that included the duration of training, injury history, anatomical location of injury, and mechanism of injury experienced by basketball players. The results showed an injury prevalence of 83.8% with 70% of them involving the growth plate area. The most common injury locations were the ankle (26.3%) and the knee (21.3%). The most dominant risk factors were direct contact and non-contact, each contributing 37.5% to the incidence of injury. These findings indicate that basketball players are highly susceptible to growth plate injuries due to the high physical demands of basketball and immature bone structure. This study emphasizes the importance of implementing injury prevention strategies through muscle strengthening, movement techniques, and adjusting training loads according to the developmental stage of basketball players.

Keywords: *growth plate; sports injury; basketball; injury prevalence*

[1] Department of Sports Science, Faculty of Sports Science, State University of Malang, Indonesia.
[*] Corresponding author: sekar.ayu.2206216@students.um.ac.id

INTRODUCTION

Increased sports involvement with high levels of training intensity and complexity performed repeatedly at a young age carries a high risk of injury (Naaktgeboren et al., 2017). Regular participation among young players, coupled with the specific risks of sport factors, can increase the likelihood of suffering injuries mainly due to the immaturity of the musculoskeletal system during the period of structural and motor development (Mendhe & Borkar, 2021). The growth plate is a common site of traumatic injury and is the most fragile area of the growing long bones in children with up to 20% of childhood fractures involving growth plate damage (Sananta et al., 2020). During the growth phase, bones are relatively weaker (2-5 times) compared to tendons and ligaments (Sananta et al., 2022).

Physical fatigue can cause muscle fatigue which is identified as a potential risk factor for injury due to rapid eccentric contractions (muscle lengthening) and consequently interferes with motor performance, thus contributing to an increase in the occurrence of injuries (Schwiete et al., 2025). As a result of repeated pressure at high intensity or frequency during training, many basketball players experience physical injuries, namely damage to the growth plate bones (Apers et al., 2021). Factors that interact at the time of injury can be intrinsic (personal), extrinsic (environmental) factors and previous injuries which can cause injuries up to 50-70% (Kilic et al., 2018). Frequent jumping, landing, and sudden changes of direction are extrinsic factors for injury in players due to exposure to high levels of eccentric loading. Furthermore, a lack of adequate strength, endurance, flexibility, and other skill-related components are intrinsic factors that increase the risk of injury (Šiupšinskas et al., 2019).

Approximately 80% of young athletes experience injuries related to the musculoskeletal system (Naaktgeboren et al., 2017). This high figure indicates that the musculoskeletal system at a young age is still in a developmental phase that is vulnerable to injury. In line with this, previous research by (Dover & Kiely, 2015) indicates that growth plate injuries account for 15-30% of all childhood bone injuries, emphasizing the importance of paying special attention to the growth plate. One form of injury related to the growth plate is a pelvic apophyseal avulsion, which is described in the medical literature as “a rare injury affecting young athletes to the growth plate or cartilage that has not yet ossified (not yet become bone)”. These injuries generally occur as a result of sudden, forceful contraction or excessive passive lengthening (stretching) of the muscle. To describe the location and type of injury to the growth plate, the Salter-Harris classification is widely used in clinical practice (Sheffer et al., 2020). Understanding the characteristics of these injuries is important in determining the appropriate rehabilitation approach, including the need for mechanical loading. This is supported by the Journal of Functional Morphology and Kinesiology (Monaco et al., 2021)

who cited that mechanical loading has an important role not only during the development of the musculoskeletal system but also after the developmental phase, as well as contributing to the maintenance of articular cartilage health.

This study examines the potential risk of growth plate injuries in young people, suggesting that high-intensity exercise can contribute to a higher risk of growth plate injuries. Overall, while exercise offers numerous benefits for physical and mental health, attention should be paid to the potential risk of injury (Smith & Merwin, 2021). Training interruptions due to injury or illness can substantially reduce the opportunity to achieve high levels of performance, therefore better knowledge of injury risk factors and prevention strategies is essential (Wik et al., 2020). Coaches need to reduce repetitive training loads and control training progression in basketball players who are experiencing peak growth (PHV) (Jayanthi et al., 2022). Coaches should use a variety of exercises to prevent excessive repetitive movements that can lead to injury, by including strengthening exercises or weight training can reduce the risk of injury by up to 68%, improve performance and health parameters (Brenner, 2016).

MATERIAL AND METHODS

Participants

The research sample consisted of children and adolescent basketball players who actively train in Malang City. The purposive sampling technique involved the deliberate selection of 80 individuals based on the following criteria: basketball players in Malang City, aged 8-17 years, players who actively train regularly, with a training frequency of at least three times a week. This research passed ethical research at State University of Malang (UM) Indonesia.

Research design

This study used a quantitative descriptive design with a cross-sectional approach to describe the prevalence of growth plate injuries in adolescent basketball athletes (Wang & Cheng, 2020). The study was conducted from October to November 2025 in Malang City.

Reported Condition Inquiry

The Reported Condition Injury is a questionnaire designed to gather information about health status. It covers personal data (age, weight, and height), duration of practice (in years), mechanism of injury, anatomical location affected, and time of injury (Bastos, et al., 2014).

Objective: The purpose of this scale is to measure the prevalence rate of growth plate injuries in Malang City basketball players and to determine the risk factors for injuries that occur in the growth plate.

Structure: This research design uses a questionnaire structure consisting of V0-V7: V0: Identification, V1: Age, V2: Weight, V3: Height, V4: Training time, V5: Injury, V6: Anatomical site, V7: Mechanism of Injury

Response Method: Responses were measured using the "Reported Condition Inquiry" questionnaire.

Interpretation: Injury History: Injury, no injuries. Mechanism of injury: No injuries, running, jump, impact, specific athletic gesture. Anatomical site: No injuries, neck, shoulder, arm, dorsal, elbow, forearm, lumbar region, wrist, hip, knee, calf, ankle. Analysis of growth plate: Growth plate, not a growth plate. Growth plate symptoms: Pain in the joints, deformities (lumps, shifts, cracks), swelling in the joints. Risk factors for growth plate injury: No injuries, overuse, non-contact, direct contact.

Validity and Reliability: The validity and reliability of the instrument were tested using Pearson correlation and Crohn's Alpha using IBM SPSS Statistics. Data analysis techniques included univariate analysis in the form of frequency distributions and percentages to describe the research results.

Analysis of statistics

In this study, the collected data will be processed using IBM SPSS Statistics. Validity and reliability tests will ensure that the questionnaire items accurately and consistently measure the variables studied. The analysis results are presented in the form of descriptive statistical tables, frequencies, and percentages.

RESULTS

Table 1. Statistical analysis of physical character test results

Physical Characteristics	N	*Minimum*	*Maximum*	*Mean ± Std. Deviation*
Age (th)	80	8.0	17.0	12.55 ± 2.2098
Weight (kg)	80	20.0	93.0	48.05 ± 13.3633
Height (cm)	80	120.0	180.0	155.52 ± 10.0252
Valid N	80			

Source: Present research

Based on the descriptive analysis results in table, the average age of respondents was 12.55 years with an age range of 8 to 17 years, reflecting that respondents were in the early to middle adolescence phase. Respondents' average weight was 48.05 kg with a weight ranging from 20 kg to 93 kg, while height showed an average value of 155.52 cm with a range of 120 cm to 180 cm. These results indicate a normal variation in physical characteristics for basketball players who are in their growth period.

Table 2. Statistical analysis of training duration results

Exercise Duration	Frequency	Percentage
0 – 5.9 months	14	17.5%
6 – 11.9 months	10	12.5%
1 – 1.9 months	23	28.7%
2 – 2.9 years	12	15.0%
3 – 3.9 years	10	12.5%
> 4 years	11	13.8%
N	**80**	**100.0%**

Source: Present research

The table shows that in Malang City, the majority have training experience of 1 to 1.9 years, with a percentage of (28.7%), making this group the most dominant. Groups with a duration of less than 1 year, namely 0 to 5.9 and 6 - 11.9 months, were (17.5%) and (12.5%), respectively, indicating that quite a lot of respondents are still in the initial phase of training. Meanwhile, groups with longer training experience, namely 2 to 2.9 years, were (15.0%), 3 to 3.9 (12.5%), and more than 4 years (13.8%), indicating that a small portion have long-term training duration.

Figure 1 shows that both children and adolescents had a higher proportion of injuries compared to those who did not experience injuries. In the children group, 75% experienced injuries, while 25% did not experience injuries. Meanwhile, in the adolescent group, the percentage of injuries was higher, at 85%, with 15% experiencing no injuries. These findings indicate that the incidence of injuries is more dominant in the adolescent group than in children, thus indicating an increasing risk of injury with age.

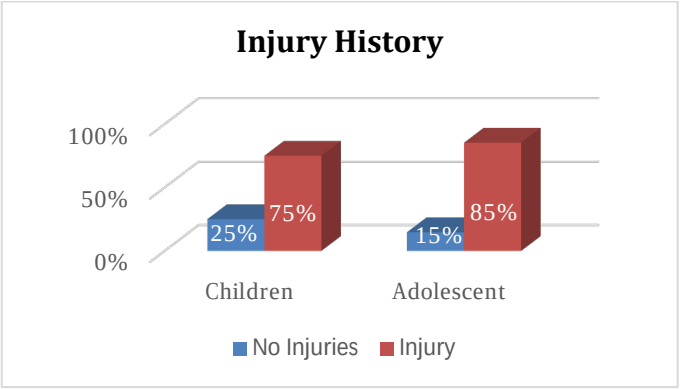

Fig. 1. Graph of injury history in children and adolescents

Figure 2 shows the differences in patterns between children and adolescents. In the children group, the most common injuries occurred during running and performing specific movements, each at 33%, while injuries from jumping were relatively low (8%), and no injuries from impacts were found. Conversely, in the adolescent group, the most dominant injuries occurred from specific movements (37%), followed by jumping (25%), running (16%), and impacts (7%). Furthermore, the percentage of non-injury in adolescents (15%) was lower than in children (25%). This suggests that in adolescents, activities with higher movement complexity and mechanical loads, such as specific movements and jumping, play a greater role in the occurrence of injuries than in children.

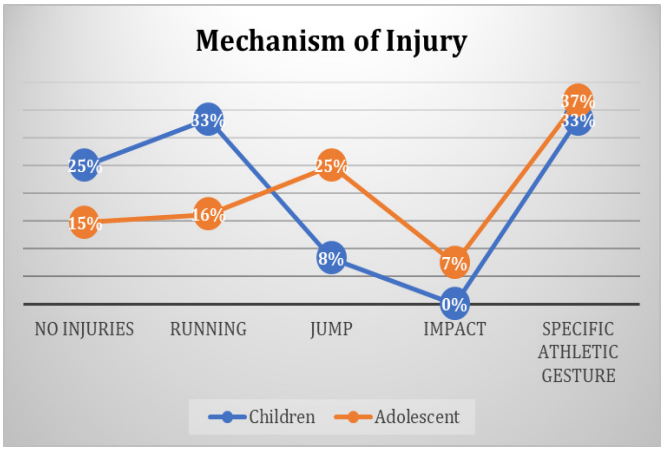

Fig. 2. Graph of mechanism injury

Figure 3 shows the distribution of injury locations between children and adolescents. In children, injuries focused on one primary area, the ankle (42%), indicating that lower extremity stability and movement control are weak points in this age group. Injuries to other body parts were relatively low, so the injury pattern in children tended to be simpler and more localized. In adolescents, injuries occurred in more body parts with a more even proportion, such as the knee (22%), ankle (24%), wrist (13%), shoulder (6%), elbow (6%), and calf (12%). This pattern reflects the increasing intensity, complexity of movements, and physical demands in adolescents, which causes the risk of injury not only to be concentrated in one joint, but also to involve various body segments.

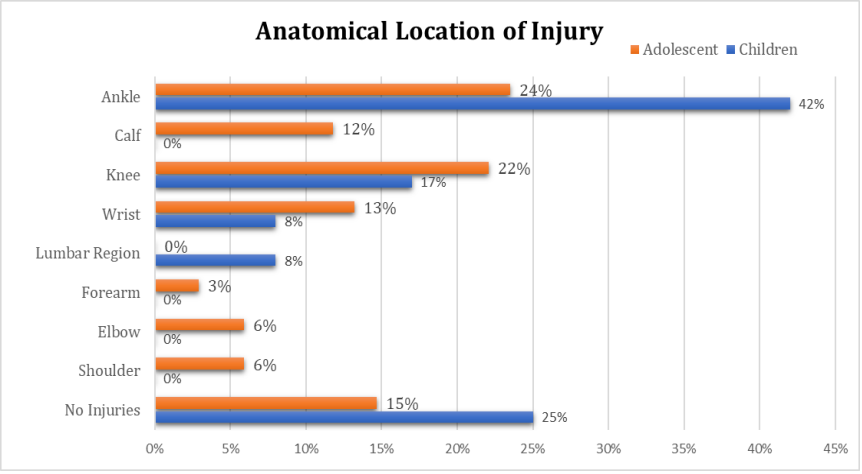

Fig. 3. Graph of anatomical site

Table 3. Statistical analysis of growth plate

Growth Plate	Frequency	Percentage
No injuries	13	16.3%
Growth plate	56	70.0%
Not a growth plate	11	13.8%
N	**80**	**100.0%**

Source: Present research

Table 3 shows that 70% of respondents experienced injuries affecting the growth plate, specifically the shoulder, elbow, wrist, knee, calf, and ankle. Meanwhile, 13.8% experienced injuries that did not involve the growth plate, and 16.3% of respondents experienced no injuries at all. The high number of

respondents in the growth plate category indicates that the growth plate area is highly susceptible to excessive stress in active basketball players because their bone structure is not yet fully mature.

Table 4. Statistical analysis of growth plate symptoms

Growth Plate Symptoms	Frequency	Percentage
Pain in the joints	23	41.1%
Deformities (lumps, shifts, cracks)	10	17.9%
Swelling in the joints	23	41.1%
N	**56**	**100.0%**

Source: Present research

Table 4 shows that of the 56 respondents who experienced growth plate injuries, 23 players (41.1%) reported joint pain and 23 players (41.1%) reported swelling at the ends of the bones. The high prevalence of these two symptoms indicates that inflammation and pain are the primary indications of growth plate injuries due to basketball activities. Meanwhile, 10 players (17.9%) reported deformities such as lumps, cracks, and bone displacement. These findings demonstrate that early detection through complaints of pain and signs of swelling is important to prevent more severe complications in the bone growth process.

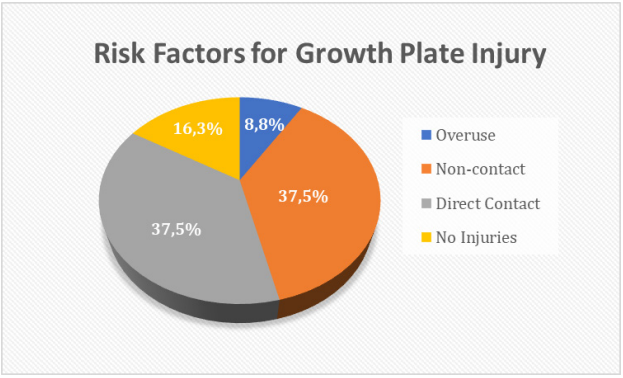

Fig. 4. Graph of risk factors for growth plate injury

Figure 4 shows that the most common risk factors for growth plate injuries are direct contact and non-contact injuries, each accounting for 37.5%.

Overuse injuries accounted for 8.8%, while 16.3% of respondents experienced no injuries. These results indicate that, in addition to physical collisions between players, sudden movements such as sprinting, sudden stops, or changes in direction are the primary causes of growth plate injuries.

DISCUSSION

The study results show that growth plate injuries are a fairly common problem among children and adolescent basketball players in Malang City. The injury rate reached 83.8% of those with a history of injury, with 70% experiencing injuries affecting the growth plate. This figure illustrates the high potential risk of skeletal injury in the 8-17 age group, a phase where bone growth is actively underway and the growth plate structure is still fragile, making it more susceptible to impact forces (Hern & Fern, 2024). The average age of respondents was 12.55 years, indicating that most players were in the peak height velocity (PHV) phase, which is a period of accelerated growth that causes an increase in height in a short time (Achmad et al., 2022).

During the growth phase, bones are relatively weaker (2-5 times) compared to tendons and ligaments, so that the growth plate becomes more susceptible to injury due to the increase in bone length which is not balanced by adaptation of the strength of the muscles and surrounding tissue (Sananta et al., 2022). Improper biomechanics, such as incorrect running, jumping, and sudden movements in basketball can put excessive stress on certain parts of the body and increase the likelihood of recurrent injuries (Forelli et al., 2024). This is reinforced by findings from the literature (Aksović et al., 2024) which is in accordance with the results of this study that the highest injury locations are at the ankle (26.3%) and knee (21.3%) which are the main centers of support in basketball movements. Injuries that occur in the knee are related to conditions such as Osgood-Schaltter which occurs due to repeated pulling of the patellar tendon on the tibial tuberosity, which is one of the active growth plate areas (Corbi et al., 2022). Ankle injuries can involve the distal epiphysis of the tibia and fibula due to rotational movements, sudden changes in direction, or landing errors. The high frequency of injuries at these two locations suggests that the loads experienced by basketball players tend to exceed the adaptive capacity of the developing bone. Growth plate injuries of these lower extremities require high vigilance and close monitoring during skeletal growth (Sabharwal & Sabharwal, 2018). Early recognition and appropriate treatment of these injuries can minimize long-term morbidity.

The respondents' training duration also reflects the high prevalence of growth plate injuries. The majority (28.7%) had a training duration of 1-1.9 years, indicating that many of them are still in the early stages of movement adaptation. Less experienced basketball players often exhibit poor motor control skills and unstable landing techniques, increasing the likelihood of growth plate injuries during intense movements (Costa e Silva et al., 2024). The high prevalence of growth plate injuries in this study indicates that children and adolescent basketball players in Malang City are at significant risk of injury due to the biological development and physical demands of their sport. This finding aligns with the literature (Emery & Pasanen, 2019) that high-intensity exercise at puberty requires close supervision to prevent serious injuries that can interfere with long-term bone growth.

Growth plate injuries in basketball players are influenced by a complex combination of risk factors, including direct contact, non-contact, and overuse (Mendhe & Borkar, 2021). The results of this study indicate that direct contact and non-contact injuries accounted for an equal percentage (37.5%), while overuse accounted for 8.8% of the total injuries. Direct contact in basketball, such as collisions during a ball grab or collisions between players, can cause sudden compression forces on bones containing active growth plates. Impacts often result in epiphyseal injuries due to shear and compression forces caused by repeated rotations or direct hits, which disrupt the growth plate. Although their frequency cannot be completely avoided in basketball, injuries due to direct contact often occur without the body's readiness or lack of ability to anticipate the impact.

Non-contact injuries were also one of the biggest risk factors identified in this study. Non-contact injuries occur when basketball players make sudden changes in direction, stop abruptly, pivot, or land after a jump (Zhang et al., 2025). These movements place significant stress on the lower extremities, particularly the knees and ankles. Because the growth plates are still open in childhood and adolescence, the high extrinsic loads from these activities can cause irritation, displacement, or damage to the growth plates. Muscle fatigue also impairs the body's ability to control movement, increasing the risk of non-contact injuries (Schwiete et al., 2025). This is supported by research data, where specific movements are the most dominant mechanism (36.3%). Epidemiological surveys show that knee injuries account for 14-33% of all injuries, with specific movements such as lay-ups, pivots, and step-backs being high-load movements on the heel and knee (Zhu et al., 2025). The characteristics of basketball require basketball players to complete many jumps, sudden stops, and runs which are potential for injury because they involve demands on strength and coordination of the knees and ankles which increase the risk of injury.

Overuse also contributes to the risk of growth plate injury. Repeated high-intensity exercise without sufficient recovery time can cause microtrauma to growing bones (Borkowski et al., 2025). The results of this study indicate that 8.8% of respondents experienced overuse injuries. The variety of movements in basketball can increase repetitive stress on the growth plates, increasing the risk of injury. Immature bone structures make them more susceptible to damage, emphasizing the importance of managing exercise, strengthening supporting muscles, and monitoring growth to prevent injuries that can disrupt growth plate development (Myers et al., 2017). High training frequency, early specialization in one sport, and relatively similar movement patterns such as repeated jumps and landings in basketball, can cause repetitive stress on the distal epiphyseal area of the tibia and fibula. In a study (Jayanthi et al., 2020) it was stated that over time, especially young basketball players, are more likely to experience overuse injuries if they have a higher level of sport specialization.

In young basketball players, as bone stiffness increases, resistance to impact decreases, and sudden overload can cause the bones to bend or bend. Swelling, hyperemia, and deformity in the physical area are symptoms of injury characterized by tenderness, because blood vessels in the area widen or experience vasodilation, causing fluid, protein, and cells to leak into the surrounding tissue. This is consistent with the results of the study, which showed that 41.1% of respondents experienced swelling at the ends of bones and 41.1% experienced pain in the joints. Due to the various injury risks experienced by basketball players, it is important that training programs take into account physical and psychological maturity, so that growing children and adolescents can adjust to their own body changes.

CONCLUSIONS

Based on the results of research that has been conducted, regarding the prevalence and factors related to growth plate injuries in children and adolescent basketball players in Malang City, it can be concluded that growth plate injuries are a fairly high problem experienced by basketball players with a prevalence of injuries reaching 83.8% and as many as 70% of which involve the growth plate area. The most common locations of injury are the ankles and knees, which are the main support areas in basketball. The most dominant risk factors come from direct contact and non-contact at 37.5%, indicating that suboptimal movement techniques and high training loads have a significant influence on the growth plate. This high number, a condition that requires special attention because it can impact the process of bone growth and the development of player performance in the future.

AUTHOR CONTRIBUTIONS

Author 1 and author 2 contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest in this research.

ACKNOWLEDGEMENTS

The authors declare no competing interests.

ETHICAL CLEARANCE

State University of Malang (UM), Research and Community Service, Institute Research Ethics Committee No.08.01.02/UN32.14.2.8/LT/2026

REFERENCES

Aksović, N., Bubanj, S., Bjelica, B., Kocić, M., Lilić, L., Zelenović, M., ... & Sufaru, C. (2024). Sports injuries in basketball players: a systematic review. *Life*, *14*(7), 898. 10.3390/life14070898

Annas, S. A. I. (2022). The Relationship Between Physical Activity And Peak Height Velocity In Children Aged 9–11 Years. *ACPES Journal of Physical Education, Sport, and Health (AJPESH)*, *2*(1), 58-62. 10.15294/ajpesh.v2i1.57681

Apers, E., Rombauts, M., & Bogaerts, S. (2021). Long-term outcome of conservatively treated lower limb apophyseal injuries in children and adolescents: A systematic review. *Translational Sports Medicine*, *4*(5), 565-586. 10.1002/tsm2.252

Bastos, F. D. N., Carvalho, L., Júnior, J. N., Vanderlei, F. M., Vanderlei, L. C., & Pastre, C. M. (2014). Sports Injuries among young basketball players: A retrospective study. *J Clin Trials*, *4*(3), 1000173. 10.4172/2167-0870.1000173

Borkowski, R., Krzepota, J., Wróbel, M., Madej, D., & Błażkiewicz, M. (2025). The impact of overtraining on injury rates in School-Age Athletes—A scoping review. *Journal of Clinical Medicine*, *14*(13), 4712. 10.3390/jcm14134712

Brenner, J. S. (2016). Sports specialization and intensive training in young athletes. *Pediatrics*, *138*(3). 10.1542/peds.2016-2148

Corbi Soler, F., Matas Garcia, S., Álvarez-Herms, J., Sitko, S., Baiget, E., Reverter Masià, J., & López Laval, I. (2022). Osgood-Schlatter Disease: Appearance, Diagnosis and Treatment: A Narrative Review. 10.3390/healthcare10061011

Costa e Silva, L., Silva, A. L., Teles, J., & Fragoso, I. (2024). Study on the influence of physical activity intensity and maturation on sports injuries in children and adolescents. *Applied Sciences*, *14*(22), 10632. 10.3390/app142210632

Dover, C., & Kiely, N. (2015). Growth plate injuries and management. *Orthopaedics and Trauma*, *29*(4), 261-267. 10.1016/j.mporth.2015.04.002

Emery, C. A., & Pasanen, K. (2019). Current trends in sport injury prevention. *Best Practice & Research Clinical Rheumatology*, *33*(1), 3-15. 10.1016/j.berh.2019.02.009

Forelli, F., Moiroux-Sahraoui, A., Nielsen-Le Roux, M., Miraglia, N., Gaspar, M., Stergiou, M., ... & DOURYANG Sr, M. (2024). Stay in the game: comprehensive approaches to decrease the risk of sports injuries. *Cureus*, *16*(12). 10.7759/cureus.76461

Hernández-García, F., Fernández-Iglesias, Á., Rodríguez Suárez, J., Gil Peña, H., López, J. M., & Pérez, R. F. (2024). The crosstalk between cartilage and bone in skeletal growth. *Biomedicines*, *12*(12), 2662. 10.3390/biomedisin12122662

Jayanthi, N., Kleithermes, S., Dugas, L., Pasulka, J., Iqbal, S., & LaBella, C. (2020). Risk of injuries associated with sport specialization and intense training patterns in young athletes: a longitudinal clinical case-control study. *Orthopaedic journal of sports medicine*, *8*(6), 2325967120922764. 10.1177/2325967120922764

Jayanthi, N., Schley, S., Cumming, S. P., Myer, G. D., Saffel, H., Hartwig, T., & Gabbett, T. J. (2022). Developmental training model for the sport specialized youth athlete: a dynamic strategy for individualizing load-response during maturation. *Sports health*, *14*(1), 142-153. 10.1177/19417381211056088

Kilic, Ö., Van Os, V., Kemler, E., Barendrecht, M., & Gouttebarge, V. (2018). The 'Sequence of Prevention' for musculoskeletal injuries among recreational basketballers: a systematic review of the scientific literature. *The Physician and sportsmedicine*, *46*(2), 197-212. 10.1080/00913847.2018.1424496

Mendhe, S., & Borkar, P. (2021). Epidemiology of musculoskeletal injuries in basketball players: Systematic review. *Int. J. Phys. Educ. Sport Health*, *8*, 111-116. 10.26603/001c.132168

Monaco, G., El Haj, A. J., Alini, M., & Stoddart, M. J. (2021). Ex vivo systems to study chondrogenic differentiation and cartilage integration. *Journal of functional morphology and kinesiology*, *6*(1), 6. 10.3390/jfmk6010006

Myers, A. M., Beam, N. W., & Fakhoury, J. D. (2017). Resistance training for children and adolescents. *Translational pediatrics*, *6*(3), 137. 10.21037/tp.2017.04.01

Naaktgeboren, K., Dorgo, S., & Boyle, J. B. (2017). Growth Plate Injuries in Children in Sports: A Review of Sever's Disease. *Strength & Conditioning Journal*, *39*(2), 59-68. 10.1519/SSC.0000000000000295

Sabharwal, S., & Sabharwal, S. (2018). Growth plate injuries of the lower extremity: Case examples and lessons learned. *Indian journal of orthopaedics*, *52*(5), 462-469. 10.4103/ortho.IJOrtho_313_17

Sananta, P., Lesmana, A., & Alwy Sugiarto, M. (2022). Growth plate injury in children: Review of literature on PubMed. *Journal of Public Health Research*, *11*(3), 22799036221104155. 10.1177/22799036221104155

Sananta, P., Oka, R. I. G. M., Dradjat, R. S., Suroto, H., Mustamsir, E., Kalsum, U., & Andarini, S. (2020). Adipose-derived stromal vascular fraction prevent bone bridge formation on growth plate injury in rat (in vivo studies) an experimental research. *Annals of Medicine and Surgery*, *60*, 211-217. 10.1016/j.amsu.2020.09.026

Schwiete, C., Roth, C., Mester, J., Broich, H., & Behringer, M. (2025). Overlaps of skeletal muscle fatigue and skeletal muscle damage: the muscle injury continuum. *Sports Medicine-Open*, *11*(1), 73. 10.1186/s40798-025-00876-z

Sheffer, B. W., Villarreal, E. D., Ochsner III, M. G., Sawyer, J. R., Spence, D. D., & Kelly, D. M. (2020). Concurrent ipsilateral tibial shaft and distal tibial fractures in pediatric patients: risk factors, frequency, and risk of missed diagnosis. *Journal of Pediatric Orthopaedics*, *40*(1), e1-e5. 10.1097/BPO.0000000000001384

Smith, P. J., & Merwin, R. M. (2021). The role of exercise in management of mental health disorders: an integrative review. *Annual review of medicine*, *72*(1), 45-62. 10.1146/annurev-med-060619-022943

Šiupšinskas, L., Garbenytė-Apolinskienė, T., Salatkaitė, S., Gudas, R., & Trumpickas, V. (2019). Association of pre-season musculoskeletal screening and functional testing with sports injuries in elite female basketball players. *Scientific reports*, *9*(1), 9286. 10.1038/s41598-019-45773-0

Wang, X., & Cheng, Z. (2020). Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest*, *158*(1), S65-S71. 10.1016/j.chest.2020.03.012

Wik, E. H., Martínez-Silván, D., Farooq, A., Cardinale, M., Johnson, A., & Bahr, R. (2020). Skeletal maturation and growth rates are related to bone and growth plate injuries in adolescent athletics. *Scandinavian journal of medicine & science in sports*, *30*(5), 894-903. 10.1111/sms.13635

Zhang, Z., Zheng, B., Zhang, Z., Kang, J., Li, M., & Sun, Y. (2025). Impact of mental fatigue on lower limb biomechanics and non-contact anterior cruciate ligament injury risk in basketball players during the stop–jump task: a self-controlled trial. *Journal of Orthopaedic Surgery and Research*, *20*(1), 671. 10.1186/s13018-025-05905-x

Zhu, A., Gao, S., Cen, X., Li, W., Song, Y., Gao, Z., & Sun, D. (2025). The effects of brace stiffness on knee joints during pull-up jump shot movements in amateur female basketball players. Applied Sciences, 15(3), 1448. 10.3390/app15031448